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[54] AUTOMATIC FLUE DAMPER

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Related U.S. Patent Documents

Reissue of:

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Appl. No.: **781,649**
Filed: **Mar. 28, 1977**

[51] **Int. Cl.**[3] **F23L 11/00**

[52] **U.S. Cl.** ..... **236/1 G;** 126/285 B

[58] **Field of Search** ..... 236/1 G, 74; 431/20; 110/163; 126/285 B

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Primary Examiner—William E. Wayner
Attorney, Agent, or Firm—Dybvig & Dybvig

[57] **ABSTRACT**

In the present invention, an automatic flue damper located in the vent stack of a household furnace or other apparatus requiring venting is interfaced with a thermostatic control and a fuel supply valve associated with the apparatus so as to maintain a vent passage to the atmosphere normally open during times when combustion is occurring in the apparatus and to close the vent passage at an appropriate time following the termination of combustion in the apparatus. The normally open vent condition is maintained by a damper positioning spring. Vent closure following combustion is accomplished by means of a direct current solenoid. Further included in the interfacing circuitry are a temperature sensing device effective to disable the solenoid, thus opening the vent, upon the appearance of unsafe stack temperatures and a pressure sensor which also disables the solenoid to open the vent stack upon the occurrence of an inappropriate discharge of fuel to the combustion chamber. The pressure sensor then also sounds an alarm to alert those nearby of the unauthorized escape of fuel.

20 Claims, 7 Drawing Figures

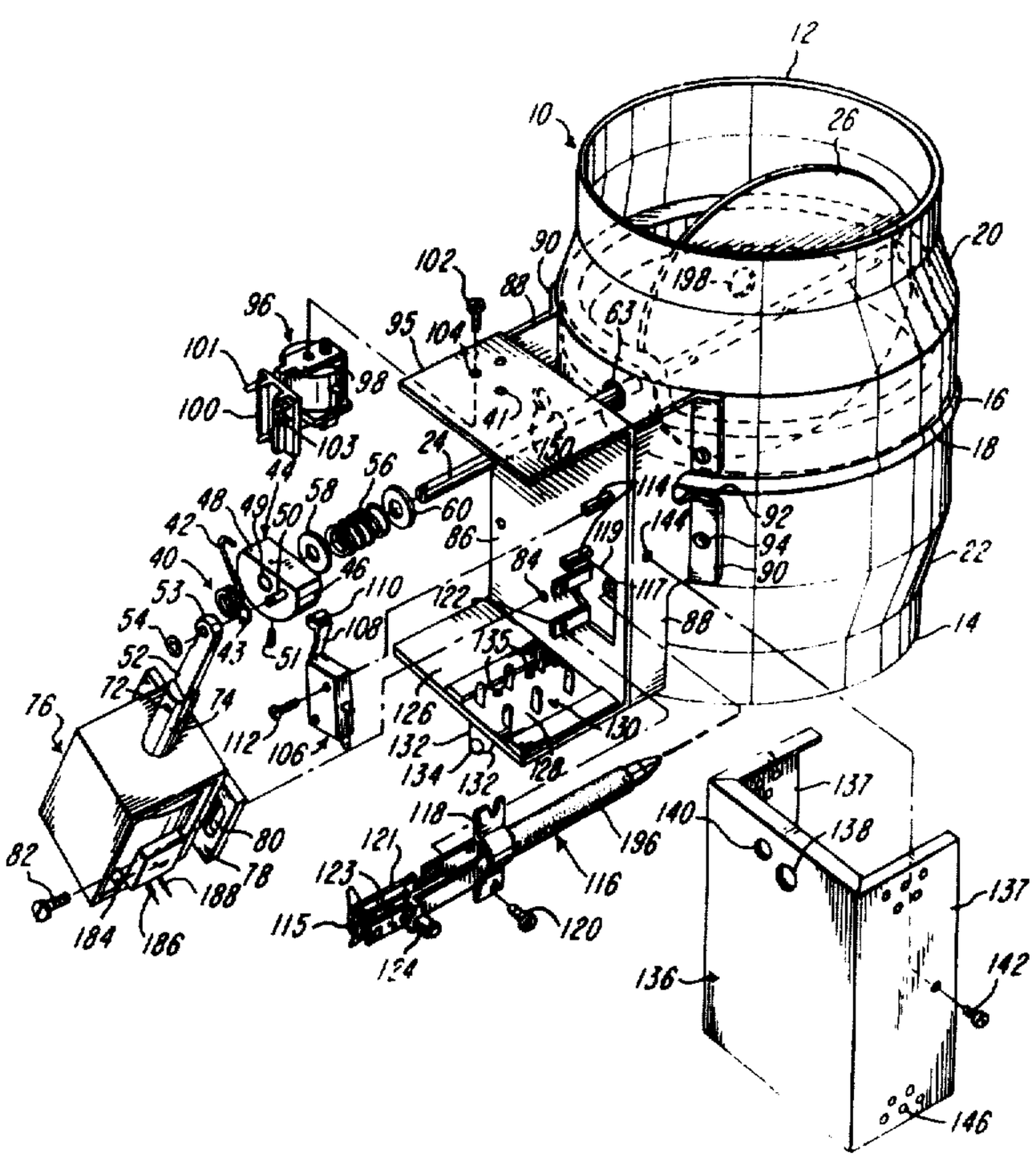


FIG-1

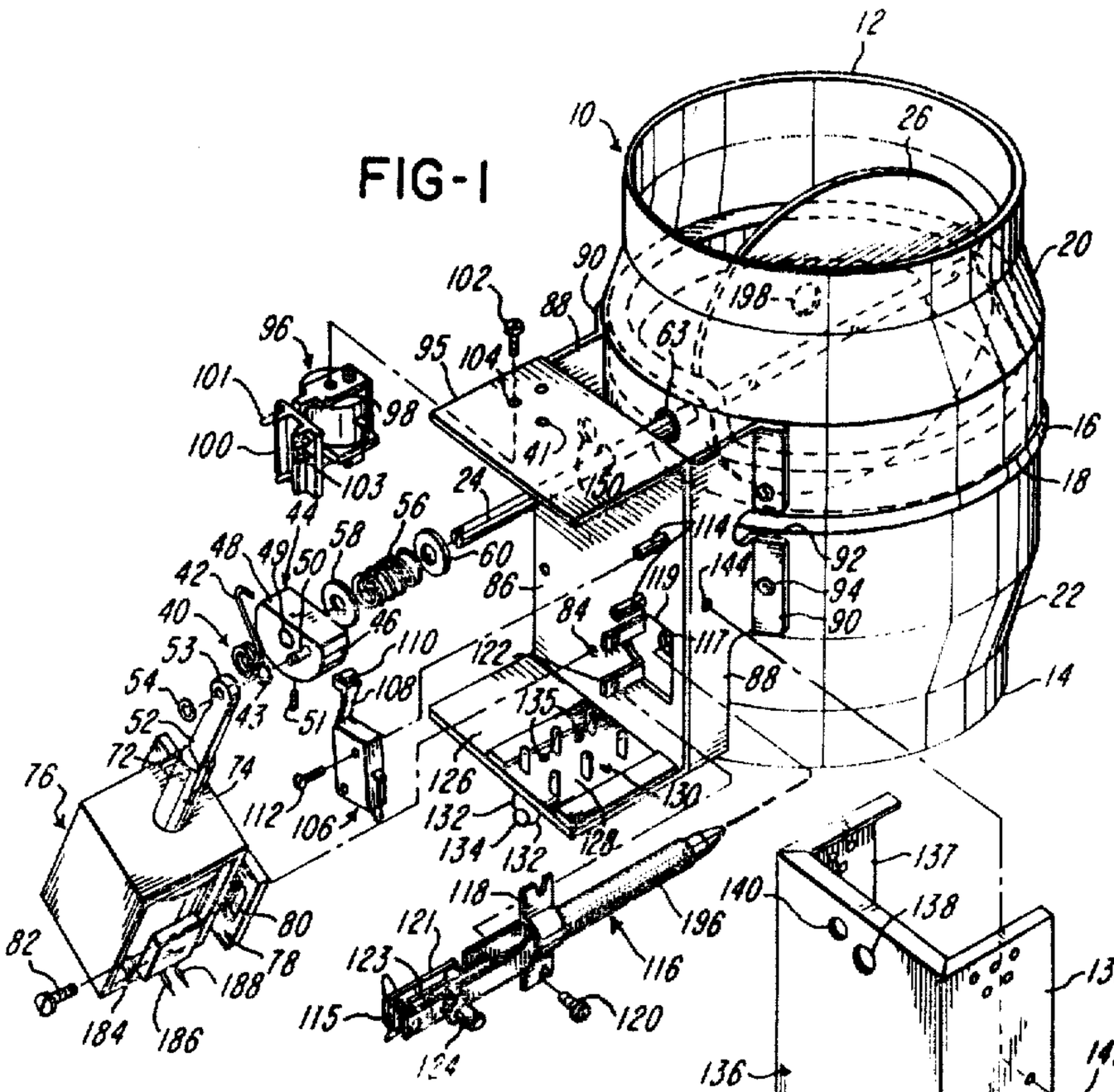


FIG-5

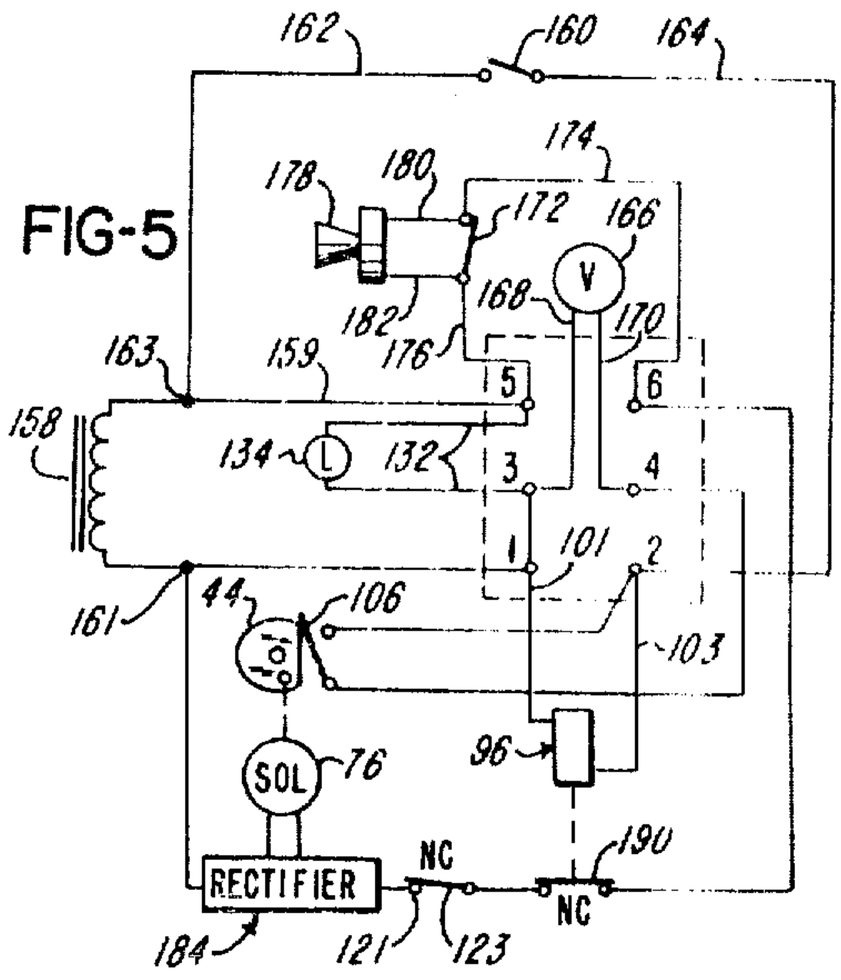
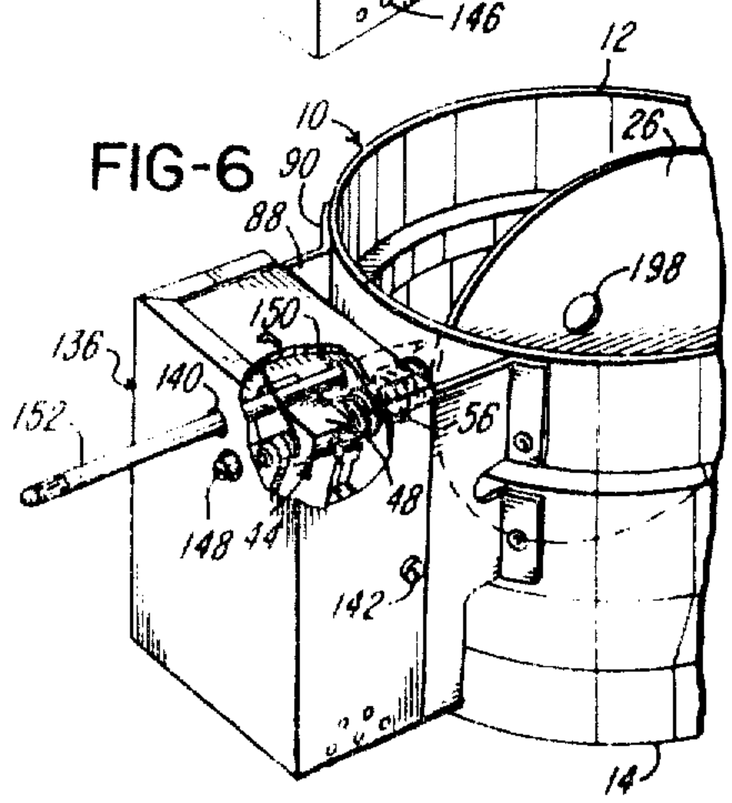


FIG-6



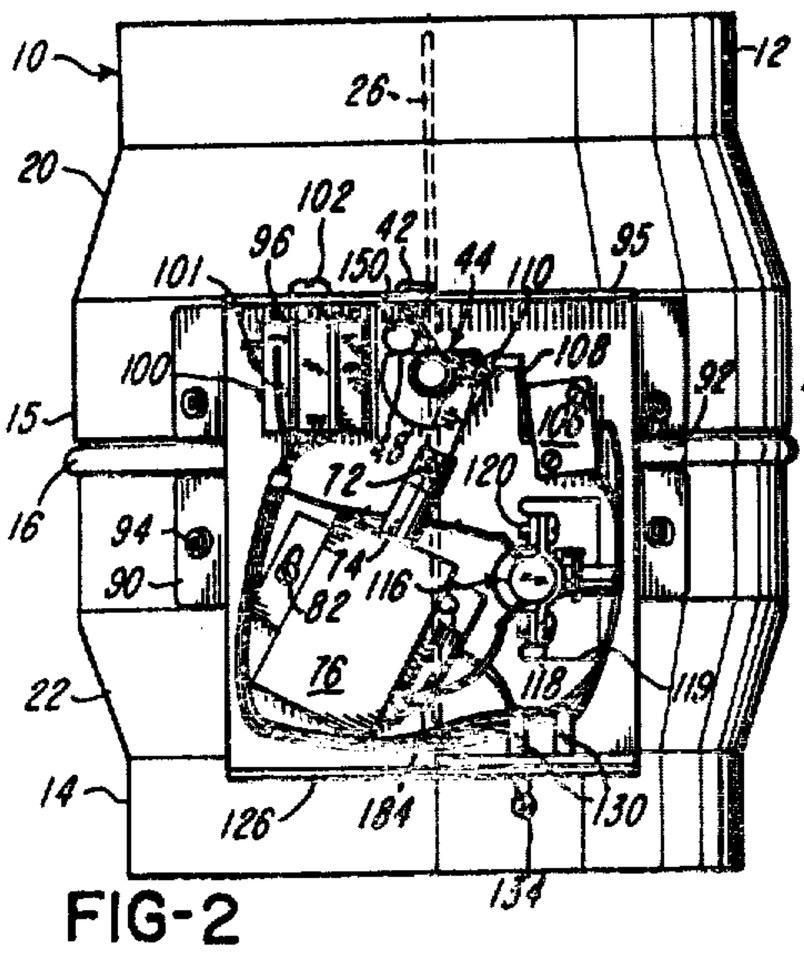


FIG-2

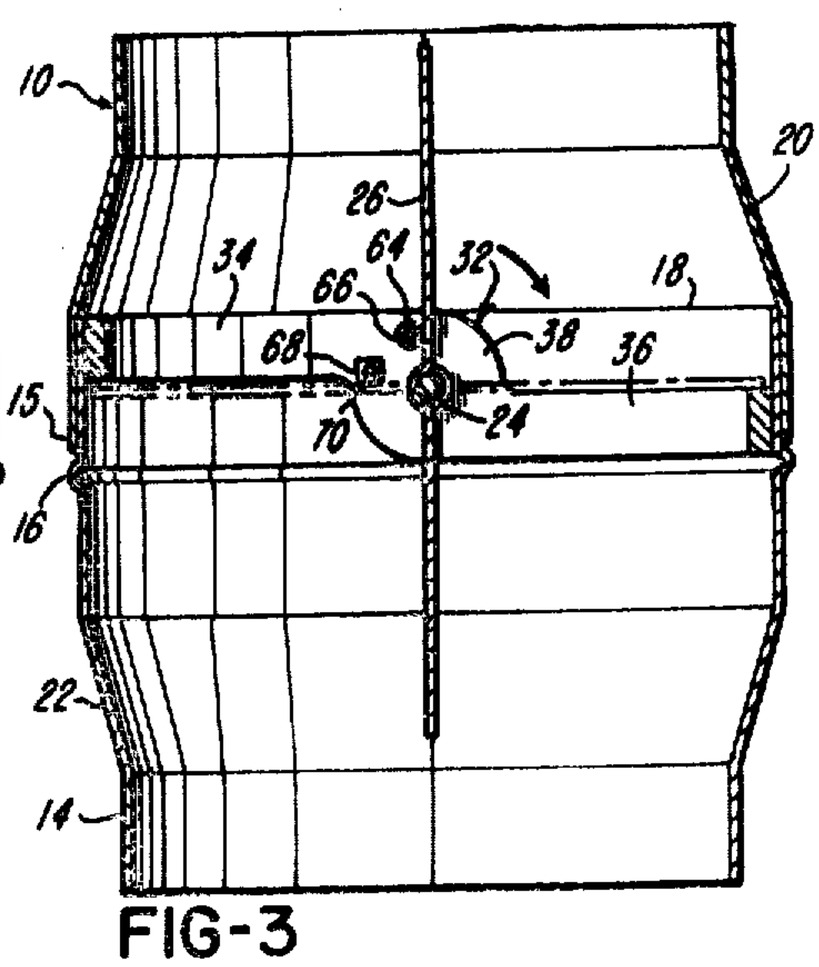


FIG-3

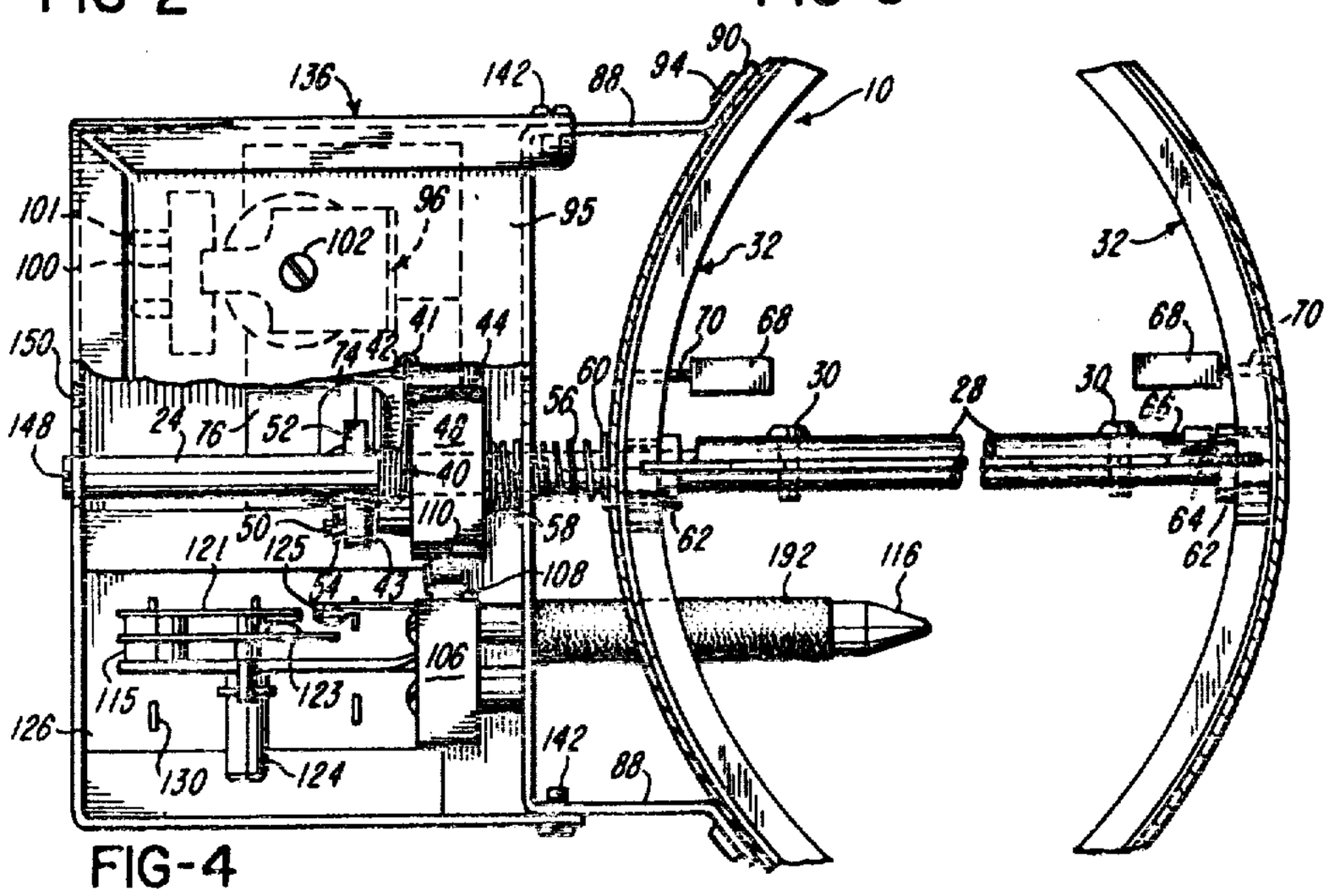


FIG-4

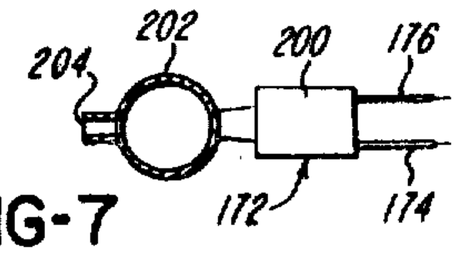


FIG-7

AUTOMATIC FLUE DAMPER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to automatic flue dampers for use in household and industrial applications and more particularly to a flue damper for association with a combustion apparatus, which damper is biased open during combustion periods and is equipped with electrical circuitry for substantially closing the damper following combustion periods so as to confine the heated atmosphere resulting from combustion.

2. Prior Art

Various flue dampers are known in the prior art. An example appears in U.S. Pat. No. 3,580,238, which discloses an automatic damper arrangement normally spring-biased to a closed position and solenoid-operated to an open position. For many applications, such a damper arrangement presents hazards which may result, for example, from a defective gas valve which permits gas to escape into the combustion chamber at a time when the furnace vent stack remains normally closed, thus flooding the household or other building with dangerous fumes.

U.S. Pat. No. 3,934,796 is of more recent vintage but continues the disadvantage of the preceding patent by employing a damper which is normally biased closed. U.S. Pat. No. 2,937,697 illustrates a prior art damper mechanism which closes combustion chamber outlets after combustion is shut off.

It should be noted that the practice in many parts of the United States has been to construct furnaces and the like without dampers, thus eliminating any need for a damper control mechanism at the expense of substantial losses of heated air through the open vent stack following periods of combustion.

An object of the present invention is to provide an improved automatic damper of the type normally closing a vent stack during times when combustion does not occur and equipped with safety features appropriate for a vent stack which is normally maintained closed.

SUMMARY OF THE INVENTION

In the present invention, the loss of desirably retained heated gases through an open vent stack has been minimized following combustion while providing a normally open vent stack during combustion periods. To accomplish this desirable mode of operation, electrically powered motive means, such as a solenoid, is used to normally close a damper located in the vent stack during periods when combustion is not occurring. Control circuitry associated with the present invention disables such motive means immediately prior to the occurrence of combustion and returns power to the motive means only after an appropriate time has elapsed following the completion of a combustion period which brings the atmosphere being heated to the desired temperature. Since the stack is closed at generally all times except during and a short time following combustion, possible hazards resulting from an unwarranted leakage of fuel in the atmosphere sought to be controlled or from an unwarranted continuance of combustion after a

thermostat has endeavored to terminate combustion are controlled in the present invention by means of specialized safety features more fully discussed in the detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view illustrating a damper mechanism in accordance with the present invention.

FIG. **2** is an elevation view of the damper mechanism with a portion broken away to schematically illustrate the wiring and other features of the invention.

FIG. **3** is a vertical section view of the damper mechanism.

FIG. **4** is a top plan view of the damper mechanism with portions broken away to simplify the illustration.

FIG. **5** is a schematic illustration of electrical circuitry appropriate to interface the damper mechanism with conventional thermostatic control circuitry.

FIG. **6** is a fragmentary perspective view with a portion broken away to illustrate the manner in which a protective measure can be taken with the damper mechanism of the present invention.

FIG. **7** is a schematic illustration showing a gas manifold having an associated pressure responsive switch mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the preferred embodiment comprises a damper housing **10** which is adapted to be interposed or otherwise placed in the vent stack (not shown) which emerges upwardly from the combustion chamber of a heating or cooling appliance. The appliance (not shown), may for example, be a gas-fired household furnace of the type having a vent stack projecting upwardly through the roof of the house. Those skilled in the art will understand, however, that the present invention is also applicable to oil-fired appliances and may be applied to numerous industrial as well as home applications.

The damper housing **10** is constructed in two separable parts, an upper part **12** and a lower part **14**. The lower part **14** terminates with an upper edge **18** telescopically received in the lower edge **15** of the upper part **12**. As shown in FIG. **3**, the lower part **14** has an expanded bead **16** which abuts the lower edge **15** of the upper part **12**.

The upper part **12** has a conical enlargement **20**, and the lower part **14** likewise has a conical enlargement **22**, the enlargements **20** and **22** providing the housing **10** with an intermediately located diameter which allows a damper **26** to be mounted within the housing **10** for rotation by means of a transverse shaft **24**. The enlargements **20** and **22** allow damper installation without diminishment in the size of the passage through which gases to be vented upwardly through the housing **10** will pass.

The damper **26** is preferably a one-piece metal sheet have a circular outer periphery and having a centrally disposed, diametric groove **28** shaped to cradle the shaft **24**. Rivets **30** best appearing in FIG. **4** affix the damper **26** to the shaft **24** so that the damper and the shaft will move in unison.

Disposed within the upper part **12** is an annular ring **32** having an upper half **34** and a lower half **36** joined by diametrically disposed hubs **38**. The upper and lower

halves **34** and **36** are axially offset so that the damper plate **26**, when rotated from the vertical position illustrated in FIG. **3** in the clockwise direction appearing in FIG. **3**, can be advanced to a generally horizontal position closely approaching but not abutting the upper and lower halves **34** and **36** of the ring **32**.

The shaft **24** is normally biased by a torsion spring **40** to place the damper **26** in the vertical position illustrated in FIG. **3**. As appears in FIG. **1**, the torsion springs **40** surrounds an end portion of the shaft **24** which projects outwardly from the housing **10**. The torsion spring **40** has an outwardly extending arm **42** which is hooked into an aperture **41** located in the upper wall of a cover means later to be described. The spring **40** also has an integrally formed hook portion **43**, whose function will be described shortly.

Affixed nonrotatably to the shaft **24** adjacent the spring **40** is a cam **44** having a circular periphery **46** interrupted as to circularity by a chordally extending flat **48**. The cam **44** has an aperture **49** sized to receive the shaft **24** and has a key member **51** radially entering through its circular periphery **46** to nonrotatably key the cam **44** to the shaft **24**.

Projecting outwardly from one side face of the cam **44**, as shown in FIG. **1**, is a pin **50** press-fitted into the body of the cam **44**. The pin **50** passes through the spring hook **43** and then passes through an aperture **53** located in a link **52**. The pin **50** is engaged at its outer end by a clamp ring **54**.

For reasons to be described, a drag is placed upon the rotation of the shaft **24** by means of a compression spring **56** which encircles the shaft **24** and acts between washers **58** and **60**, the washer **58** bearing against the side of the cam **44** which is opposite the pin **50**, and the washer **60** bearing against the outside wall of the housing part **12**.

In the assembled device, the clearance between the housing part **12** and the cam **44** is small in relation to length of the compression spring **56** and this condition establishes a frictional drag upon rotation of the shaft **24** by pressing the washers **58** and **60** respectively against the cam **44** and the housing part **12**.

The shaft **24** is otherwise supported for free rotation by means of bushings **62** disposed centrally in the hubs **38** located on diametrically opposite sides of the ring **32**. As appears in FIG. **1**, the upper part **12** of the housing **10** has an aperture **63** through which the shaft **24** passes outwardly of the housing **10**.

Rotation of the shaft **24** and its affixed damper plate **26** is restricted as follows. Referring to the open or vertically disposed position illustrated in FIG. **3**, the damper plate **26** is biased to rotate in the counterclockwise direction by means of the torsion spring **40** but is stopped upon reaching the illustrated vertical position by means of a resilient tube **64** surrounding a pin **66** pressed into a suitable aperture located in the ring **32**.

Solenoid mechanism to be described is energizable to cause a rotation of the damper plate **26** in the clockwise direction as it appears in FIG. **3**, whereupon the damper plate is caused to seat against a pair of bumpers **68**, each surrounding a pin **70**, there being two such pins located to opposite sides of the ring **32** as appears in FIG. **4**. Two bumpers **68** are preferred in this construction for absorbing the greater momentum of the damper plate **26** imparted by the solenoid. The compression spring **56** cooperates with the washers **58** and **60** to reduce bouncing of the damper plate against the bumpers **68**. A single resilient tube **64**, acting in cooperation with the drag mechanism, is found sufficient to absorb the relatively smaller momentum imparted to the damper plate **26** when returned by the spring **40** to the vertical position illustrated in FIG. **3**.

The solenoid, which is employed to move the damper from the vertical position illustrated in FIG. **3** to its horizontal position resting upon the bumpers **68**, is identified by the reference number **76** in FIG. **1**. This solenoid has an axially movable armature **74** pivotally connected to the aforementioned link **52** by means of a pin **72** passing diametrically across a bifurcated end portion of the armature **74**. Because the link **52** is pivotally joined to the pin **50** located on the cam **44**, energization of the solenoid **76** will draw the armature **74** downwardly as appears in FIG. **1**, thus rotating the shaft **24** in the clockwise direction as it appears in FIG. **1**. The spring **40** yieldably resists such motion and acts upon solenoid deenergization to return the cam **44** as well as the shaft **24** to approximately their original positions illustrated in FIG. **1**.

The solenoid **76** is provided with oppositely projecting wing portions **78**, each having a slot **80** for the receipt of a threaded fastener **82** which enters an aperture **84** located in a cover plate **86** to mount the solenoid **76** to the cover plate **86**.

Cover plate **86** can be seen in FIG. **1** to have side portions **88** bent downwardly from the cover plate **86** for supporting the cover plate away from the housing **10**. The side portions **88** each have outwardly projecting wings **90** matching the wall contours of the upper and lower housing parts and separated by a notch **92** sized to receive the housing bead **16**. The wings **90** are attached to the upper and lower housing parts by an appropriate number of rivets **94**.

The cover plate **86** can also be seen to have outwardly bent walls **95** and **126** which cooperate to receive therebetween the aforementioned solenoid **76**.

The wall **95** is provided with an aperture **104** adapted to receive a threaded screw **102** which threadedly engages the ferromagnetic frame **98** of an electromagnetic relay **96** having appropriate terminals, later to be described, mounted on a terminal support **100**. The wall **95** also has located thereon the aforementioned aperture **41** for receiving the spring arm **42**.

Mounted to the cover plate **86** by a fastener **112** is a switch **106** having an outwardly projecting operator arm **108** terminating with a cam follower **110**, the follower **110** biased to follow the periphery of the aforementioned cam **44**. The switch **106** is spaced an appropriate distance from the cover plate **86** by means of a spacer sleeve **114** bearing against the cover plate **86** and surrounding fastener **112**.

Also mounted to the cover plate **86** is a commercially available heat sensor **116** equipped with wings **118** secured by threaded fasteners such as shown at **120** to suitable support posts **122** struck from the cover plate **86**.

The sensor **116** passes into the interior of the housing **10** through an aperture **117** formed in the lower part **14** of that housing. The cover plate **86** is also provided with a window **119** aligned with the aperture **117** to accommodate the sensor **116**.

As best seen in FIG. **4**, the sensor **116** includes switch elements **121** and **123** mounted to insulating means **115**. The switch element **123** has an aperture (not shown) through which passes an adjuster **124**, the adjuster **124** being adjustable to regulate the position of the switch element **121**, such adjustment being followed by the

switch element **123**. The sensor **116** further includes an operator **125** having a position which changes with temperature. When the operator **125** bears against the switch element **123** with a pressure sufficient to separate the switch elements **121** and **123**, the sensor **116**, which comprises a normally closed switch, becomes an open switch.

The aforementioned wall **126** has mounted on that face thereof which confronts the wall **95** a dielectric plate **128** supporting a plurality of electrically conductive terminal members designated generally by the reference number **130**. As best appears in FIG. **1**, the terminal members **130** are six in number and for convenience have been numbered **1**, **2**, **3**, **4**, **5** and **6** with appropriate legends applied in FIG. **5**.

A lamp **134** disposed under the wall **126** has lead wires **132** passing through suitable apertures **135** for soldered engagement to the terminal members **3** and **5**.

The confronting wall members **95** and **126** cooperate to receive thereon a cover shield **136** having one relatively large aperture **138** and another relatively small aperture **140** in one face thereof. The aperture **138** is so located as to receive the previously described shaft **24**. The shaft **24** has a notch **148** in the end face thereof which is exposed by the aperture **138**. The applications for this notch **148** along with the aperture **140** will be described in succeeding remarks.

Referring further to the cover shield **136**, the shield is formed in a general U shape by bending downwardly therefrom side walls **137** which cooperate with the end walls **95** and **126** of the cover plate **128** to form a rectangular box receiving several of the electrical components heretofore described. Cover shield **136** is fixed into position by means of one or more threaded fasteners, such as shown at **142** in FIG. **1**. The side walls **137** are also provided with several ventilation apertures **146** for the purpose of minimizing the buildup of heat about the electrical components assembled into the volume enclosed by the cover plate **86**, its side walls **95** and **126** and the cover shield **136**.

The cover plate **86** has an aperture **150** therein coaxially aligned with the aforementioned aperture **140** located in the cover shield **136**. The alignment of the apertures **140** and **150** and their diametric size are such that a tool, such as a conventional wood pencil **152**, may be passed coaxially through both apertures **140** and **150**, as is shown in FIG. **6**.

Assuming the solenoid **76** not to be energized, the peripheral flat **48** of the cam **44** will be in a generally horizontal position below the inserted pencil **152** when the housing **10** has been assembled in a desired vertical position. The consequence is that the pencil **152** may be used to lock the damper plate **26** in a position opening the housing **10**. This feature is desirable in the event of failure of the spring **40** to give assurance that the vent housing will remain open.

In the preceding portions of this specification, a device adapted to be inserted in the vent stack or flue of a heating or cooling apparatus utilizing fuel combustion has been described. The electrical components included in the device comprise a motive means or solenoid **76**, a relay **96**, a cam-operated switch **106**, a heat sensor **116** and a lamp **134**. Associated with the solenoid **76** and not heretofore described is a rectifier **184** having terminals **186** and **188**, which is built into the solenoid package as shown in FIG. **1**.

For the purpose of describing an application for the disclosed invention, one can assume an existing house (not shown) which is already equipped with a gas furnace, a thermostat, a gas valve and a transformer stepping down the normal 115 volts available in the household to a lower level, such as 24 volts AC. It can further be assumed that the thermostat is a thermally responsive switch **160** and is connected in series with the transformer secondary **158** and possibly other components. The installer cuts the thermostat connections and by suitable extension wires **162** and **164** connects the cut thermostat connections respectively to the terminals **1** and **2** of the present device, as is illustrated in FIG. **5**. The installer next locates the gas valve, which has two wires leading thereto, cuts such wires and by suitable extensions **168** and **170** connects the cut wires emanating from the gas valve to the terminals **3** and **4**, as illustrated in FIG. **5**.

The relay coil **96** can be seen in FIG. **5** to have been connected in series with the thermostat switch **160** and the transformer secondary **158** by reason of terminal connections **101** and **103** extending from the relay coil to the terminals **1** and **2**. Depending upon the particular type of relay being employed, the relay may tend to chatter or even fail to operate upon closure of the switch **160** if the gas valve or the transformer secondary have been connected with the wrong polarity.

To test the operativeness of the connections, the previously described lamp **134** has been assembled with the previously described connections to terminals **3** and **5** for use as a single device. Furthermore, the terminal **5** is provided with a wire **159** extending therefrom with its distal end initially unattached. The installer touches this loose end successively to the opposite ends **161** and **163** of the secondary, noting which end of the secondary provides a steady glow of the lamp **134**, and permanently attaches the heretofore loose end of the wire **159** to the end of the secondary which provides the steadiest lamp glow. This provides a power connection to the relay **96** which is of the proper polarity.

It will be noted that the terminals **1** and **3** could have been constructed as a single terminal. However, the two terminals are preferably provided so as to simplify the installation procedure and to provide for the attachment of other circuit elements not necessary to the present invention. Likewise, the terminal **6** might have been omitted but simplifies the wiring of the components.

The illustration of FIG. **5** assumes the proper connection was made to the end **163** of the secondary **158**. Since the installer will not ordinarily know the transformer polarity without a test such as described, however, the permanent connection for the wire **159** is ordinarily not established until a test such as described.

The installer next connects a pressure switch **172** having lead connections **174** and **176** across the circuit board terminals **5** and **6**. As is shown in FIG. **7**, the pressure switch **172** is contained in a housing **200** installed in communication with the gas manifold **202** so as to respond to the pressure of gas which flows in the manifold to enter the combustion chamber through a gas orifice **204**. The function of the pressure switch will be later described.

The installer also places an audible alarm device **178**, which is of conventional, commercially available construction, across the leads **174** and **176** for the pressure switch **172** by means of lead connections **180** and **182** extending to the alarm device.

With the foregoing installations, the structure of the present application is in readiness for operation. One can assume that the thermostat switch **160** is initially

open and, therefore, the thermostat switch is not demanding heat. At such time, the solenoid **76** is energized to close the damper **26** over a safety circuit path which extends from the terminal **163** of the transformer secondary over the test wire **159**, to the terminal **5** and from there over the pressure switch **172** to terminal **6** and from there over the normally closed relay switch **190** and the thermal switch elements **121** and **123**, then the rectifier **184** to the opposite terminal **161** of the secondary **158**. The fact that the solenoid **76** is energized means that the cam **44** has been located by the solenoid at the position illustrated in FIG. **5** to open the switch **106**, but this is of no consequence because the open thermostat switch **160** has already interrupted the power circuit placing secondary **158** across the terminals **1** and **2**. The safety circuit referred to above is so designated because that circuit will interrupt the application of power to the rectifier **184** and the solenoid **76** so as to permit the spring **40** to move the damper **26** to its open position in the housing **10** whenever any of the following occurs: the occurrence of a demand for heat which closes the thermostat switch **160**, thus energizing the relay **96** and opening the relay switch **190**, the presence of an excessive gas temperature in the vent stack, which opens the thermal switch elements **121** and **123**, or the presence of a gas pressure exerted upon the pressure switch **172**.

Upon movement of the thermostat switch to a position which would demand heat, the relay **96** would be energized because the thermostat switch, being now closed, would place the relay **96** across the transformer secondary. The energization of the relay **96** would then open the normally closed relay switch **190**, thus opening the safety circuit and deenergizing the solenoid **76**. This would enable the spring **40** to move the damper plate **26** to the normally open position. As the damper plate **26** approaches the vertical position illustrated in FIG. **3**, the switch **106** is closed by operation of the cam **44** to complete a combustion control circuit. This control circuit places the gas valve **166** in parallel with the relay **96** and in series with the transformer secondary as well as the thermostat switch, the control circuit proceeding from the gas valve **166** to the terminal **3** and from there to the terminal **1**, the transformer secondary, the thermostat switch, the terminal **2**, the switch **106**, the terminal **4** and thence to the other side of the gas valve. Thus, closure of the thermostat switch **160** completed a control circuit which permitted the damper plate **26** to move toward the open position illustrated in FIG. **3** and in so doing to energize the gas valve **166** so as to initiate combustion.

When the house or medium being heated has reached a temperature level sufficient to open the thermostat switch **160**, the series circuit between the transformer secondary and the relay **96** is broken, permitting the relay switch **190** to close. When the switch **190** has closed, the solenoid is energized, thus moving the damper plate **26** to its closed position during which the switch **106** is opened to deenergize the gas valve. Since many combustion devices to which the present invention is suited utilize a pilot light which produces a continuing release of combustion products at a low level, the bumpers **68** are preferably so located that the damper plate **26** is not permitted to fully close the housing **10**.

Should there have occurred a mechanical failure such that the gas valve would fail to deenergize, a continuing gas pressure against the pressure switch **172** would cause that switch to open. The opening of the switch **172** does two things. First the series circuit connecting the transformer secondary **158** in series with the relay **96** and the thermostat switch is opened. This permits the spring **40** to move the damper **26** to its open position, thus to be assured that gas escaping the gas manifold is provided a path through the damper housing to the ambient atmosphere. Secondly, the opening of the switch **172** removes a shunt across the audible alarm device **178**, with the consequence that the alarm device is energized by the transformer secondary through the path including the test wire **159**, the terminal **5**, the alarm device **178**, the terminal **6**, the normally closed relay switch **190** (now closed because the thermostat switch **160** is open), the heat sensor **116** and the rectifier **184**, back to the transformer secondary **158**. The audible alarm **178** then announces to those in the household that an improper operation is occurring.

In this case, the improper operation would be the ecape of gas into the furnace chamber and quite possibly to other regions of the house. The hazard is great if the furnace has a pilot light, and may be equally scvere if the furnace has an electronic ignition device. If the gas with which the furnace is fueled is a natural gas, the defective condition, assuming an electronic igniter, may be of only secondary importance since the natural gas being lighter than air will be able to rise up the vent stack through the now open damper housing to escape to the surrounding atmosphere. Should the fuel be a heavier gas, such as so-called LP gas, the gas escaping the gas manifold to the furnace chamber will not rise up the vent stack even though the damper **26** is in the open position. In such cases, the audible alarm provided by the device **178** is essential to alert the occupants of the household of a hazardous condition.

Another operating defect that can occur is that the gas valve may fail to close sufficiently to terminate a continuing combustion in the furnace chamber, although it does close sufficiently to allow the pressure switch **172** to close. Assuming the thermostat switch **160** is open and thus seeking to discontinue combustion, the damper plate **26** may nevertheless be driven by the solenoid **76** to the closed position. An ensuing accumulation of relatively hot exhaust gases under the damper **26** will elevate the temperature of the heat sensor **116** so as to separate its switch elements **121** and **123** and thereby disable the solenoid **76**. This permits the spring **40** to move the damper plate **26** to its open position, whereupon appropriate ventilation is provided in view of the continuing combustion. The heat sensor **116** is normally preset by a manipulation of the adjuster **124** to operate at approximately 200° F. To prevent an undesired cyclic operation of the heat sensor, that element is preferably surrounded by a heat-absorbing medium **192**, which may be an electrical conductor or a nonconductor or a composite of the two, the purpose of such medium being to retain enough heat in contact with the heat sensor **116** so that, should a condition obtain in which the heat sensor contacts are opened due to excess heat in the vent stack, this open circuit condition will remain for a period of time sufficient to enable the spring **40** to move the damper plate **26** to its open position.

In order to enhance the sensitivity of the heat sensor, it is desirable in many applications to provide the damper plate **26** with an aperture **198** as shown in FIG. **1**, such aperture overlying the heat sensor **116** so as to direct alongside the heat sensor those gases seeking to

flow upwardly through the housing **10**, thus maximizing the tendency of such gases to deliver heat to the heat sensor.

During any such improper operation occasioned by a defect of the gas valve, the damper plate **26** is preferably locked in its open position by the use of a tool such as the described pencil **152**, which locks the damper in the open position until appropriate repairs can be made.

The foregoing discussion has assumed the prior existence of a house heated by means of a gas furnace and encompasses the procedures employed for LP gas-fueled furnaces as well as natural gas-fueled furnaces. The discussion has also made reference to electronic pilot lights as opposed to the more conventional gas-burning pilot lights.

Those skilled in the art will appreciate that the above described installation of a device embodying the present invention is appropriately referred to as a retrofit installation. Thus, the house is already built and may have been heated successfully for years, but the homeowner has now elected to connserve on fuel costs by retrofitting the present invention to the household vent stack. Since the damper **26** is positively driven by the spring **40** and the solenoid **76**, it can be mounted in any position and thus does not require that the vent stack extend vertically.

While the disclosed device has designed accommodation either for LP gas or for natural gas, those skilled in the art will appreciate that the pressure switch **172** and its associated audible alarm mechanism may be replaced by a shunt (not shown) across the terminals **5** and **6**. This results in an automatic damper which operates the same as described except, of course, that it lacks the safety of the pressure switch **172** and the audible alarm **178**. Where retrofit is contemplated into homes or other facilities utilizing LP gas fuel, the pressure switch **172**, as well as the audible alarm device **178**, are obviously preferable.

The present damper mechanism is also well suited for retrofit into homes utilizing oil burners, in which case the aforementioned shunt connected across the terminals **5** and **6** is desirable and the pressure switch **172**, as well as its associated alarm device **178**, are no longer needed.

While the present description has been addressed primarily to retrofit installations, it should be appreciated that the present invention has obvious utility as original equipment for houses and other facilities yet to be constructed. In the case of original equipment installations, the installer will frequently have adequate knowledge concerning the transformer secondary to eliminate the need for the test wire **159** previously described; and, in this case, the light **134** may be omitted.

Although the preferred embodiments of the present invention have been described, it will be understood that various changes may be made within the scope of the appended claims.

Having thus described my invention, I claim:

1. In a mechanism for controllably venting gases from the flue of a combustion apparatus, said mechanism comprising a housing for mounting to said flue and into which said gases pass, a damper mounted in said housing and movable between a first position opening said housing for the passage of gases therefrom and a second position substantially closing said housing against the passage of gases therethrough, the improvements comprising yieldable means biasing said damper to said first position, motive means for holding said damper against the bias of said yieldable means in said second position, heat sensor means disposed in said housing upstream of said damper for disabling said motive means upon sensing heated gases in said housing and means for connection in circuit with said motive means of a thermostat responsive to a medium heated by the combustion apparatus for also disabling said motive means.

2. The improvement of claim **1** further including heat-absorbing means in contact with said heat sensor means for prolonging the disability of said motive means upon movement of said damper to said first position.

3. The improvement of claim **1** wherein said combustion apparatus includes a valve for regulating the passage of combustible fuel to said apparatus, and including pressure sensor means responsive to the pressure of the combustible fuel released by said valve for disabling said motive means.

4. The improvement of claim **3** further including alarm means responsive to said pressure sensor means for sounding an audible alarm upon operation of said pressure sensor means to disable said motive means.

5. The improvement of claim **3** wherein said heat sensor means and said pressure sensor means comprise electrical switches and said motive means is an electrical solenoid, the heat sensor switch and pressure sensor switch being connected electrically in series with said solenoid and a source of electrical power.

6. In a heating system of the type comprising a combustion apparatus, a thermostat for regulating the operation of said apparatus, a flue for venting exhaust gas resulting from the operation of said apparatus; a damper mounted in said flue, yielding means biasing said damper to a first position opening said flue, motive means energizable to move said damper against the bias of said yielding means to a second position substantially closing said flue, terminal means for connection of said motive means to a source of power, a safety circuit including first, normally closed switch means electrically connected in series with said motive means between said terminal means, relay means for moving said switch means from its normally closed position to an open position, and a control circuit for connecting said relay means in series with said thermostat between said terminals, the improvement including sensor means exposed to gas passing through said heating system for interrupting said safety circuit.

7. The system of claim **6** wherein said sensor means comprises a heat sensor supported in said flue, second, normally closed switch means included in said safety circuit, and means responsive to said heat sensor for opening said second switch means.

8. The system of claim **6** wherein said system includes a gas orifice for delivering gas to said combustion apparatus, said sensor means comprising a third, normally closed switch means included in said control circuit, and means responsive to the pressure of gas passing to said orifice for opening said third switch means.

9. The system of claim **8** further including audible alarm means electrically connected across said third switch means.

10. In an automatic damper mechanism for retrofit installation in the flue of a combustion apparatus of the type comprising a valve for regulating the flow of fuel for combustion therein, said valve having a pair of valve terminals, and comprising a thermostat *having a thermostat* switch in series with a voltage source for regulating the operation of said combustion apparatus in response

to heat demand, said voltage source having end terminals, said thermostat switch and said voltage source disposed in series between terminals of said thermostat; the improvement comprising a circuit board having at least four terminals, a first pair of said circuit board terminals for electrical connection respectively to said valve terminals, one terminal of said first pair and a third of said circuit board terminals comprising a second pair of terminals for electrical connection respectively to said thermostat terminals, an electric signal device, means electrically connecting said signal device between a remaining one of said circuit board terminals and said one terminal, and a wire connected at one end to said remaining one of said terminals, the other end of said wire movable for selective connection to opposite end terminals of said voltage source whereby upon touching said other end successively to said end terminals an installer may locate for permanent connection of said other end that end terminal which most steadily energizes said signal device.

11. In a vent mechanism for venting gases from a combustion system, said vent mechanism of the type having a housing through which said gases pass, a damper, shaft means mounting said damper for rotation in said housing, yieldable means rotatably biasing said shaft to a first position wherein said damper opens said housing, motive means for moving said shaft against the bias of said yieldable means to a second position substantially closing said housing, the improvements wherein said motive means comprises a straight pull solenoid having an armature, a cam member keyed to said shaft and having a periphery encircling said shaft, and link means connecting the armature of said solenoid eccentrically to said cam means, said cam means having a peripheral flat, said vent mechanism having an aperture through a wall of said housing and cover means covering said aperture, said solenoid and said cam means, said cover means having a second aperture therethrough aligned with said periphery and the first mentioned aperture for passing a tool adjacent said flat to block rotation of said cam member should said yieldable means be disabled.

12. An automatic damper mechanism for installation into the vent stack of a combustion apparatus for satisfying the heat demand of a thermostat switch comprising, in combination:

a damper housing;

a damper mounted in said housing for movement between a first position opening said housing for the passage of gases therethrough and a second position substantially closing said housing;

yieldable means for biasing said damper to said first position;

electrical solenoid means for moving said damper against the bias of said yieldable means to said second position, said housing including bumper means engaged by said damper to locate said second position;

means for exerting a drag upon the movement of said damper to prevent bouncing of said damper against said bumper means; and

a safety circuit for electrically connecting said solenoid in series with a source of power for operating said solenoid, said safety circuit including first switch means for interrupting the continuity thereof, said damper mechanism including a relay, means for electrical attachment of said relay to said thermostatic switch so that said relay is energized upon closure of said thermostatic switch, said first switch means responsive to said relay so that said first switch means is opened by said relay upon closure of said thermostatic switch;

said safety circuit including second switch means, said damper mechanism including a heat sensor disposed in said housing for opening said second switch in response to elevated temperatures in said housing, said damper having an opening therethrough for inducing gases seeking to escape said housing to flow adjacent said heat sensor;

said safety circuit including third switch means, and means responsive to the pressure of fuel passing to said combustion apparatus for opening said third switch means when fuel passes to said combustion apparatus.

13. In a mechanism for controllably venting gases from a combustion apparatus, said apparatus including a gas orifice for delivering fuel for combustion in said apparatus, said mechanism comprising a housing into which said gases pass, a damper mounted in said housing and movable between a first position opening said housing for the passage of gases therefrom and a second position substantially closing said housing against the passage of gases therethrough, the improvements comprising yieldable means biasing said damper to said first position, motive means for holding said damper against the bias of said yieldable means in said second position, pressure sensor means for disabling said motive means upon sensing the pressure of fuel being delivered to said combustion and means for connection in circuit with said motive means of a thermostat responsive to a medium heated by the combustion apparatus for also disabling said motive means.

14. The improvement of claim **2** wherein said heat-absorbing means surrounds said heat sensor means.

15. The improvement of claim **2** wherein said heat-absorbing means is sized to prolong the disability of said motive means at least until said damper is moved by said yieldable means to said first position.

16. In a heating system of the type comprising a combustion apparatus, a thermostat for regulating the operation of said apparatus, a flue for venting exhaust gas resulting from the operation of said apparatus; a damper mounted in said flue, yieldable means biasing said damper to a first position opening said flue, motive means energizable to move said damper against the bias of said yieldable means to a second position substantially closing said flue, terminal means for connection of said motive means to a source of power, a safety circuit including first switchable means electrically connected in series with said motive means between said terminal means for delivering to said motive means sufficient power from said source for operating said motive means, means for switching said switchable means to terminate the delivery of sufficient power from said source for operating said motive means, and a control circuit for connecting said means for switching in series with said thermostat between said terminal means, the improvement including sensor means exposed to gas passing through said heating system for interrupting said safety circuit.

17. The system of claim 16 wherein said sensor means comprises a heat sensor supported in said flue, second switchable means included in said safety circuit, and means responsive to said heat sensor for switching said second siwtchable means.

18. The system of claim 16 wherein said system includes a gap orifice for delivering gas to said combustion appara-

tus, said sensor means comprising a third switchable means included in said control circuit, and means responsive to the presence of gas passing to said orifice for switching said third switchable means.

19. The system of claim 18 further including audible alarm means electrically connected across said third switchable means.

20. An automatic damper mechanism for installation into the vent stack of a combustion apparatus for satisfying the heat demand of a thermostat switch comprising, in combination:

a damper housing;

a damper mounted in said housing for movement between a first position opening said housing for the passage of gases therethrough and a second position substantially closing said housing;

yieldable means for biasing said damper to said first position;

electrical solenoid means for moving said damper against the bias of said yieldable means to said second position, said housing including bumper means engaged by said damper to locate said second position;

means for exerting a drag upon the movement of said damper to prevent bouncing of said damper against said bumper means; and

a safety circuit for electrically connecting said solenoid means in series with a source of power for operating said solenoid means, said safety circuit including first switch means for interrupting the continuity thereof, said damper mechanism including a relay, means for electrical attachment of said relay to said thermostatic switch so that said relay is energized upon closure of said thermostatic switch, said first switch means responsive to said relay so that said first switch means is switched by said relay upon closure of said thermostatic switch;

said safety circuit including second switch means, said damper mechanism including a heat sensor disposed in said housing for opening said second switch in response to elevated temperatures in said housing, said damper having an opening therethrough for inducing gases seeking to escape said housing to flow adjacent said heat sensor;

said safety circuit including third switch means, and means responsive to the pressure of fuel passing to said combustion apparatus for switching said third switch means when fuel passes to said combustion apparatus.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : Reissue Patent No. 31,112

DATED : Reissued December 28, 1982

INVENTOR(S) : John Prikkel, III

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 29, change "single" to read ---signal---.

Column 6, line 66, change "installations" to read ---installation---.

Column 9, line 21, change "connserve" to read ---conserve---.

Claim 6, line 45, after "means" insert ---disposed upstream of said damper and---.

Claim 13, line 31, after "combustion" insert ---apparatus---.

Claim 16, line 59, after "means" insert ---disposed upstream of said damper and---.

Claim 18, line 68, change "gap" to read ---gas---.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : Reissue Patent No. 31,112
DATED : Reissued December 28, 1982
INVENTOR(S) : John Prikkel, III

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The following claims should be added:

21. The mechanism of claim 1 wherein said damper has an aperture therethrough overlying said heat sensor for directing the flow of gases through said housing.

22. The mechanism of claim 1 further including a fuel supply valve connected in circuit with said motive means and means responsive to movement of said damper to said second position for interrupting the circuit connection to said fuel supply valve.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : Reissue Patent No. 31,112

DATED : December 28, 1982

INVENTOR(S) : John Prikkel, III

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

23. The mechanism of claim 1 wherein said motive means is a direct current motive means.

On the title page, "20 Claims" should read -- 23 Claims --.

Signed and Sealed this

Twenty-fifth Day of *October 1983*

[SEAL]

Attest:

GERALD J. MOSSINGHOFF

Attesting Officer

Commissioner of Patents and Trademarks