Oct. 29, 1940. C. H. LEWIS 2,219,629

VERNIER QUADRANT DAMPER FOR AUTOMATIC FURNACE CONTROLS

Filed April 24, 1939

Fig. 1.

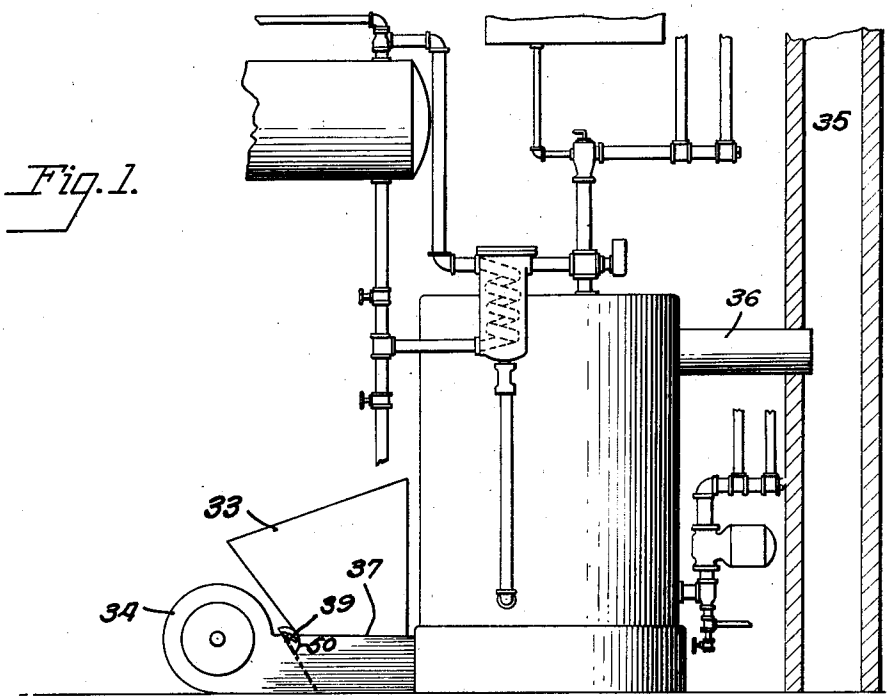


Fig. 2.

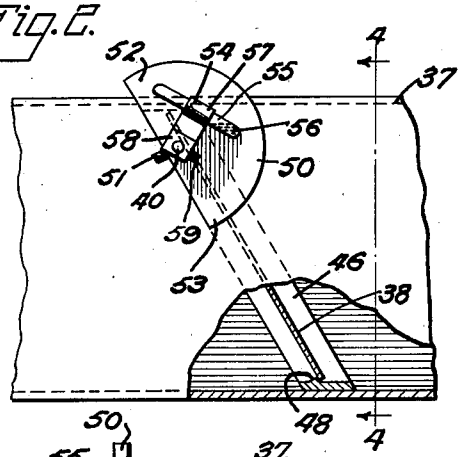


Fig. 3.

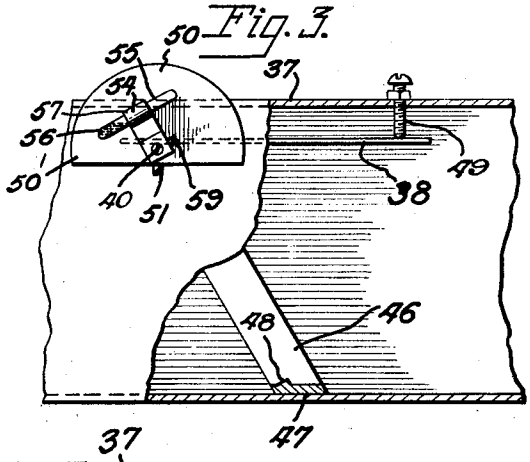


Fig. 4.

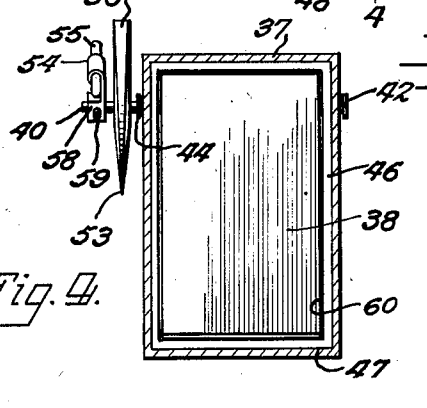
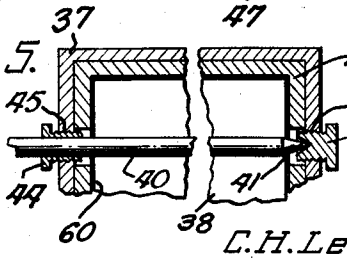


Fig. 5.



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VERNIER QUADRANT DAMPER FOR AUTOMATIC FURNACE CONTROLS

Clarence H. Lewis, Salem, Va.

Application April 24, 1939, Serial No. 269,769

8 Claims. (Cl. 110—69)

This invention relates to dampers, and more particularly to automatic dampers for relatively rapidly regulating draft to a furnace of the fluid or solid fuel type to render the controls more effective in controlling the fire and draft.

In the art of automatic furnace controls, it is common practice to have a thermostat responsive to the temperature of an inclosure being heated, which thermostat controls the feeding of fuel and air to support combustion. It is not an uncommon situation in the use of fuels for the fuel supply to override the thermostat, that is, for a quantity of fuel to be released into the combustion chamber after the thermostat has theoretically cut off combustion. This is analogous to the momentum of moving bodies when it is attempted to stop them or vice versa. The increased rate of combustion after a call for heat causes the resulting greater natural draft, due to the greater volume of hot products of combustion, to have an inertia effect tending to carry on at the greater rate of fuel consumption.

The accumulation of fuel, especially liquid fuel, is always a possible cause of explosion, and necessarily a serious hazard. In the use of gaseous fuels a similar condition exists when unburned combustible gases are left in the firebox. With solid fuels the feeding of fuel to the firebox to create an appropriate required amount of heat, necessarily implies that the instant the fuel feed is cut off the rate of combustion then will naturally exceed the demand for heat on its system. Under such conditions combustible gases will be liberated in the firebox from the partly burned fuel. If these gases are not dissipated, an explosive mixture may develop resulting in a subsequent explosion.

One of the objects of this invention is to avoid the heretofore enumerated difficulties commonly found in furnace operation.

Yet another object is to provide means for insuring complete combustion of unburned fluids in the combustion chamber. A further object is to provide a damper which will quickly open under forced draft conditions for full draft supply.

Other objects and advantages of this invention will appear from the following description taken in connection with the accompanying drawing.

In the drawing, wherein like reference characters indicate corresponding parts in the various figures:

Figure 1 is a partial side elevation showing the parts of an automatic stoker boiler system;

Figure 2 is an enlarged view of the draft damper part of the apparatus shown in Figure 1, with the damper closed and shown partly in section;

Figure 3 is a similar view showing the damper in open position;

Figure 4 is a transverse cross section view on the line 4—4 of Figure 2;

Figure 5 is an enlarged cross section showing details of the damper mounting.

Considering the drawing in greater detail, an automatic, solid fuel, stoker fired heating system is partially indicated in Figuge 1 comprising a so-called winter-summer hook-up for heating a house or the like in the winter and also the domestic hot water supply; and for heating the domestic hot water supply alone in the summer; by a single burner or source of heating; the fuel being solid, liquid or gaseous. Although the invention is most efficient with this type of system, it is equally useful for any heating system, especially for the control of the draft in the off periods, that is, when there is no demand for heat.

Fuel is supplied in this illustrated system in the form of solid fuel which is dumped into the hopper 33, and is then fed by the usual means into the combustion chamber of the boiler.

Fan 34 and stoker 33 are controlled by inclosure temperatures or other thermostats not shown, and the products of combustion are arranged to pass up a chimney 35 by a pipe connection 36.

The air supply for combustion from the fan 34 is by way of the conduit or air-duct 37, which latter is controlled by damper 38, having appropriate damper adjusting mechanism 39. The damper is pivotally mounted in the air-duct by means of shaft 40 which latter is mounted by means of anti-friction or other type low-friction bearings. As shown, this construction may comprise a cone bearing 41 at one end of the shaft mounted in the member 42, which is threaded into the air-duct at 43, and the opposite end is supported for oscillating movement in a bushing 44, similarly mounted at 45 in the air-duct.

The damper is provided with a substantially rectangular frame or housing 46, having angularly extending outer walls 47 to fit into the air-duct as indicated. A ridge 48 serves as a limit stop for the damper when in the position indicated in Figure 2, and an adjustable limit stop 49 serves to limit the upward oscillating movement of the damper. It will be understood that the damper is normally heavier—that is, unbal-

anced to the right of the shaft **40**, as seen in Figure 3. In other words, it is always biased toward closed position even when fully open.

A vernier quadrant **50** is mounted on the shaft **40** by means of a set-screw **51** which allows the quadrant to be adjusted with respect to the shaft, as clearly indicated in Figure 4. This quadrant is featured having an enlarged thickness at one end **52** and tapering off to the opposite thin edge **53**. This tapering or wedge shaped thickness of the quadrant is such that as the damper moves open, the degree of unbalance is first relatively great in proportion to the angle of opening, and then increases less rapidly. When the damper is opening the very rapid increase in forced draft prevents this weight from having much effect save as to a quick opening.

When the draft is shut off the damper begins to close. The closing movement is gradually accelerated by the increasing weight of quadrant **50** on the unbalanced side of the shaft.

A further balancing element is mounted on the shaft **40** comprising the device **54**, which may be a glass tube **55** partly filled with mercury **56** and engaged by the socket **57** which latter is a part of a collar **58** which is in turn locked to the shaft **40** by a set-screw **59**. This member may also be adjusted readily with respect to the shaft **40**. Here again in the opening of the damper, a certain degree of quick opening movement is permitted, allowing the damper to completely open the draft duct and abut against the limit stop **49**.

In the off-cycle of operation, i. e., during closing of the damper, the blower **34** is shut off by a thermostat or other means thereby stopping the forced draft. The damper will then start to close acting only against the increased natural draft through the system. The damper will continue to close in a gradually increasing manner until it reaches a certain point, at which time the device **55** will cause the damper to completely close in a very rapid manner.

In Figures 4 and 5, a small marginal space **60** is arranged at the sides of the damper, when the latter is in a closed position, so that for example in solid fuel burning systems, an appropriate small or minimum amount of draft will always be available to burn gases tending to accummulate above the fire bed.

This device provides at all times a proper minimum amount of air or natural draft for combustion through apertures **60**. It is also effective, on a call for heat, to rapidly increase the draft by adding to the original natural draft a greatly increased forced draft and to rapidly shut off the forced draft when heat is not required. At all times on the shutting off of draft, a sufficient amount of air will be supplied after the shutting down of the fuel supply to completely burn all gaseous fuels in the fire box. In connection with solid fuel, the air supply will be cut off in such a manner as to completely consume any unburned gases above the fire bed, but will at the same time reduce the main air supply in such a manner as to respond to the thermostatic furnace control.

When the damper is in operation it regulates the flow of air through the conduit **37** to the combustion chamber. When a control, manual or automatic, "calls for heat" the fuel supply to the combustion chamber is increased and the blower **34** is started in operation creating a forced draft. The air pressure of the forced draft acting on the surface of the damper is such as to overcome the unbalanced weight of the damper thereby forcing it, the damper, open against the limit stop **49** to provide an unobstructed passageway for the air. The damper will quickly open to its maximum position in view of the unbalanced weight of the quadrant **50** which is greatest at the end **50'**. This opening movement is also sharply increased by the tilting of tube **55**.

The increased fuel and air rapidly develop a very large volume of products of combustion which rise rapidly through the stack and materially increase the natural draft in the chimney. When the inclosure is sufficiently heated the "call for heat" is terminated and the forced air draft is stopped. At this time there is a forcible natural draft due to the intense combustion in the furnace. This draft is, of course, much less violent than the forced draft, and as the direction of the natural draft current at the time the forced draft is cut off is parallel to the direction of the open damper, it had little effect in holding the damper open. Therefore, the damper starts to close. As it closes, its area impinged by the natural draft current progressively increases so that in the absence of any special means to oppose it, its rate of closing will be progressively decreased, this retarded closing action or dwell unduly maintaining the activity of the combustion. The wedge shaped weight on the damper provides a progressively increasing increment to the closing pressure of the damper which materially shortens this dwell. There is a period, however, when the closing pressure of the damper and the sustaining pressure of the natural draft have a ratio of one to one, in which position the supplied draft is insufficient to sustain the rate of combustion in the furnace, so that the force of the natural draft decreases and the damper closes still further, until the tube **55** again passes its critical point, shifting the mercury to the closing side for effecting a rapid complete closure of the damper.

Although the closing and opening operation of the damper is described in relation to time, it will be understood that the complete opening or closing cycle of the damper will take place in a relatively very short total period of time.

An appropriate scale may be mounted upon the air-duct **37** so that the quadrant **50** and element **56** may be adjusted in accordance with predetermined standards. It will be understood, however, that slight variations in adjustment will always be required to meet the peculiarities of a particular installation.

The sensitivity of this damper is increased through the use of close-fitting cone-shaped bearings on both ends of the shaft. A basic object of the damper is to control combustion during the off periods of the stoker or burner, and by so doing, to keep the fire bed automatically banked during the off periods.

The counter-weight **50** and the mercury tube **55** act in unison in assisting to open the damper diaphragm **38**. When the stoker fan starts the air pressure strikes the diaphragm **38**, which throws off center the counter-weight **50** and displaces the mercury to the opposite end of the tube **55**, which tends to lift the diaphragm **38** into a horizontal position in the air duct, thereby eliminating entirely the back pressure of the stoker fan. This allows the stoker fan to operate and deliver to the burner head its entire designed volume of air.

The counter-weight **50** is adjustable angularly around the shaft, also the holder **58** of

the mercury tube **55** is adjustable angularly about the shaft, and the mercury tube **55** is also movable longitudinally in the holding clip **56**. With these adjustments or variations, any draft conditions can be met.

Immediately after the stoker fan ceases to operate, the suction or natural draft has a tendency to keep the diaphragm **38** in a partially open position. This is desirable to prevent explosion in the fire box, also it allows the tuyères or burner head to be properly cooled. At the same time, it retards combustion, which decreases the stack temperature, thereby decreasing the natural draft through the air duct. This finally comes to an almost closed position, in which position the mercury in tube **55** again returns to the end of the tube towards the burner and locks the damper **38** in a closed position so that it cannot be opened from a gust of wind, which momentarily increases the natural draft through the smoke pipe furnace and air duct **37**. Without this mercury tube locking the damper in a closed position, it has been found during stormy weather the diaphragm **38** would be partially open, which would increase combustion, thereby raising the stack temperature and increasing the natural draft, which once started increases, which causes overheating and burning out of fuel when same is not wanted. This causes trouble especially during summer months.

Although the damper has been described in connection with a preferred use as applied to the intake draft conduit for a forced draft heating system, it will be readily understood that the invention may be applied to other parts or places in a heating system.

Another purpose is to eliminate frequent starting and stopping of the stoker by some form of hold-fire stoker control, as an example an electric time clock starting and stopping the stoker every half hour to replenish fuel supply that has burned out by natural draft. By eliminating this frequent action of stoker, the firebed is maintained at proper depth for good combustion, current is saved, also wear on stoker is less. In other words by the use of this damper the stoker can be operated by an immersion type control without the use of additional controls, and by so doing coal is also saved.

Although a preferred embodiment of this invention is illustrated and described, variations within the true spirit and scope of the same are to be determined by the appended claims.

What I claim is:

1. In a furnace combustion system including a combustion chamber, a conduit for supplying air to said combustion chamber, a fan periodically automatically actuated for forcing air through said conduit into said combustion chamber, said conduit supplying a limited amount of air under natural draft to said combustion chamber during off periods of said fan, in combination with said conduit, damper mechanism positioned in said conduit at such point as to control the air supply to said combustion chamber, comprising a hinged damper opening toward said furnace, normally having a closing bias against the sustaining force of the natural draft which force normally progressively increases as the damper moves in a closing direction until the ratio of damper weight to draft sustaining pressure becomes 1 to 1, producing a dwell in the damper movement, and having a range of swing from a closed position in which it substantially closes said conduit to an open position in which it lies substantially parallel to the direction of flow of air through said conduit, a weight at one end of the axis of said damper, extending on opposite sides of the vertical plane which embraces the axis of said damper, said weight normally contributing to the closing bias of said damper and swingable with said damper as the latter opens, the value of the damper-closing force of said weight being less than the damper-opening pressure of said fan blast against said damper for all angular positions of said damper, whereby said damper opens fully under the pressure of said fan blast, said weight being of progressively increasing mass from the end which leads, in the closing movement of said damper, whereby in the angular movement of said damper in a closing direction, the closing force of said weight is augmented by a progressively increasing increment, thereby reducing the duration of said dwell.

2. In the furnace system as claimed in claim 1, said weight being angularly adjustable about the axis of the damper.

3. Furnace combustion system as claimed in claim 1, including also an overbalancing weight swingable with said damper, having its critical position coinciding approximately with the said position of dwell of said damper, whereby upon slight closing movement of said damper beyond said dwell position, said last mentioned weight is overbalanced, quickly closing said damper.

4. Furnace combustion system as claimed in claim 1, including also an overbalancing weight swingable with said damper, having its critical position coinciding approximately with the said position of dwell of said damper, whereby upon slight closing movement of said damper beyond said dwell position, said last mentioned weight is overbalanced, quickly closing said damper, said last mentioned weight being angularly adjustable about the axis of the damper.

5. In a furnace combustion system including a combustion chamber, a conduit for supplying air to said combustion chamber, a fan periodically automatically actuated for forcing air through said conduit into said combustion chamber, said conduit supplying a limited amount of air under natural draft to said combustion chamber during off periods of said fan, in combination with said conduit, damper mechanism positioned in said conduit at such point as to control the air supply to said combustion chamber, comprising a hinged damper opening toward said furnace, normally having a closing bias against the sustaining force of the natural draft which normally progressively increases as the damper moves in a closing direction until the ratio of damper weight to the sustaining draft pressure becomes 1 to 1, producing a dwell in the damper movement, a weight at one end of the axis of said damper, extending on opposite sides of the vertical plane which embraces the axis of said damper, said weight normally contributing to the closing bias of said damper and swingable with said damper as the latter opens, said weight being of progressively increasing mass from the end which leads, in the closing movement of said damper, whereby in the angular movement of said damper in a closing direction, the closing force of said weight is augmented by a progressively increasing increment, thereby reducing the duration of said dwell.

6. In the furnace system as claimed in claim 5, said weight being angularly adjustable about the axis of the damper.

7. Furnace combustion system as claimed in claim 5, including also an overbalancing weight swingable with said damper, having its critical position coinciding approximately with the said position of dwell of said damper, whereby upon slight closing movement of said damper beyond said dwell position, said last mentioned weight is overbalanced, quickly closing said damper.

8. Furnace combustion system as claimed in claim 5, including also an overbalancing weight swingable with said damper, having its critical position coinciding approximately with the said position of dwell of said damper, whereby upon slight closing movement of said damper beyond said dwell position, said last mentioned weight is overbalanced, quickly closing said damper, said last mentioned weight being angularly adjustable about the axis of the damper.

CLARENCE H. LEWIS.