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AUTOMATIC REGULATOR FOR FEEDING FUEL TO HEATING APPARATUS.

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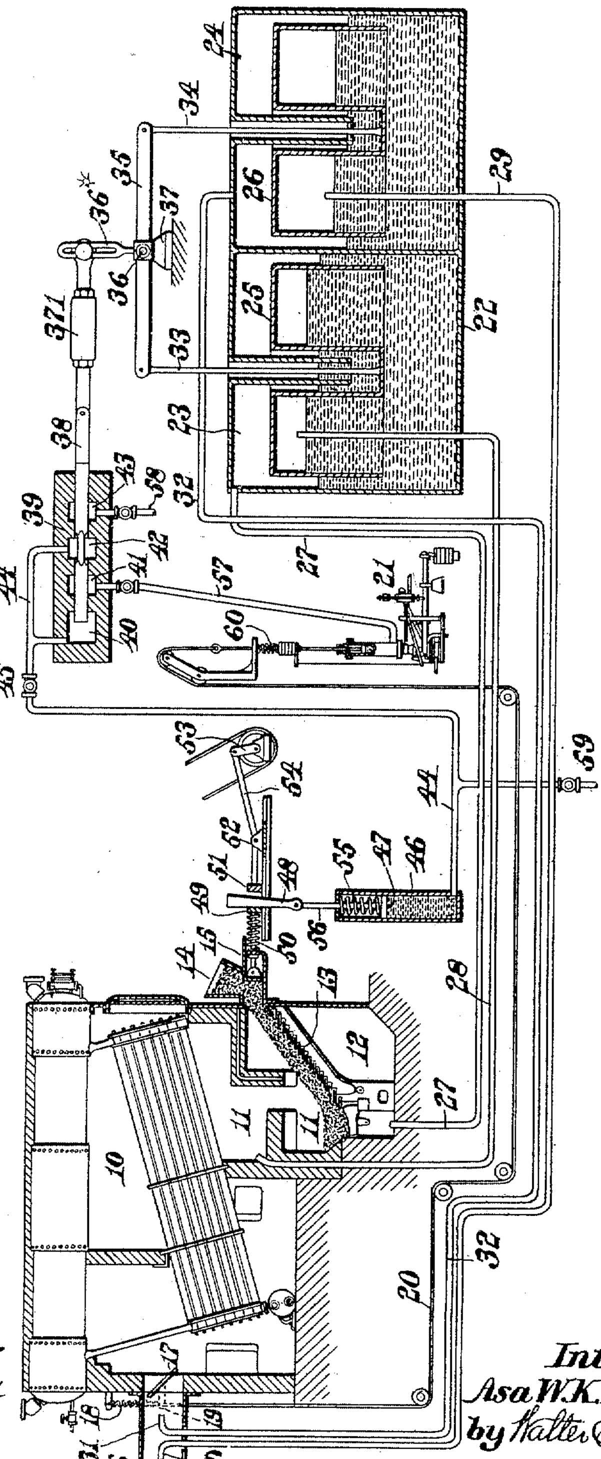

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UNITED STATES PATENT OFFICE.

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AUTOMATIC REGULATOR FOR FEEDING FUEL TO HEATING APPARATUS.

980,401. Specification of Letters Patent. **Patented Jan. 3, 1911.**

Application filed August 6, 1909. Serial No. 511,651.

To all whom it may concern:

Be it known that I, Asa White Kenney Billings, a citizen of the United States of America, and a resident of Habana, in the Province of Habana and Republic of Cuba, have invented certain new and useful Improvements in Automatic Regulators for Feeding Fuel to Heating Apparatus, of which the following is a specification.

This invention relates to a device for altering automatically the rate of supply of fuel to a furnace, in order to maintain the most economical conditions of combustion. While its principal application is to the mechanically stoked furnaces in general use for generating steam, and such a combination is described in this application and shown in the drawing, for convenience, other applications of the same device to a furnace for other purposes, or to any apparatus in which the variation in the ratio between two pressure differentials resulting from the operation of said device may be used to alter another operation, thereby affecting the difference between the two pressure differentials and restoring it to its former value, are obvious.

In the ordinary operation of a mechanical stoker, the rate of feed of the fuel is adjusted by hand by the attendant by slowing down or stopping the mechanism when the fire is too full, or starting it or speeding it up when the furnace is too empty. When too full there is loss, due to imperfect combustion, lowering of the rate of combustion and capacity of boiler due to clogging of fire, and trouble due to the formation of clinker with greater facility in such a fire. If there is too little fuel, there is a loss, due to excess of air, and trouble due to the inability of the furnace to respond to sudden demands for power. In either case the loss of efficiency is considerable and is due primarily to the lack of a means of varying the supply of fuel continuously so as to maintain at all times just those conditions as to thickness and condition of fuel bed, etc., to correspond to the most efficient conditions of combustion, as may have been determined previously by experiment. For any particular installation there is for each set of conditions a certain proportion of air supplied to the fuel which gives these desired results; when this condition exists there is a definite value for example to the ratio of the pressure differential or "velocity-head" obtained by a pair of tubes immersed in, and one facing toward and the other facing away from the current of gases in the exit, and the pressure differential above and below the fuelbed. If the fuelbed becomes too thin, or has holes in it, too great a proportion of air is admitted, and the ratio of the first to the second pressure differential above mentioned, becomes greater than normal. If on the contrary the fuelbed becomes too thick and the passage of air through said bed in proper proportion is retarded and prevented, the ratio abovementioned decreases below normal. In practical operation this ratio may be taken as a guide to the efficiency of the combustion conditions and a device influenced by this ratio may be used to control the feed of fuel to the furnace and to thus maintain the desired conditions as nearly as is practicable at whatever point has been previously found to give the highest efficiency. In addition when the load on the boiler or the heating requirements on the furnace vary rapidly it is desirable to be able to anticipate the changes in the furnace conditions due to the accelerated or retarded rate of combustion by accelerating or retarding correspondingly the rate of supply of fuel, in advance of the tendency to depart by reason of this from the best conditions, thus rendering the operation of the furnace more uniform.

The drawing represents in diagram a section of a tubular boiler with a stoker applied thereto and showing connected therewith an apparatus for regulating the feed of the stoker by means of balanced mechanism operable by the variation in the ratio between two pressure differentials in different portions of said furnace, the mechanism for regulating the feed of fuel of the stoker being shown considerably enlarged in proportion to said furnace.

In the drawing, 10 represents a water tube boiler of any well-known construction provided with a fire-pot 11 and ash-pit 12. Between the fire-pot 11 and ash-pit 12 is an inclined grate 13 supporting the fuel, at the upper end of which is a hopper 14 supplied with fuel adapted to be forced on to the grate 13 by means of a pusher 15. At the opposite end of said boiler is an exit 16 for the products of combustion adapted to be closed by means of a damper 17. This damper 17 is normally retained in open position by means of a spring 18 operating a member 19 secured to the damper pivot.

The arm 19 is connected by means of a cord 20 to a suitable damper regulator 21. Located at a convenient point is a casing 22 provided with two inclosed chambers 23 and 24 in each of which is located an inverted pan 25—26, the open ends of which are immersed in a liquid contained within the chambers 23 and 24.

The chamber 23 is connected by means of a pipe 27 to the ash-pit 12 and the fire-pot 11 is connected by means of the pipe 28 to the interior of the inverted pan or float 25, the other inverted pan or float 26 being connected by means of a pump 29 to the suction tube 30 of a "Pitot" tube located in the exit 16 for the flue gases from said fire-pot 11. The pressure tube 31 of the "Pitot" in the exit 16 for the flue gases is connected by means of a pipe 32 to the interior of the chamber 24.

The floats 25 and 26 are connected by the members 33 and 34 to the opposite ends of a rocker member 35 pivoted at 36 to some suitable standard 37. The rocker member 35 is provided with a slotted arm 36* to which is adjustably connected a member 371 the opposite end of which is pivotally connected to a valve-rod 38 extending through the balanced valve 39 provided with the compartments 40, 41, 42, and 43.

The compartments 40 and 42 are connected by means of a pipe 44, having a valve 45 therein, to a cylinder 46 having a piston 47 fitting its interior chamber, the piston rod of which is connected to a wedge member 48. On one side of the wedge 48 is a plate 49 connected to the pusher 15 and retained in contact with one face of said wedge 48 by means of the spring 50. On the opposite side of the wedge 48 is a member 51 connected to a slide 52, between which and a revoluble crank 53 is interposed a connecting rod 54. It is obvious that during the rotation of the crank 53, the slide 52 and member 51 connected thereto will be reciprocated.

During the reciprocation of the member 51 it will come in contact with one face of the wedge member 48 and cause a movement of the pusher 15 to cause a certain amount of the fuel contained in the hopper 14 to be pushed into the fire-pot 11 onto the grate 13. It is obvious that the amount of feed of the pusher 15 is determined entirely by the position of the wedge member 48. The lower the position of this wedge member 48 the greater the movement of the pusher member 15, caused by the rotation of the crank 53; the higher this wedge member the more lost motion there is between the member 51 and the wedge member 48 and consequently the less movement of the pusher member.

A spring 55 surrounding the piston rod 56 of the piston 47 tends to lower the position of the wedge member 48, the spring 55 acting upon the piston 47 against the pressure of the liquid contained within said cylinder 46 beneath said piston, this liquid being supplied thereto through the pipe 44 from the balanced valve 39.

The chamber 41 in the balanced valve 39 is connected by means of the valved pipe 57 to the piston cylinder of the hydraulic damper regulator 21. From the chamber 43 of the balanced valve 39 extends a valved waste pipe 58, while the pipe 44 has branching therefrom a valved waste pipe 59.

The spring 55 acting on the piston 47 normally retains the wedge 48 in its lowest position when there is no fluid pressure acting against the piston 47 and under these conditions returns the piston preferably to the position corresponding to the maximum feed of fuel, it being obvious that for each value of pressure of fluid within the cylinder 46 there is a corresponding rate of feed. The pressure of this fluid in the cylinder 46, which preferably is water condensed from the steam mains and otherwise returned into the feed water, is varied by means of the partially balanced valve 39 moved by the arm 36 through the connector 37, this arm 36 being connected to the lever 35, the opposite ends of which are connected to the floats 25 and 26 as heretofore described. As one of these floats is subject to one pressure differential and the other float to the other pressure differential by means of suitable pipe connections, as has been heretofore described, the variations in the ratio of the two pressure differentials will move the lever 35 about its pivot 36 and operate the valve 39 to regulate the flow of liquid through the pipe 44 to the cylinder 46.

To prevent too violent variations in the rate of feed, the movement of the balanced valve 39 and floats 25—26 is compensated for by being subjected to the variable partial pressure in the cylinder 46, applied to one end of the balanced valve, as for instance, in the compartment 40.

To anticipate the changes in the rate of feed required by change in load on the boiler, the damper regulator 21 is made to vary the fluid pressure as delivered to the chamber 41 and through the pipes 44 to the cylinder 46, either by causing a movement of the damper regulator to be opposed by a spring 60, or otherwise, so that each damper opening corresponds to a definite value of the fluid pressure within said damper regulator cylinder. As said damper regulator cylinder is connected by the pipe 57 to the valve 39 for controlling the pressure in the cylinder 46 any operation of the damper regulator will control the operation of the feed regulating devices.

The action of the entire device is as follows: For a given load on the boiler 10 and with normal conditions in the furnace 11, the damper regulator 21 automatically holds the damper 17 connected to its piston at the proper opening, by maintaining a definite fluid pressure corresponding to the pressure and the position of said piston, in the cylinder of the regulator. By means of the pipe connection 57 above-mentioned, this fluid pressure in the damper regulator piston is transmitted to the balanced valve 39 controlled by the balanced floats 25—26. As long as the furnace conditions remain normal, said balanced floats 25—26 maintain the balanced valve 39 in its normal central position, thereby keeping the stoker regulator piston 47 in a fixed position, and the stoker feed controlled thereby at a constant rate to maintain the furnace combustion conditions constant. If, however, the fire becomes too thin, due to lack of fuel in sufficient amount, the proportionate air-supply increases, the "velocity-head" pressure differential increases due to the increased velocity of the gases at the same time that the pressure differential above and below the fuelbed decreases, the floats 25—26 are no longer in equilibrium and they move the balanced valve 39 so as to allow part of the fluid in the cylinder 46 of the feed regulator to escape, thereby lowering the pressure in same and permitting the piston to move to another position corresponding to an increased rate of feed of the fuel, after which the compensating effect of this reduced fluid pressure causes the balanced floats 25—26 to return to their normal position and prevent further changes in the rate of feed until the conditions again change. When the increased rate of feed of the fuel has closed the holes in the fire or thickened the fuelbed, the balanced floats 25—26 will move in the opposite direction, thereby admitting fluid under pressure into the cylinder below the feed regulator piston, which will return to its normal position, the balanced floats also returning to their central position after this movement, due to the action of the compensating device already described. When the fires become too thick the converse action takes place, the feed being slowed down until the balanced floats return to the central position and remaining thus until the furnace conditions are corrected, when the balanced floats will again allow the stoker feed to return to normal. If the steam pressure meanwhile changes, falling, for example, so that the regulator piston falls somewhat and opens the damper 17 wider, the pressure below said damper regulator piston is thereby reduced, and this pressure being transmitted to the feed regulators through the balanced valve causes the stoker to increase its rate of feed either at the next slight movement of the valve, or if there is a certain slight leakage in the said balanced valve at both its ports the effect will be immediate without requiring movement of the balanced valve. In this way the feed is increased as soon as the damper opens, without waiting for the increased draft to make the fire depart from normal conditions.

It is evident from the foregoing that the present invention is a useful improvement on the means of regulating the feed of a furnace fed automatically, so as to maintain the most efficient conditions for combustion, as determined beforehand by experiment, and fixed by the adjustment of the device described.

It is believed that the operation and many advantages of the invention will be fully understood by reference to the description of the drawings and to the claims hereinafter given.

Having thus described my invention, I claim:

1. In a device of the class described, the combination of a heating device; a member adapted to contain fuel for said heating device; a continuously reciprocating mechanism for feeding a portion of said fuel to said heating device at each forward stroke; and means operable by the change of ratio between two gas pressure differentials in different parts of the heating device for regulating the operation of said fuel feeding mechanism.

2. In a device of the class described, the combination of a heating device; a member adapted to contain fuel for said heating device; a continuously reciprocating member for feeding a portion of said fuel to said heating device at each forward stroke; and means operable by the change of ratio between two gas pressure differentials in different parts of the heating device for regulating the stroke of said feeding member.

3. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; and means operable by the changes of ratio between two pressure differentials in different parts of the heating device for varying the pressure in said cylinder whereby the stroke regulating device may be affected by said variations in pressure in said cylinder.

4. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; and a pair of balanced floats operable by the changes of ratio between two pressure differentials in different parts of the heating device for varying the pressure in said cylinder whereby the stroke regulating device

may be affected by said variations in pressure in said cylinder.

5. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; a damper regulator, including a liquid-containing cylinder; a pipe therefrom to said feed regulator cylinder; and means operable by the changes of ratio between two pressure differentials in different parts of the heating device for varying the pressure in said feed regulating cylinder whereby the stroke regulating device may be affected by said variations in pressure in said cylinder.

6. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; a damper regulator, including a liquid-containing cylinder; a pipe therefrom to said feed regulator cylinder; a valve in said connecting pipe; and means operable by the changes of ratio between two pressure differentials in different parts of the heating device for controlling the operation of said valve.

7. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; a damper regulator including a liquid-containing cylinder; a pipe therefrom to said feed regulator cylinder; a valve in said connecting pipe; two inclosed balanced floats for operating said valve; and connecting pipes from said inclosures and the interior of said floats to different portions of said heating device.

8. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; a damper regulator including a liquid-containing cylinder; a pipe therefrom to said feed regulator cylinder; a valve in said connecting pipe; two inclosed balanced floats for operating said valve; a pipe from one inclosure to the ash-pit of the heating device; a pipe from the float in said inclosure to the combination chamber; a pipe from the other inclosure to the pressure tube of a pitot in the exit for flue gases; and a pipe from the interior of the float in said second inclosure to the suction tube of the pitot in said exit.

9. In a device of the class described, the combination of a heating device; a fuel-feeding mechanism therefor; a device for regulating the stroke thereof; a cylinder containing a liquid under pressure; a piston therein connected to said regulating device; a damper regulator including a liquid-containing cylinder; a pipe therefrom to said feed regulator cylinder; a valve in said connecting pipe; two inclosed balanced floats for operating said valve; a pipe from one inclosure to the ash-pit of the heating device; a pipe from the float in said inclosure to the combustion chamber; a pipe from the other inclosure to the pressure tube of a pitot in the exit for flue gases; a pipe from the interior of the float in said second inclosure to the suction tube of the pitot in said exit; and a rocker member interposed between and connected to said floats and valve.

10. In a device of the class described, the combination of a heating device; a pair of inclosed floats; a pipe from one inclosure to the ash-pit of the heating device; a pipe from the float in said inclosure to the combustion chamber; a pipe from the other inclosure to the pressure tube of a pitot in the exit for flue gases; a pipe from the float in the second inclosure to the suction tube of said pitot; a fuel-feeding mechanism; and mechanism between said fuel-feeding mechanism and said floats whereby the stroke of the former is controlled by the operation of the latter.

11. In a device of the class described, the combination of a device having two pressure differentials; a pair of inclosed floats; means for controlling the operation of one float by one pressure differential; means for controlling the operation of the other float by the other pressure differential; a regulator controlling the operation of said device; and mechanism interposed between said regulator and floats whereby its operation is controlled by the combined operation of said floats.

12. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for regulating the supply of fuel to said heating device; and means interposed between said mechanism and said floats whereby the operation of said mechanism is controlled by the combined operation of said floats.

13. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating

device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for regulating the supply of fuel to said heating device; a damper for said heating device; and means, including mechanism for regulating the operation of said damper, interposed between said mechanism and said floats whereby the operation of said feed regulating mechanism is controlled by the combined operation of said floats.

14. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for regulating the supply of fuel to said heating device; a rocker member, the movement of which is controlled by the movements of said floats; and means interposed between said rocker member and said fuel-feeding mechanism whereby the operation of said feeding mechanism is controlled by the operation of said rocker member.

15. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for regulating the supply of fuel to said heating device; a rocker member, the movement of which is controlled by the movements of said floats; a damper for said heating device; and means, including mechanism for regulating the operation of said damper, interposed between said rocker member and said fuel-feeding mechanism whereby the operation of said feeding mechanism is controlled by the operation of said rocker member.

16. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism; and mechanism between said regulator and floats whereby the operation of said regulator is controlled by the combined movements of said floats.

17. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism; a rocker member connected to said floats and operated thereby; and mechanism between said regulator and rocker member whereby the operation of said regulator is controlled by the combined movements of said floats.

18. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism, including a piston chamber; means for supplying liquid under pressure to said chamber; a valve for controlling the admission of said liquid to said chamber; a rocker member connected to said floats and operated thereby; and a connector between said valve and rocker member whereby said valve movement is controlled by the operation of said rocker member.

19. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism, including a piston chamber; means for supplying liquid under pressure to said chamber; a balanced valve for controlling the admission of said liquid to said chamber; a rocker member connected to said floats and operated thereby; and a connector between said valve and rocker member whereby said valve movement is controlled by the operation of said rocker member.

20. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism, including a piston chamber; means, including a regulator for the damper of said heating device, for supplying liquid under pressure to said chamber; a valve for controlling the admission of said liquid to

said chamber; a rocker member connected to said floats and operated thereby; and a connector between said valve and rocker member whereby said valve movement is controlled by the operation of said rocker member.

21. In a device of the class described, the combination of a heating device; a pair of inclosed floats; means for controlling the operation of one of said floats by a pressure differential in one portion of said heating device; means for controlling the operation of the other float by a pressure differential in another portion of said heating device; mechanism for feeding fuel to said heating device; a device to regulate the feed of said mechanism, including a piston chamber; a resilient member within said chamber acting on said piston; means for supplying liquid under pressure to said chamber on the opposite side of said piston; a valve for controlling the admission of said liquid to said chamber; a rocker member connected to said floats and operated thereby; and a connector between said valve and rocker member whereby said valve movement is controlled by the operation of said rocker member.

22. In a device of the class described, the combination of a heating device having pressure differentials in two portions thereof; mechanism for controlling the operation of said device; a regulator for said controlling mechanism including an inclosed chamber and a spring-controlled piston therein; means for admitting to said chamber liquid under pressure; and a mechanism operable by the combined pressure differentials in said two portions of the heating device for controlling the admission of liquid to said chamber.

23. In a device of the class described, the combination of a heating device having pressure differentials in two portions thereof; mechanism for controlling the operation of said device; a regulator for said controlling mechanism including an inclosed chamber and a spring-controlled piston therein; means for admitting to said chamber liquid under pressure; and a float mechanism operable by the combined pressure differentials in said two portions of the heating device for controlling the admission of liquid to said chamber.

24. In a device of the class described, the combination of a heating device; mechanism for supplying fuel thereto; a device for regulating the feed thereof; a spring-pressed piston connected to said feed regulator; a casing for said piston; a damper for said heating device; a hydraulic regulator for said damper; and a pipe connection between said damper regulator cylinder and said piston casing.

25. In a device of the class described, the combination of a heating device; mechanism for supplying fuel thereto; a device for regulating the feed thereof; a spring-pressed piston connected to said feed regulator; a casing for said piston; a damper for said heating device; a hydraulic regulator for said damper; a pipe connection between said damper regulator cylinder and said piston casing; a valve in said pipe connection; and means for automatically operating said valve in accordance with the conditions of the fire in said heating device.

Signed by me at New York city, New York this fourth day of August, 1909.

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Witnesses:

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