April 14, 1925. 1,533,800

F. HENNEBOHLE

APPARATUS FOR CONTROLLING STEAM PRESSURE IN BOILERS

Filed Feb. 11 1921 2 Sheets-Sheet 1

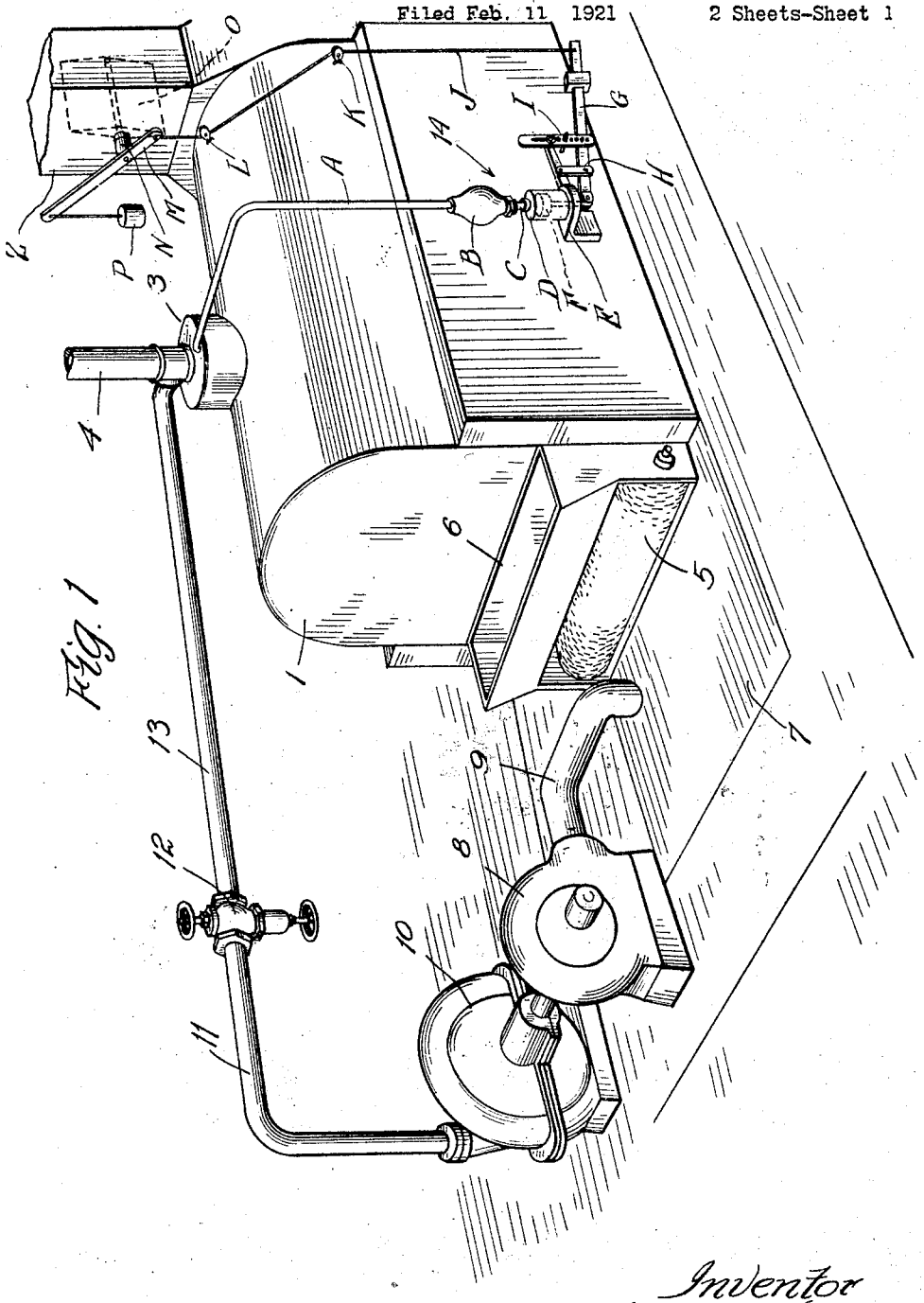



Fig. 1

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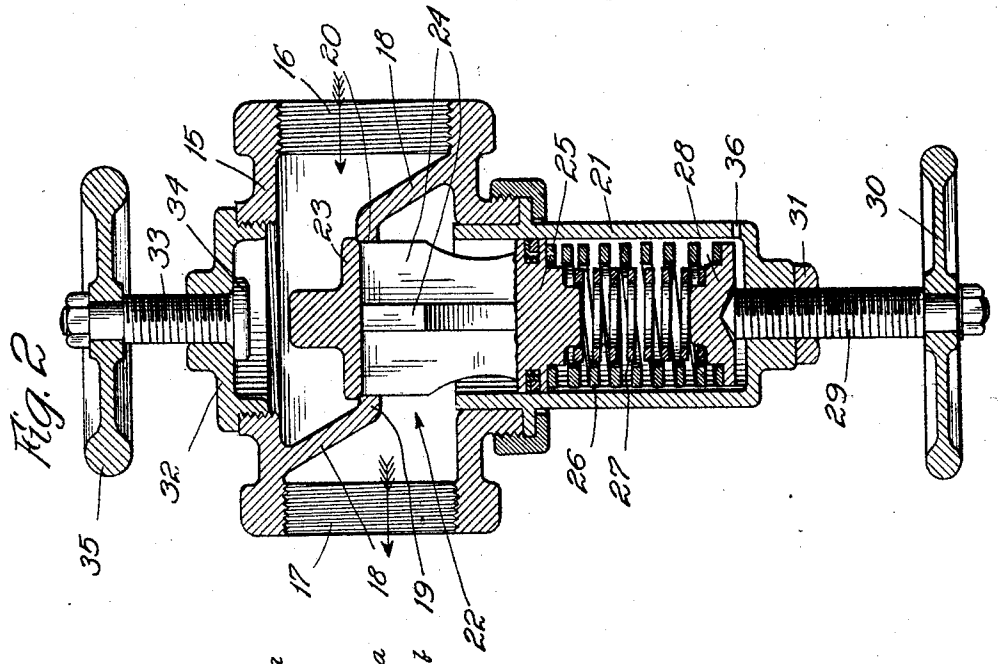



Fig. 2

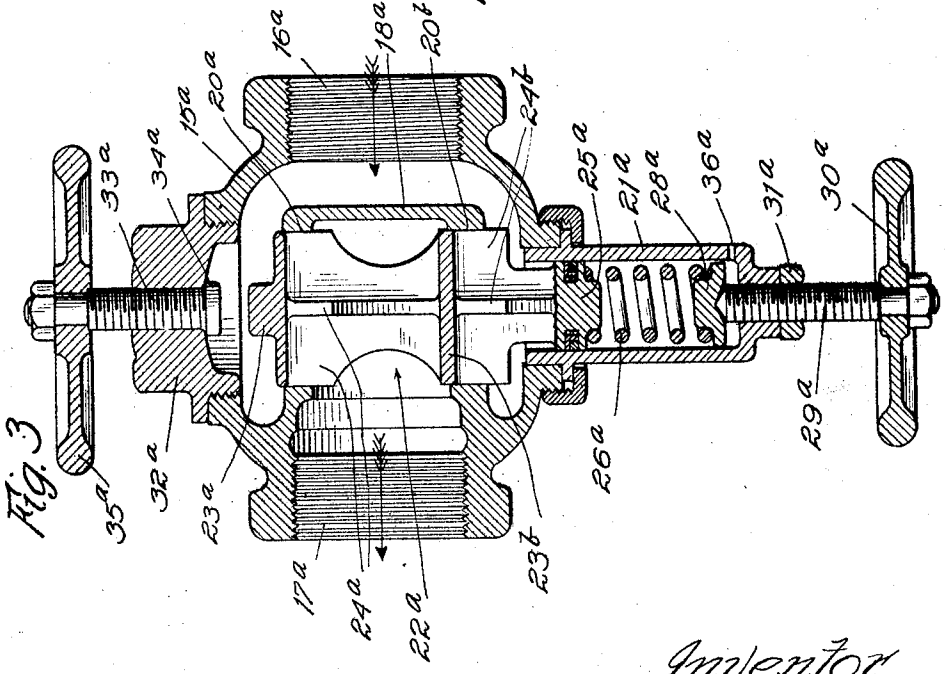



Fig. 3

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# UNITED STATES PATENT OFFICE.

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## APPARATUS FOR CONTROLLING STEAM PRESSURE IN BOILERS.

Application filed February 11, 1921. Serial No. 444,253.

*To all whom it may concern:*

Be it known that I, FRANK HENNEBOHLE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Controlling Steam Pressure in Boilers, of which the following is a specification.

The invention relates to an apparatus for controlling the pressure in steam boilers, and more particularly to automatic means for varying the rate of fuel combustion in the fire box of a boiler by the employment of a forced draft of varying volume to supplement the natural draft and further by providing controls for the natural draft.

In steam power plants, the boilers are usually subjected to varying demands in the consumption of steam by the power units being operated thereby.

The variable load upon a steam engine driving industrial equipment, for example, wherein the operation of the machinery involves the irregular use of power, is directly reflected in its consumption of steam. With a sudden increase of load, and consequent sudden increase of steam consumption, the boiler pressure is drawn down and the efficiency of the engine is seriously reduced at the period of greatest demand.

Obviously, increased steam consumption requires a proportionately increased steam production in the boilers to maintain evenly a desired steam pressure, a requirement to be met by increasing the amount of heat generated in the fire box.

Conversely, when the steam consumption is decreased and the boiler pressure thereby rises above that which it is desired to maintain, it is necessary to reduce the steam production by checking combustion in the fire-box.

Pressure regulated dampers heretofore have been used in the smoke flue, the damper being operable, by increased boiler pressure, to partially close the flue and check the draft from the fire. The damper being fully open with normal boiler pressure, such a device is obviously not adapted to cause an increase in combustion when the boiler pressure is decreased below normal.

It is the principal object of this invention to provide in connection with a pressure regulated damper operating to check the natural draft of the furnace when the same is abnormally great, positively acting automatic means controlled by the boiler pressure, for increasing or decreasing the volume of an induced draft to supplement the natural draft in the fire box, as the boiler pressure falls below or rises above a predetermined point, thereby increasing or decreasing combustion in the fire box, and, in either case, restoring the desired boiler pressure.

Another object is to provide in connection with a steam actuated blower, an improved form of automatic means for varying the speed of the blower in proportion to the rise and fall of pressure in the boiler.

Other objects and advantages will appear in the following description of a preferred embodiment of my invention, illustrated in the accompanying drawings. It is to be understood, however, that in the interpretation of the appended claims, they are not to be limited to the precise construction or arrangement set forth except as may be necessitated by the state of the prior art.

In the drawings, Figure 1 represents a boiler equipped with draft inducing means embodying my invention. Fig. 2 is a sectional view of the controlling valve as employed in smaller units, and Fig. 3 is a sectional view of my valve as adapted to larger units.

Referring to Fig. 1 which is more or less diagrammatic, the numeral 1 indicates a boiler of conventionnal type, having a smoke stack 2 and a steam dome 3 from which a steam line 4 leads to a steam engine or other translational devices (not shown). The boiler may be equipped with a mechanical stoker having chain grates 5 and a feed hopper 6. An ash pit running beneath the fire box, extends forwardly of the boiler and is covered by a floor plate 7. A centrifugal blower 8 is adapted to force air through a tube 9 opening into the ash pit through the plate 7. The blower is actuated by a steam turbine 10 receiving its steam supply from a pipe 11 leading from a controlling valve 12, which latter is connected by a pipe 13 to the steam dome 3. The valve 12 is adapted, as hereinafter more fully described, to regulate automatically the supply of steam to the turbine 10.

The valve 12 may be adjusted to main-

tain a given steam supply to the turbine, under normal conditions of boiler pressure and steam consumption, whereby a sufficient draft is supplied to the grates to support a balancing fuel combustion and steam production. With a lowering of pressure in the boiler and pipe 13 due to abnormal steam consumption, the valve 12 automatically admits an increased steam supply to the turbine 10. Speeding up the latter and the blower 8, increases the forced draft through the grates and builds up the boiler pressure with the increased rate of fuel combustion. After normal operating conditions are restored the valve 12 operates to cut down the steam supply to the turbine, and reduce the draft to the grates.

A partial shut-down of the power plant, reducing the steam consumption below normal and raising the boiler pressure, causes the controlling valve to further reduce the steam supply to the turbine and proportionately reduce the air supply to the fire.

The controlling valve may be manually closed against automatic operation, as may be desired in case of a shut-down, or to prevent excessive draft during the firing up of a boiler preliminary to its being put in service.

The great advantage in boiler plant operation which I have accomplished in automatically balancing fuel combustion and steam production with boiler pressure and steam consumption, through the variable range of power demands, may be effected by my automatic valve control in combination with other draft inducing means, than that herein illustrated, as, for example, the employment of steam jets in the fire box or stack receiving their steam supply from the controlling valve.

To effect a more rapid checking of the rate of fuel combustion when the boiler pressure rises above that of normal operation as, for example, where the draft inducing means has been cut out of operation but because of an abnormal natural draft, or because of other conditions, the fuel combustion is too great, it may be desirable to supplement the operative result from the automatic control of the blower by employing a pressure controlled damper in the smoke-flue automatically operable to close the flue and check the fire until normal pressure is restored.

Any well-known or preferred construction of controlling device may be employed to operate the damper. That herein illustrated and indicated generally at 14 comprises a steam connection A leading from the steam dome 3 to a condensation chamber in the casing B. A pipe C connects the lower end of the casing B with the upper end of the cylinder D mounted on a fixed bracket E suitably secured to the side of the boiler. A reciprocatory piston F operating within the cylinder carries a piston rod pivotally attached to one end of the lever G having its fulcrum pivoted on a support H fixed to the bracket E. A member I adjustably mounted on the bracket E is adapted to limit the upward movement of the lever G as may be desired. To the other end of the lever G is attached a cable J running through sheaves K and L to a lever M being attached to one end of that lever. The lever M is rigidly secured to a shaft N extending through the smoke-flue 2 and having suitable bearings in the walls of the stack. Within the flue a damper O is rigidly mounted on the shaft and is adapted in its operative movement to open or partially close the smoke flue. The opposite end of the lever M carries a suspended weight P adapted to oppose the movement of the lever by the cable and maintain the latter in taut condition.

In the operation of the auxiliary damper device, steam passing through the connection A is condensed in the chamber B, the condensation water therefrom passing through the pipe C into the cylinder D into operative contact with the piston F. The weight P and the relation of the opposite ends of the levers G and M to their respective fulcrums are so arranged that the increase of boiler pressure above a predetermined maximum pressure results in forcing downwardly the piston F thereby operating the lever G, the cable J and the lever M to turn the damper O within the flue and effect a partial closure thereof. The degree of closure of the flue effected by this movement of the damper is predetermined by the position of the stop pin in the adjustable member I which limits the upward swing of the cable end of the lever G. The damper will be held in closed position until the boiler pressure recedes below the predetermined maximum whereupon the weight on the lever G operates to overcome the pressure upon the piston and the damper O is turned into normal open position. Adjustment to the desired maximum pressure at which the piston will be operated may be made by shifting the weight upon the outer end of the lever G.

It will be seen that in the case of excessive boiler pressure, the damper is operated to aid in checking combustion in the fire box, but that the damper is inoperable by itself to effect an increase in the draft under conditions of decreased steam pressure below that normally to be maintained with the flue open. In the latter event, increased combustion in the fire box is effected wholly by supplementing the natural draft by means of the automatically operating draft inducing blower.

My preferred construction of the control-

ling valve, by means of which the automatic regulation of the draft inducing blower is accomplished, and as illustrated in Fig. 2, is adapted for use with a boiler installation of moderate size. For large batteries of boilers I employ the construction illustrated in Fig. 3, which embodies a balanced valve member and large flow capacity.

Referring to Fig. 2, the numeral 15 indicates a tubular valve body having an inlet 16 and an outlet 17, both of the latter being adapted for connection with steam piping. An integral web 18 effects a closure of the interior of the body and is formed with a plane portion 19 parallel to the axis of the body and having an aperture 20, the upper marginal edge of which forms a valve seat.

A laterally extending, cylindrical casing 21 is fixed in an opening in the side of the body 15, having an open end of its interior chamber in register with the valve aperture 20. A valve member 22 carries a head 23 adapted to effect a closure of the valve aperture 20 and from which depend crossed wings 24 extending into the casing 21. A piston 25, carried by the wings 24 is reciprocably engaged in steam-tight contact with the inner walls of the casing 21. A pair of oppositely coiled compression springs 26 and 27 are confined between the piston 25 and a support 28 located in the closed outer end of the casing and tend to force the piston toward the valve body and raise the valve head from its seat. The oppositely arranged pitch of the coiled springs prevents their catching one upon the other in operation. An air vent 36 provides for the escape of air trapped by the reciprocating piston. A screw-threaded spindle 29, entering through the closed end wall of the casing 21, engages the support 28 oppositely to the compression springs. A hand wheel 30 is mounted on the outer end of the spindle. A lock nut 31 is provided to secure the spindle in any desired position. A cap 32 is secured in an aperture through the side of the valve body 15 positioned opposite to and concentric with the valve aperture 20. A screw-threaded stem 33 extends through the cap 32 and has a flange 34 adapted to abut the valve head 23 to force the latter to its seat. A hand wheel 35 is mounted on the outer end of the stem.

In operation, the flange 34 is turned down to secure the valve head 23 in its seat until it is desired to utilize forced draft with the boiler. The flange 34 is then backed off, releasing the valve head to be raised from its seat by the springs 26 and 27. Thereupon live steam from the boiler connection 13 entering the inlet 16 flows in the direction indicated by the arrows, through the aperture 20 and outlet 17 to the blower actuating turbine 10. The degree to which the valve head will open the valve aperture depends upon the relation between the steam pressure upon the upper or inlet side of the head 23 and the tension of the springs 26 and 27. The spring tension may be adjusted by turning the spindle 29 in or out of the casing to move the support 28, and increase or decrease the compression of the springs. A balanced relation may be obtained by such an adjustment at any boiler pressure which it is desirable to maintain. Fluctuations from that boiler pressure operate to relieve or increase the steam pressure upon the head 23 in variable opposition to the constant spring tension, resulting in the automatic further opening or closing of the valve aperture and the increase or decrease of steam supply to the blower actuating turbine.

Referring to the modified form of greater capacity illustrated in Fig. 3, the controlling valve comprises a body $15^a$ having an inlet $16^a$ and an outlet $17^a$. A closure $18^a$ integral with the body is provided with a pair of concentric valve apertures $20^a$ and $20^b$ forming valve seats. A cylindrical casing $21^a$ extends laterally from an opening in the body in which it is secured with its axis coincident with the axis of the valve apertures.

A valve member $22^a$ carries a head $23^a$ adapted to seat in the valve aperture $20^a$, and also a valve diaphragm $23^b$ adapted to effect a steam tight closure of the valve aperture $20^b$. Crossed wings $24^a$ connect the head $23^a$ and the diaphragm $23^b$, and from the latter depend supplemental wings $24^b$ extending into the casing $21^a$. A piston $25^a$ is fixed on the lower ends of the wings $24^b$ in reciprocable steam tight engagement with the interior surface of the wall of the casing $21^a$. A coiled compression spring $26^a$ is tensioned between the piston $25^a$ and a support $28^a$ located in the outer closed end of the casing, and tends to force the piston inwardly and disengage the valve head and diaphragm from their seats.

The construction of the parts $29^a$ to $36^a$ inclusive being substantially similar to the corresponding parts 29 to 36 inclusive in Fig. 2, need not be further described.

In its operation the last described valve construction is similar to that first described except that the valve member $22^a$ is balanced in the relation of the valve head $23^a$ and the diaphragm $23^b$ to the stream pressure in the valve inlet. The steam pressure upon the upper face of the head $23^a$ is counter opposed by the pressure upon the lower side of the diaphragm $23^b$ of similar cross area. Also in the present structure the piston $25^a$ receives the full boiler pressure from the inlet side of the valve, and is designed to operate the valve member in its automatic closure of the two valve apertures.

The counter opposed tension of the spring $26^a$ may be adjusted to the steam pressure

upon the upper face of the piston 25ª to secure the same operative results, as previously described in that connection.

It will now be apparent that I have provided effective means for accomplishing the objects set forth, and have thereby accomplished substantial economies and uniform efficiency in the operation of steam plants equipped with my invention.

I claim as my invention:

1. A control system for regulating the passage of pressure fluid in proportions inverse to the supply pressure comprising, in combination, a fluid pressure source, a fluid consumer, a valve between said source and said consumer adapted to control the fluid consumed, said valve having a valve member balanced on its outlet side and controlling communication from the inlet to the outlet side of the valve, spring means tending normally to open said valve member, said spring means being most forceful in the closed position of the valve member, a piston arranged for motion by pressure thereon from the inlet side of the valve, said piston being arranged to move said valve member toward closure by an increase of pressure on said piston, and said spring means being adjusted to hold said valve member in open balanced position in the normal use of the valve against the force of said pressure on said piston.

2. A control system for regulating the passage of pressure fluid in proportions inverse to the supply pressure comprising, in combination, a fluid pressure source, a fluid consumer, a valve between said source and said consumer adapted to control the fluid consumed, said valve having a valve member balanced on its outlet side, means tending to close said valve member by increasing pressure on the inlet side of the valve, and other means tending to open the valve independently of the fluid pressure, said means being most forceful in the closed position of the valve, and said two means being arranged to oppose each other to balance the valve member between its extreme positions in the normal use of the valve.

3. In combination, a source of fluid pressure, a fluid consumer and a self-contained automatic valve between said source and said consumer, said valve having a valve member therein balanced on the outlet side whether opened or closed and movable to vary the opening of the valve, said valve out of use being normally wide open, and said valve member being movable toward closure by an increase in pressure in said source, whereby in use the valve member regulates the passage of pressure fluid thru said valve in proportions inversely related to said pressure.

4. A control system for regulating the passage of pressure fluid in proportions inverse to the supply pressure comprising, in combination, a fluid pressure source, a fluid consumer, a valve between said source and said consumer adapted to control the fluid consumed said valve having a valve member balanced on its outlet side and controlling passage of fluid therethru said valve member being arranged for motion toward closure by pressure from the inlet side of the valve, and means opposing said motion with a force increasing toward closure of the valve member, whereby the valve member tends to become balanced in operation to move with variation of either force to a new balanced position.

5. A control system for regulating the passage of pressure fluid in proportions inverse to the supply pressure comprising, in combination, a fluid pressure source, a fluid consumer, a valve between said source and said consumer adapted to control the fluid consumed, said valve having a valve member balanced on its outlet side and adapted to regulate the passage of pressure fluid therethru, said valve member being arranged for motion toward closure by pressure from the inlet side of the valve, and means opposing said motion with a force increasing toward closure of the valve member, whereby the valve member tends to become balanced in operation to move with variation of either force to a new balanced position, and means to vary the force of the motion opposing means.

6. In a fluid pressure supply line, a valve having a valve seat therein between the inlet and the outlet of the valve, a valve constantly balanced on its outlet side and movable to close said seat by pressure of the fluid supply at the inlet, mechanical means tending to open the valve member with a force inversely proportional to the extent of opening of said valve member, whereby said valve member becomes balanced by said means acting against the fluid pressure at the valve inlet, whereby to regulate the passage of fluid thru said valve inversely as the fluid pressure varies.

In testimony whereof, I have hereunto set my hand.

FRANK HENNEBOHLE.