

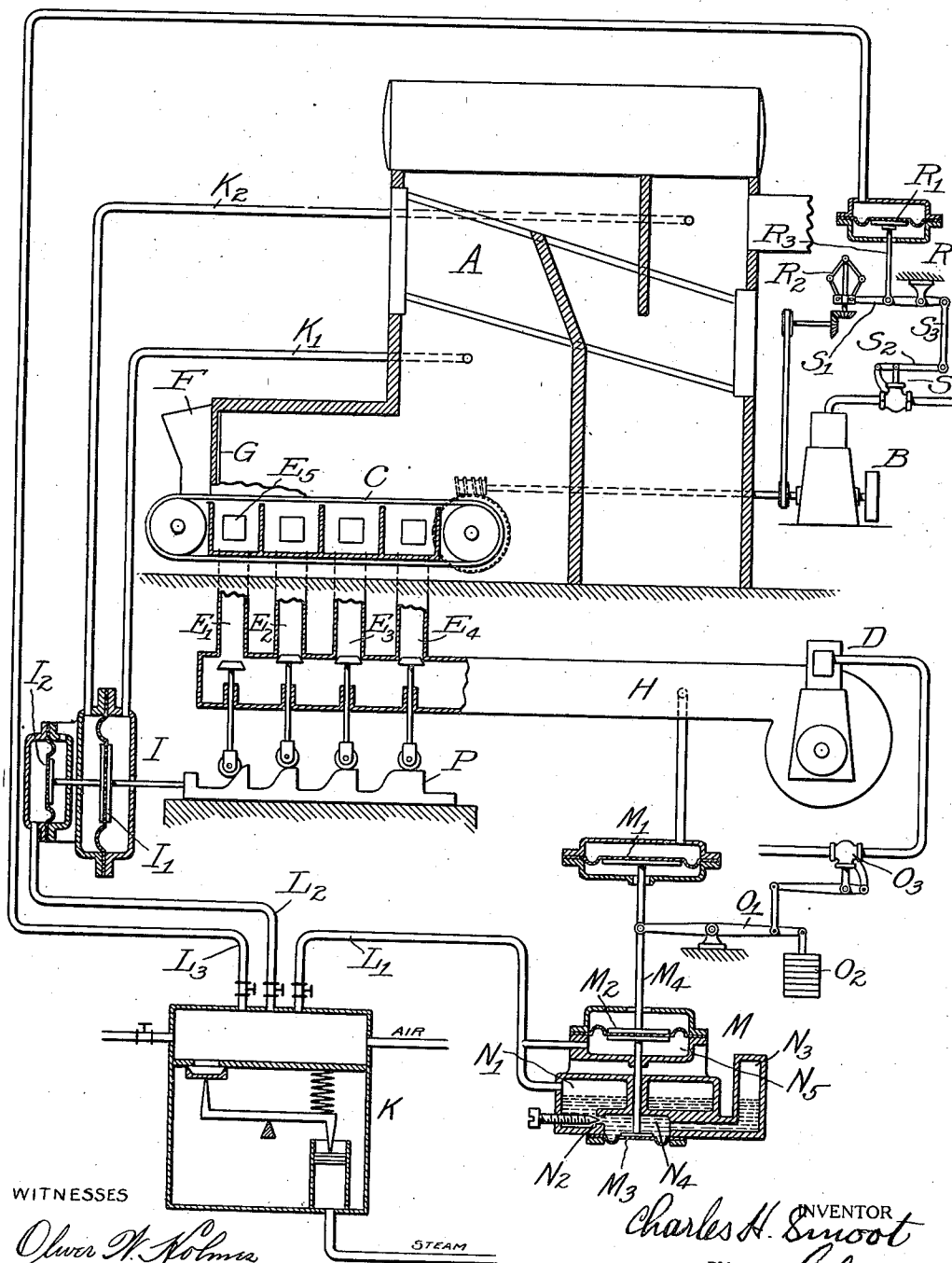
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FURNACE REGULATION

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WITNESSES

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FURNACE REGULATION.

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This invention relates to regulators for controlling the draft through the grates of furnace stokers where the draft is applied with varying force to sectionalized areas of the grate.

In certain types of stokers, it is found desirable to run with a uniform thickness of fuel on the grate and to vary the amount of steam generated by changing the speed of the stoker which directly controls the amount of fuel drawn into the fire and in addition the length of the fire.

At light loads, air is supplied to only a limited length of the grate, where complete combustion is produced, and as the boiler output is increased, additional sections admitting air under the grate are opened to give a greater length of grate supplied with air and a corresponding increase in speed of stoker, which draws out the fire, increasing the combustion area with the rating. In doing this, it is also found desirable for practical reasons to maintain a nearly uniform maximum air pressure under the grate, which results in a nearly uniform maximum quantity of fuel consumed per square foot of active area.

The reason for maintaining nearly uniform maximum air pressure is in most instances due to the size of fuel being burned, which is often very fine, and would be carried bodily from the grate by the air blast, if the quantity of air passing through a given area be increased above a definite value, which corresponds to the maximum air pressure found efficient under the grate. This air pressure is therefore not in any wise dependent upon the total amount of fuel burned, but is determined by the size of the fuel. The amount of fuel to be burned and the output of the boiler is determined by the area of grate, which receives air from underneath and fuel above for combustion.

Owing to the slow speed of the chain and the comparatively slow rate of fuel combustion upon the chain, it is impractical to obtain a rapid change in length of fire, either increasing or decreasing, so that when rapid changes of steam output are demanded, they can only be obtained by changing the quantity of air passed through the then-existing

area of fuel under combustion, which calls for a higher or lower air pressure than the normal fuel, which is conducive to maximum economy.

In the system of stoker regulation which I have invented, these two conflicting conditions are provided for by the use of an air pressure regulator of very special characteristics, together with a stoker speed regulator and an air volume regulator, all being under the control of a master regulator whose function is to set the pace in response to the load placed on the boiler.

The air pressure regulator, on a sudden change in load, produces a corresponding change in air pressure, which permits the existing length of fire to meet such load changes as best it may. Subsequent to such change in air pressure, the regulator slowly, with a time element under control and adjustment, returns the pressure to its normal value. As the pressure is returned to its normal value, the quantity of air passing through a given area of grate is reduced or increased and an air volume regulator, opening or closing successively various dampers underneath the grate, comes into play, keeping the air volume at its normal value and giving air to a greater or less area of grate. Thus, after a change in load has occurred, the momentary change is met by a momentary change in air pressure to give time for the change in speed of stoker under control of stoker engine to lengthen or shorten, or increase or decrease the area of fuel, and coincidentally with such change, an air volume regulator is provided, which, by opening or closing successive dampers, supplies air to a greater or less area of grate, as needed.

By these means, no matter what the load on the boiler may be, just as soon as it reaches a steady value, without material rates of increase or decrease, the regulating system adjusts the length of fire in such a way as to restore the air pressure to the constant normal value found most suitable for the fuel being burned.

The system which I have invented for this purpose, is outlined in the accompanying drawing, in which A is a conventional steam

boiler, B the stoker engine driving the chain grate C. D is an engine driven fan supplying air under pressure. E^1 , E^2 , E^3 , and E^4 are a series of dampers admitting air to chambers underneath the chain grate. F is the hopper containing fuel to be burned, which is drawn into the fire under the gate G, whose height determines the thickness of fuel bed. K is a master regulator which, receiving steam pressure, allows compressed air to pass through pipes L^1 , L^2 and L^3 to various pieces of regulating apparatus. M is an air pressure regulator, provided with diaphragm M^1 , which receives the air blast pressure on its upper face and atmospheric pressure on its lower face. Diaphragm M^2 receives atmospheric pressure above and the pressure from master governor K underneath. Diaphragm M^3 in chamber N^4 , receives the pressure of a viscous fluid in chamber N^1 of the air pressure regulator through the restricted orifice N^2 . Chamber N^3 is an air cushion connected to chamber N^4 . The diaphragms M^1 , M^2 and M^3 are all secured to a central rod M^4 . O^1 is a fulcrum lever to which adjusting weight O^2 is attached. The lever O^1 is also connected to the valve O^3 , which controls the supply of steam to the engine driven fan D and to the diaphragm rod M^4 .

The operation of this air pressure regulator is as follows:

A change of load occurring on the boiler, which would reduce the steam pressure by virtue of the action of the master regulator (as described in my U. S. Reissue Patent No. 16,507, dated December 21, 1926, will give an increasing pressure in pipe L^1 , which pressure is immediately conveyed to diaphragm M^2 and exerts an upward effort which is only balanced by an increase in air pressure from the fan D exerting an increased downward effort on diaphragm M^1 .

Owing to the restriction of orifice N^2 no immediate change in pressure occurs in chamber N^4 so that immediately after a change of condition the force applied to diaphragm M^3 remains constant and is not affected by such change.

The initial lack of balance in force between pressure on diaphragms M^1 and M^2 displaces control valve O^3 and effects a change in speed of the engine D and pressure of air delivered in the duct H. Thus a change in steam pressure at master regulator produces immediately a change in air pressure in duct H through the action of the regulator M.

The viscous fluid in chamber N^1 passes slowly through orifice N^2 , increasing the pressure in chamber N^4 until eventually the pressure in this chamber is equal to the pressure in chamber N^3 under diaphragm M^2 , which neutralizes the effort of these two diaphragms, causing a motion of regulator le-

ver O^1 and throttle valve O^3 which returns the pressure in duct H to the value it was originally, which would be the value determined by the weight O^2 acting alone as counterpoise against the pressure on diaphragm M^1 .

The action of this regulator therefore is to produce a momentary change in pressure of duct H on changes of master load pressure in pipe L^1 in response to change of steam pressure or load and then by a time interval under control of opening of restricted orifice N^2 return the pressure in duct H to its original value.

The regulator I controls the volume of air passing through the boiler A in such a manner that the pressure difference between pipes K^1 and K^2 which are connected across the drop in draft through the boiler tubes and act on diaphragm I^1 with a force which is just counterbalanced by the master loading pressure in pipe L^2 acting in an opposite direction on the diaphragm I^2 , one side of which is open to atmosphere.

The action of this regulator is as follows:

Any motion produced by a lack of balance between pressures on diaphragms I^1 and I^2 cause a translation motion to cam plate P, which through the action of rollers opens consecutively valves E^1 , E^2 , etc., on right hand motion and closes them on left hand motion. As cam plate P is moved to the right, the valves E^1 , E^2 , etc., are progressively opened and an increasing quantity of air is passed through the boiler which produces an increased pressure difference due to resistance of the boiler between pipes K^1 and K^2 , reacting on diaphragm I^1 to produce a closing action on valves E^1 , etc.

Thus it will be seen that the pressure from the master controller K applied through pipe L^2 to regulator I changes the volume of air passing through boiler A and regulator I operates to change this volume through the valves E^1 , etc., continuing to operate until the change in volume called for by the master regulator has been produced.

R is the speed regulator controlling the stoker engine B. It is provided with a diaphragm R^1 , whose upper side is connected to pipe L^3 from master regulator K. The lower side is open to atmosphere.

R^2 is a centrifugal speed regulator whose centrifugal action operating to lift lever S^1 , is opposed by the downward force of diaphragm R^1 also operating on the lever S^1 through rod R^3 .

S is a throttle valve actuated by levers S^1 , S^2 and rod S^3 , transmitting motion from the speed governor to the valve.

The action of regulator R is as follows:

The engine is driven to such a speed that the pull of the governor R^2 is always counterpoised by the force of diaphragm R^1 , which in turn is determined by the pressure

in pipe L⁵ from master regulator. Any change in pressure in pipe L⁵ will momentarily cause a lack of balance between the force on diaphragm R¹ and the pull of centrifugal governor R², which has an action on throttle valve S to increase or decrease the steam supply as necessary to produce a change in speed of engine and of governor R² such that the new speed produces complete balance between the upward pull of the speed governor and the downward force of diaphragm R¹.

It will be seen from the above that with this system of stoker regulation, I accomplish the result desired, by supplying fixed relative proportions between fuel and air at all times, and that in addition to maintaining this ratio, which is desirable for good combustion efficiency, I have provided a system which allows for momentary changes in load being met by momentary changes in air pressure and without corresponding changes in length of fuel bed, while after a sufficient time has elapsed to permit the slow moving stoker to alter the length of the fuel bed the air pressure is restored to its normal suitable value and in so doing causes a corresponding change in position of the inlet valves E whereby the length of grate supplied with air is after a time interval altered in proportion to the load being carried. The amount of such time delay between changes in length of fire and changes in load on the fire is an adjustable element entirely controlled by the area of restricted orifice N².

It will further be seen that if diaphragms M² and M³ are not exactly equal in area, I can further give what is often desirable—a moderate increase in pressure in duct H with increase in load on the boiler and quantity of air flowing, such that this increase is just sufficient to overcome the friction in duct H, valves E¹, etc., and maintain in the chambers underneath the grate, for example chamber E⁵, a constant pressure at all ratings, since the pressure in duct H has been increased just enough to overcome the loss in pressure by friction between chamber E⁵ and duct H. Similarly adjustments may be made or proportions adopted that will permit of some variation from the normal pressure under the grate.

It will be obvious to the skilled engineer that there are many other methods of operating the valves E¹, E², etc., also that a suitable power relay may be interposed between diaphragm regulator I and the cam plate P for the purpose of greatly increasing the power delivered to the cam plate P to overcome the very material frictional resistance which it encounters. The addition of a power relay between regulator proper and element to be operated by regulator in no wise constitutes a change in the nature of this invention.

The invention has been particularly described with reference to a stoker of the chain grate type as an example. It is evident that the invention may be applied to other forms of stokers.

I claim:—

1. In a system of combustion control for stokers, the combination of a grate and means for varying in sections the area of air supply to the grate, with means for successively admitting air to such sections, and means responsive to changes in boiler rating for controlling said air admission means.

2. In a system of combustion control for stokers, the combination of a grate and means for varying in sections the area of air supply to the grate, with means for successively admitting air to such sections, means responsive to changes in boiler rating for controlling said air admission means, and means also responsive to boiler rating for controlling the speed of the stoker.

3. In a system of combustion control for stokers, means for normally supplying air under constant pressure to a series of sections of the grate, means for admitting such air successively to such sections, means responsive to boiler rating for controlling such admission means, loaded means responsive to the air pressure tending to keep the air pressure constant, means responsive immediately to the steam demands for causing the air pressure to be changed temporarily, and means responsive to the steam demands with a time delay for counteracting the last mentioned means to restore the air pressure to normal when sufficient time has elapsed to enable the grate to meet the changed conditions.

4. The combination comprising a grate, a plurality of draft chambers each admitting air to a section of the grate, means for supplying a forced draft varying in volume but normally at uniform pressure, means for admitting the draft to the chambers successively, and means responsive to boiler rating controlling such admission means.

5. The combination comprising a grate with means for feeding fuel thereto, a plurality of draft chambers each admitting air to a section of the grate, means for supplying a forced draft varying in volume but normally at uniform pressure, means for admitting the draft to the chambers successively, means responsive to boiler rating controlling such admission means, and other means responsive to boiler rating for controlling the stoker feed.

6. The combination comprising a grate with means for feeding fuel thereto, a plurality of draft chambers each admitting air to a section of the grate, means for supplying a forced draft normally at uniform pressure, means for admitting the draft to the chambers successively, means responsive

to boiler rating controlling such admission means, other means responsive to boiler rating for controlling the stoker feed, and loaded means responsive to the air pressure for normally holding the said pressure constant.

7. The combination comprising a grate with means for feeding fuel thereto, a plurality of draft chambers each admitting air to a section of the grate, means for supplying a draft normally at uniform pressure, means for admitting the draft to the chambers successively, means responsive to boiler rating controlling such admission means, other means responsive to boiler rating for controlling the fuel feed proportionately with the air volume, loaded means responsive to the air pressure for normally holding the said pressure constant, and a centralized master controller in which means responsive to steam pressure controls an auxiliary medium, and connections from the master controller to the fuel feed control and the air volume control whereby the auxiliary medium simultaneously governs both controls in response to steam demands.

8. The combination comprising a grate with means for feeding fuel thereto, a plurality of draft chambers each admitting air to a section of the grate, means for supplying a forced draft normally at uniform pressure, means for admitting the draft to the chambers successively, means responsive to boiler rating controlling such admission means, other means responsive to boiler rating for controlling the fuel feed proportionately with the air volume, loaded means responsive to the air pressure for normally holding the said pressure constant, and means responsive to boiler rating for temporarily controlling said loaded means with other means reacting upon it, including a retarding device, to restore the load to normal after the lapse of sufficient time to enable the fuel feeding means to meet the changed conditions.

9. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a chain grate stoker, means for furnishing a forced draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the forced draft, and controlling means for said opening means responsive to the drop in air pressure through the furnace.

10. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a chain grate stoker, means for furnishing a forced draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the forced draft, controlling means for said opening means responsive to the drop in air pressure

through the furnace, and means responsive to steam demands for varying the speed of the stoker.

11. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a chain grate stoker, means for furnishing a forced draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the forced draft to vary the air volume, controlling means for said opening means responsive to the drop in air pressure through the furnace, a centralized master controller in which means responsive to steam pressure controls an auxiliary medium, and connections from the master controller to the stoker feed control and the air volume control whereby the auxiliary medium simultaneously governs both controls in response to steam demands.

12. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a chain grate stoker, means for furnishing a forced draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the forced draft to vary the air volume, controlling means for said opening means responsive to the drop in air pressure through the furnace, a centralized master controller in which means responsive to steam pressure controls an auxiliary medium, connections from the master controller to the stoker feed control and the air volume control whereby the auxiliary medium simultaneously governs both controls in response to steam demands, loaded means responsive to the air pressure for normally holding said air pressure constant, and means connecting the said control mechanism with the master controller whereby the auxiliary medium affects the loading temporarily in response to sudden changes in steam demands, with a retarding device also under control of the auxiliary medium for gradually cancelling out the effect of the temporary demand upon the loading until the air pressure is returned to normal.

13. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a stoker, means for furnishing draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the draft, and controlling means for said opening means responsive to a function of the volume of air flowing through the furnace.

14. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a stoker, means for furnishing draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the forced draft, and controlling

means for said opening means responsive to the drop in air pressure through the furnace.

15. In apparatus for regulating combustion in steam boiler furnaces, the combination comprising a stoker, means for furnishing draft to the fuel on said stoker, means for sectionalizing the draft at the stoker, means for opening up in succession such sections to the draft, controlling means for said opening means responsive to the drop in air pressure through the furnace, and means responsive to steam demands for varying the speed of the stoker. 10

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