G. H. GIBSON.

FLOW CONTROLLING APPARATUS.

APPLICATION FILED JUNE 1, 1914.

1,166,758.

Patented Jan. 4, 1916.

2 SHEETS—SHEET 1.

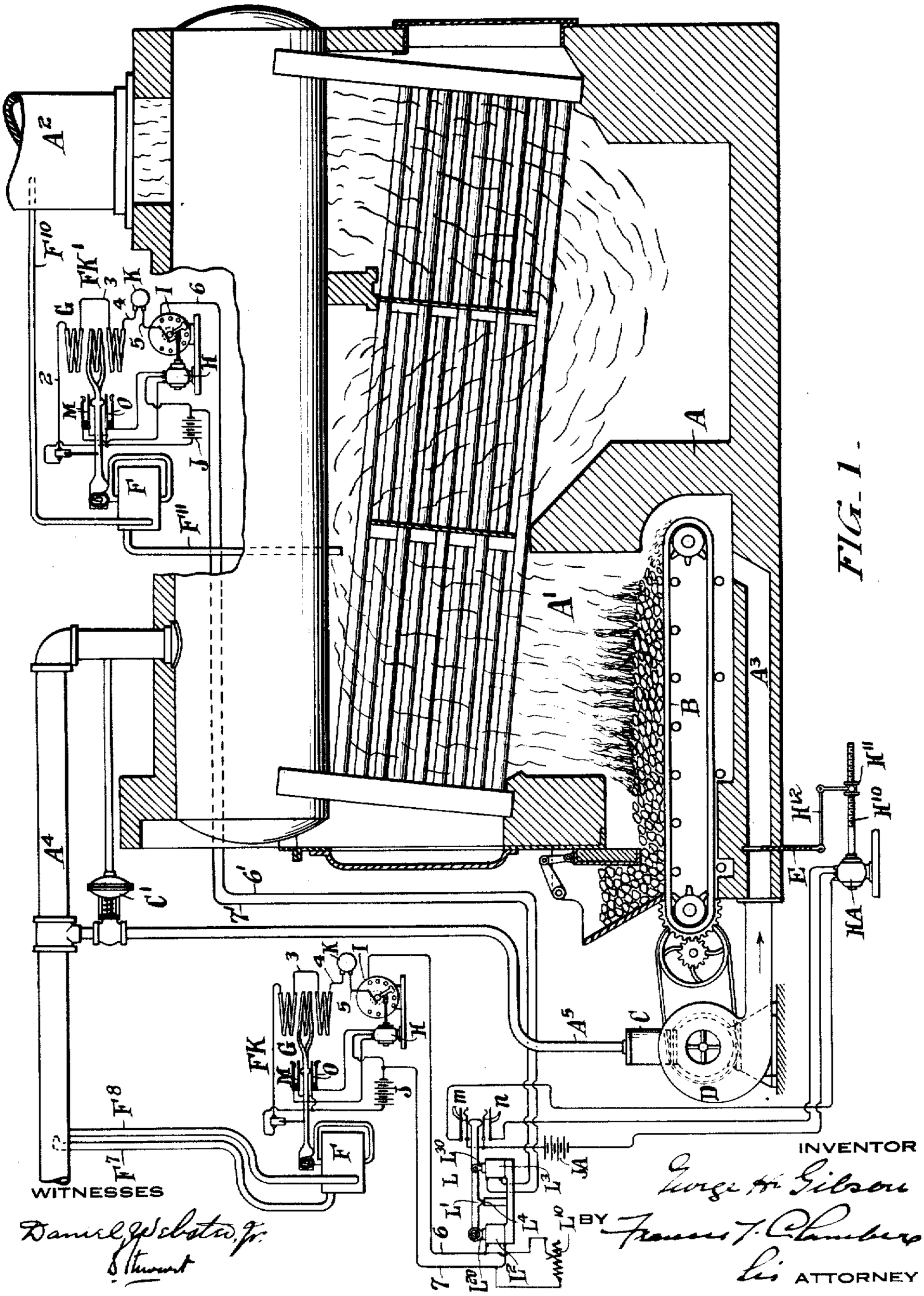

FIG. 1.

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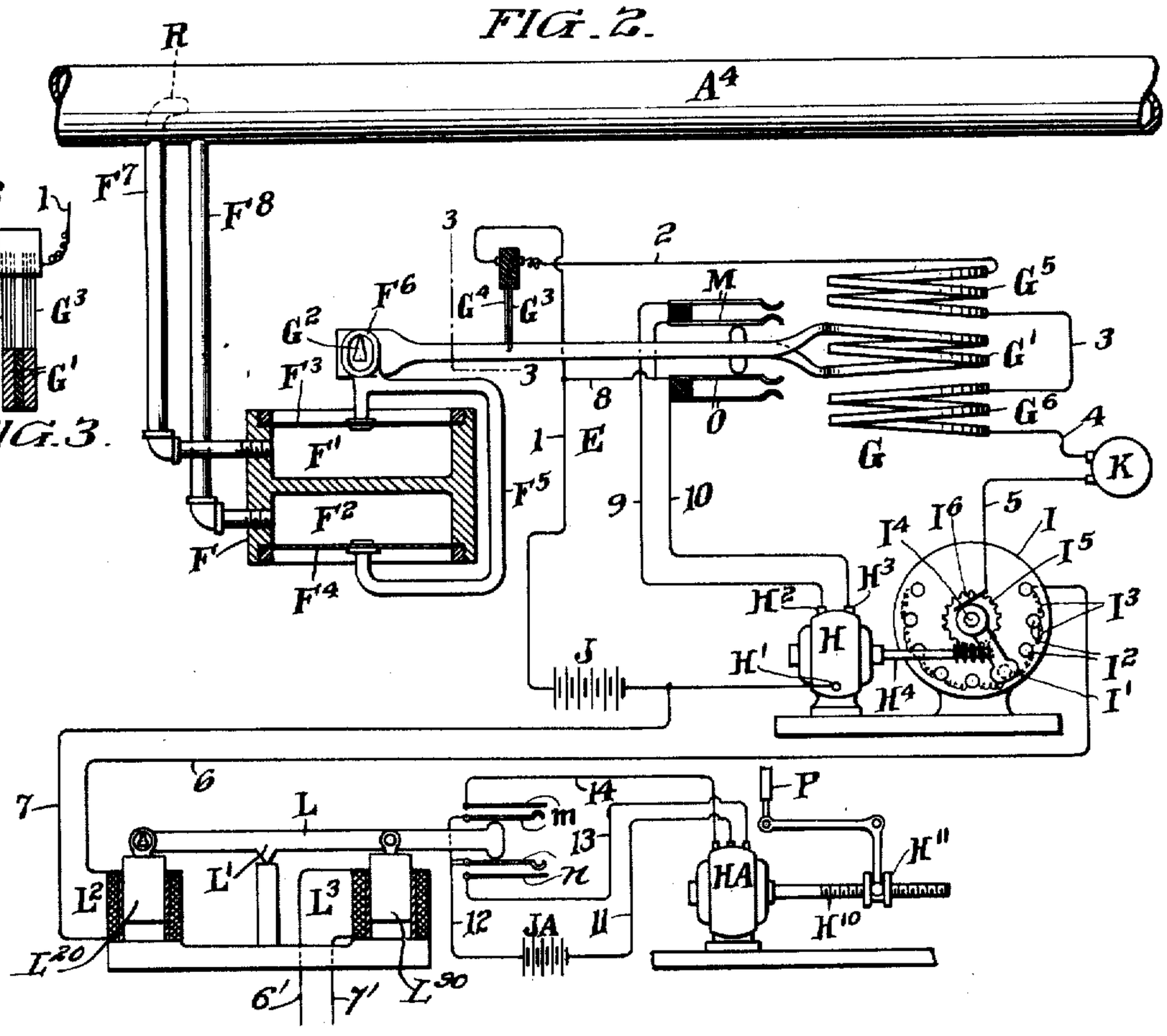
2 SHEETS—SHEET 2.

FIG. 2.



WITNESSES

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FLOW-CONTROLLING APPARATUS.

1,166,758. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed June 1, 1914. Serial No. 842,306.

To all whom it may concern:

Be it known that I, GEORGE H. GIBSON, a citizen of the United States of America, residing in Montclair, in the county of Essex, in the State of New Jersey, have invented certain new and useful Improvements in Flow-Controlling Apparatus, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

The object of my invention, broadly considered, is to provide simple and effective means whereby the rate of flow of a fluid is automatically varied in response to changes in another quantity, such as another fluid rate of flow, so as to preserve a desired ratio between the first mentioned rate of flow and said quantity.

A specific object of my invention is to provide for a desirable automatic control of combustion in a boiler furnace. This I accomplish, in accordance with the present invention, by the means which I have devised for maintaining a predetermined ratio between the amount of the gaseous products of combustion flowing out of the boiler furnace and the amount of steam being withdrawn from the boiler.

The various features of novelty characterizing my invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention, however, and of the advantages possessed by it, reference should be had to the accompanying drawings and descriptive matter, in which I have illustrated and described forms in which my invention may be embodied.

Of the drawings: Figure 1 is a diagrammatic representation of a furnace boiler with provisions for automatically maintaining a predetermined ratio between the amount of gaseous products of combustion issuing from the boiler furnace and the amount of steam being withdrawn from the boiler; Fig. 2 is a diagram on a larger scale than Fig. 1 of a portion of the apparatus shown therein; and Fig. 3 is a section on the line 3—3 of Fig. 2.

In the drawings, A represents a boiler furnace of common type, A′ the combustion chamber thereof, A^2 the smoke outlet, and A^3 the air inlet to the combustion chamber. Coal is fed into the combustion chamber by a traveling grate or automatic stoker B, which is operated by a suitable motor C, shown as a steam engine. As shown, the supply of steam to the engine C is automatically controlled through the automatic regulating valve C′ in the motor supply pipe A^5 in response to variations in the boiler pressure, the supply of steam being decreased or increased, accordingly as the boiler pressure falls or rises between predetermined limits. So far as the use of the present invention is concerned, the control of the engine speed is unimportant, and might be at the will of the boiler attendant. As shown, the engine C also drives the draft fan D, which discharges into the air inlet conduit A^3. The volume of air flowing through the passage A^3 is controlled by a damper E.

The damper E is automatically adjusted to maintain the desired combustion as the withdrawal of steam through the pipe A^4 varies, by mechanism including an element responsive to the rate of flow of steam through the pipe A^4 and a second element responsive to the actual rate of combustion. In the preferred form in which this mechanism is illustrated in Figs. 1, 2 and 3, the one element comprises means for maintaining a current of electricity proportional in strength to the rate of steam flow through the pipe A^4; the second element comprises means for maintaining another electric current proportional in strength to the volume of flow of gaseous products of combustion out of the combustion chamber of the furnace, and means, automatically actuated by variations in the ratio between these two electric currents are provided for adjusting the damper E as required to restore the ratio to a predetermined constant quantity.

The apparatus for maintaining an electric current proportional in strength to the rate of steam flow through the conduit A^4 is collectively indicated by the symbol FK, and is shown best in Figs. 2 and 3. As shown, this apparatus comprises a differential pressure device F having two chambers F′ and F^2, oppositely facing wall portions of which are formed by flexible diaphragms F^3 and F^4. The chamber F′ is connected by a pipe F^7 to a Pitot tube R projecting into the steam pipe A^4, and the static pressure in the steam pipe A^4 adjacent the point at which the Pitot tube enters the latter is transmitted to the chamber F^2 through the pipe F^8. The diaphragms F^3 and F^4 are connected at their centers to

a yoke F^5 which is positively connected, as by means of the eyes F^6 and pivot pin G^2 to the lever of an electro-dynamometer G of the Kelvin balance type. This lever is formed by the elongated end portions of a conductor, the intermediate portion of which forms the floating coil G′ of the electro-dynamometer. The lever is suspended and fulcrumed by the flexible conductors G^3 and G^4, connected one to one end, and the other to the other terminal portion of the coil G′—see Fig. 3. Cooperating with the floating coil of the electro-dynamometer are upper and lower stationary coils G^5 and G^6. The current passing through the coils G′, G^5 and G^6 is supplied from a suitable source, conventionally illustrated as a battery J, and the intensity of this current is regulated as required to maintain the lever in its neutral position by means of a rheostat I, which is adjusted by a motor H. The rheostat I, as conventionally illustrated, comprises a contact arm I′ sweeping over a series of contact studs I^2 connected in series by resistance sections I^3. The arm I′ is carried by a shaft I^4, which also carries the worm gear I^5 in mesh with the worm H^4 carried by the shaft of the motor H. The motor H is reversible, and runs in one direction when a suitable source of electric current is connected to its terminals H′ and H^3, and in the opposite direction when current is supplied to the motor terminals H′ and H^2.

The circuit connections are as follows: A conductor 1 leads from one side of the battery J to the flexible conductor G^3, which, as already explained, is connected to one end of the conductor forming the floating coil G′ of the dynamometer G. The flexible conductor G^4 connected to the other terminal of the floating coil G′, is connected by the conductor 2 to one terminal of the stationary coil G^5. The second terminal of the stationary coil G^5 is connected by the conductor 3 to one terminal of the stationary coil G^6. A conductor 4 connects the second terminal of the coil G^6 to one terminal of the ammeter K, and the other terminal of the latter is connected by the conductor 5 and brush I^6 to the movable contact arm I′ of the rheostat I. The contact stud at one end of the row of studs I^2 is connected by the conductor 6 to one terminal of a balance coil L^2. The second terminal of the coil L^2 is connected by the conductor 7 to the opposite side of the battery J from that to which the conductor 1 is connected. The conductor 1 is connected by a conductor 8 to one of a pair of contacts M and one of a pair of contacts O. The second of the pair of contacts M is connected to the motor terminal H^2, and the second of the contacts O is connected by a conductor 10 to the motor terminal H^3. The motor terminal H′ is connected to the conductor 7.

In the neutral position of the floating coil of the balance G, the two contacts M are out of engagement with one another, and this is true also of the two contacts O. When the floating coil G′ moves downward, as it does on an increase in the rate of steam flow through the pipe A^4, the contacts O are closed, thus energizing the winding of the motor of which H′ and H^3 are the terminals, whereupon the motor H is operated in the direction to move the contact arm I′ counter-clockwise, and thus decrease the number of resistance sections I^3 in circuit. This, by increasing the current flow through the coils G′, G^5 and G^6, tends to restore the floating coil to its neutral position. On a decrease in the steam flow, the decrease in the differential of the pressures in the chambers F′ and F^2 results in a closure of the contacts M, and this causes the motor H to rotate the contact arm I′ in the clockwise direction, increasing the number of resistance sections I^3 in circuit, and correspondingly reducing the current flow through the coils G′, G^5 and G^6. Inasmuch as the difference between the pressures in the chambers F′ and F^2 will be proportional to the square of the rate of steam flow through the pipe A^4, while the electromagnetic interaction between the current in the coils G′, G^5 and G^6 is proportional to the square of the strength of the electric current, it follows that the strength of the electric current flowing through these coils is in linear proportion to the rate of steam flow through the pipe A^4. The ammeter K will thus furnish a measure of the rate of steam flow.

The apparatus collectively indicated by the symbol FK′ may be identical with that indicated by the symbol FK, except that in the apparatus FK′ the lower chamber (F^2) of the device F is connected by a conduit F^{10} to the smoke stack A^2, while the upper chamber (F′) is connected by a pipe F^{11} to the combustion chamber A′. With this arrangement the current flowing through the balance coil L^3, to the terminals of which the conductors 6′ and 7′ of the device FK′ are connected, will be approximately proportional to the draft through the combustion space.

The instrument L for maintaining the desired ratio between the electric currents passing through the coils L^2 and L^3, comprises a lever L′, fulcrumed at L^4, and having pivotally connected to it at opposite sides of its fulcrum, cores L^{20} and L^{30}, extending into the coils L^2 and L^3, respectively. One end of the lever L moves upward and closes a pair of contacts *m*, when the pull of the coil L^2 overbalances the pull of the coil L^3, and moves downward and closes the pair of contacts *o*, when the pull of the coil L^3 exceeds the pull of the coil L^2. When the contacts *m* are closed, a circuit is thereby closed which includes a source of current, as the battery JA, and the winding

of a motor HA, which causes the latter to rotate in the direction which causes its threaded spindle H^{10} to move the nut H^{11} to the right. This shifts the lever H^{12} so as to lower the damper E and permit a greater flow of air into the combustion chamber of the boiler, whereby the pull of the coil L^3 will be increased sufficiently to return the lever L to its normal position. Conversely, when the rate of steam flow decreases, the lever L is shifted to close the contacts *o*. This closes the second circuit of the motor HA, and causes the latter to rotate in the opposite direction from that in which it rotates when the contacts *m* are closed, and thereby move the damper E toward its closed position.

It will be understood, of course, that the actual strength of the current flowing through the coils of balance G of the device FK may or may not be the same as the strength of the current flowing through the balance G of the device FK′, when the balance lever L is held in its neutral position. Furthermore, the ratio between the strength of the currents flowing through the balances G of the devices FK and FK′ necessary to maintain the balance L in its neutral position, may be adjusted, as, for instance, by shunting the coil L^2 by a variable resistance L^{10}, as shown. It is to be observed that the position of the damper E is not varied in simple response to variations in the rate at which steam is withdrawn from the boiler through the pipe A^4, but is varied in position as required to maintain the desired ratio between the rate of steam flow and the rate of combustion in the combustion chamber of the boiler furnace. The rate of flow through the combustion chamber of the boiler is obviously affected not only by the setting of the damper E, but also by the speed of the engine C or other fan driving motor; and more important still by the resistance of the fuel bed to the passage of air therethrough, and this resistance varies from time to time between quite wide limits.

While it is convenient to have the forces actually opposed to one another in the balancing mechanism L proportional to the rates of flow of the steam and gaseous products of combustion, rather than to the squares of these rates of flows, since in this case, simple instruments K can be employed to directly indicate the flow velocities, the maintenance of the desired ratio between the two flow velocities can be had by balancing forces proportional to the squares of the flow velocities, or by balancing forces which are other like functions of the two flow velocities. Alternative means of furnace regulation are disclosed in my application for patent, Serial No. 864,734, filed October 3, 1914, which, while later in date of filing than this case, is intended to generically cover certain novel features of the furnace regulation disclosed, but not generically claimed herein.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the forms of apparatus disclosed without departing from the spirit of my invention, and that under some conditions certain features of my invention may be used without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The combination with a steam generating boiler, of means responsive to the amount of steam being withdrawn from the boiler, means responsive to the volume of draft through the furnace, and means controlled jointly by the two first mentioned means for regulating said volume of draft.

2. Means for maintaining a desired ratio between two fluid rates of flow, comprising in combination, means for opposing a force which is a function of one of the rates of flow by a force which is a function of the other rate of flow, and means actuated by the differential of said forces, when one overbalances the other, for adjusting one of said rates of flow to bring about an equilibrium between said forces.

3. The combination with a steam generating boiler, of pressure differential controlled means for maintaining an electric current proportional in strength to the rate at which steam is withdrawn from the boiler, pressure differential controlled means for maintaining an electric current proportional in strength to the volume of draft through the furnace, a draft regulating device, and electro-magnetic means jointly controlled by said currents for maintaining a volume of draft proportional to the rate at which steam is withdrawn from the boiler.

4. Means for maintaining a desired ratio between two fluid rates of flow, comprising in combination, means for maintaining an electric current proportional in strength to one rate of flow, means for maintaining a second electric current proportional in strength to the other rate of flow, and electro-magnetic means jointly controlled by said currents for adjusting one of said rates of flow to maintain a predetermined ratio between the two rates of flow as the other of said rates of flow varies.

5. The combination with two closed conduits, of means for maintaining a desired ratio between the fluid rates of flow therethrough comprising in combination, a differential pressure mechanism including four

chambers each with a movable wall portion, pressure transmitting connections between two of said chambers and two points respectively, in one of said conduits between which a pressure differential exists which is a function of the fluid rate of flow through the conduit, and similar connections between the other two chambers and the other conduit, and means connected to, and acted upon by the movable wall portions of said four chambers for adjusting the flow through one of said conduits as the flow through the other varies.

GEORGE H. GIBSON.

Witnesses:
PAUL A. BAUCEL,
ROBERT G. CLIFTON.

DISCLAIMER.

1,166,758.—*George H. Gibson*, Montclair, N. J. FLOW-CONTROLLING APPARATUS.

Patent dated January 4, 1916. Disclaimer filed August 5, 1927, by the patentee.

Hereby enters this disclaimer to the flow controlling means specified in claim 2 of said Letters Patent except in steam generating apparatus to adjust the rate of flow of a fluid supplied thereto in such manner as to maintain a desired ratio between the rate of flow of such fluid and the rate of flow of steam being withdrawn from said apparatus.

[*Official Gazette August 23, 1927*]