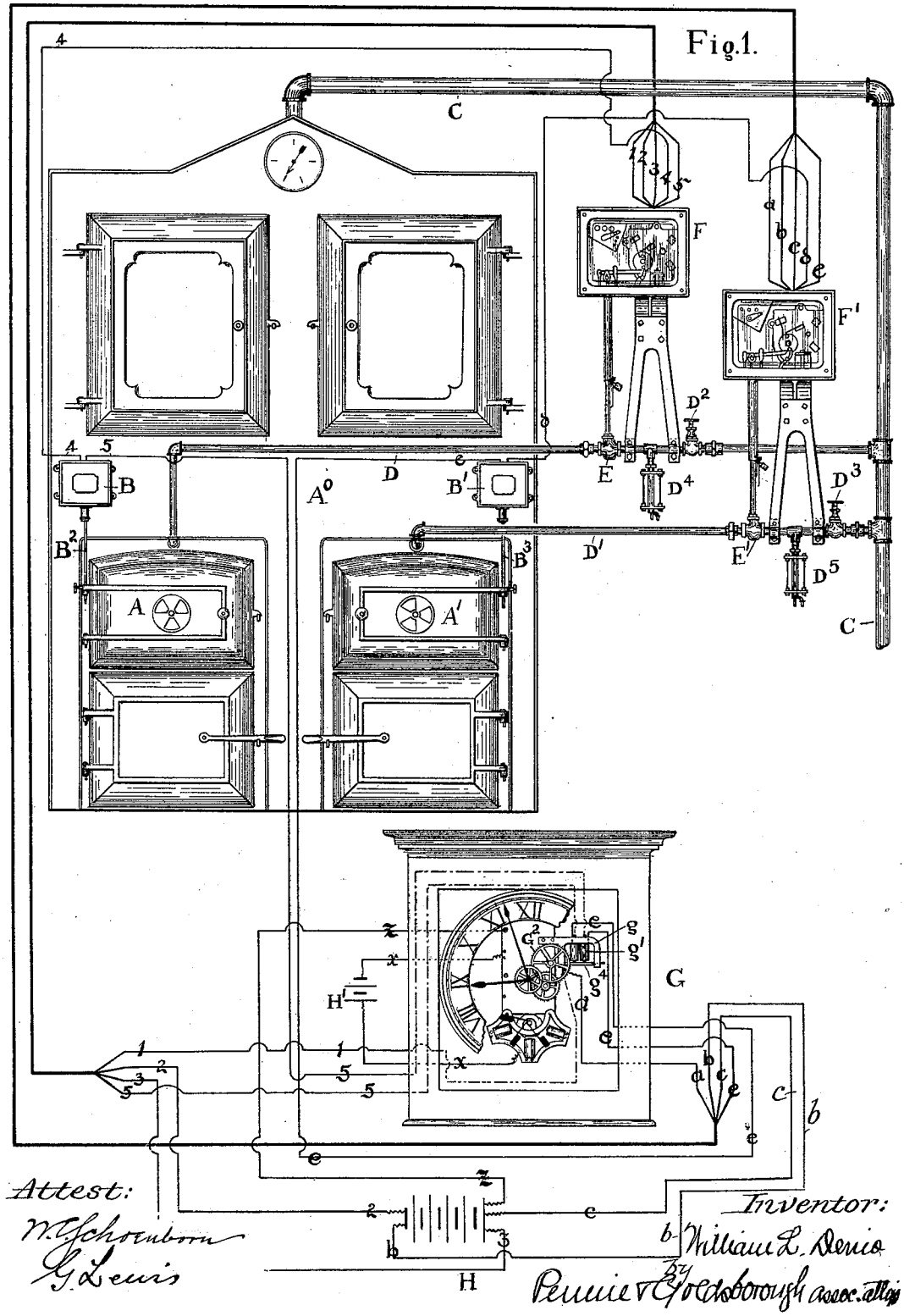
(No Model.) 5 Sheets—Sheet 1.

W. L. DENIO.

SMOKE CONSUMING DEVICE.

No. 588,405. Patented Aug. 17, 1897.

Fig. 1.



Attest:
W. C. Schoenborn
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Inventor:
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By Pennie & Goldsborough Assoc. Attys

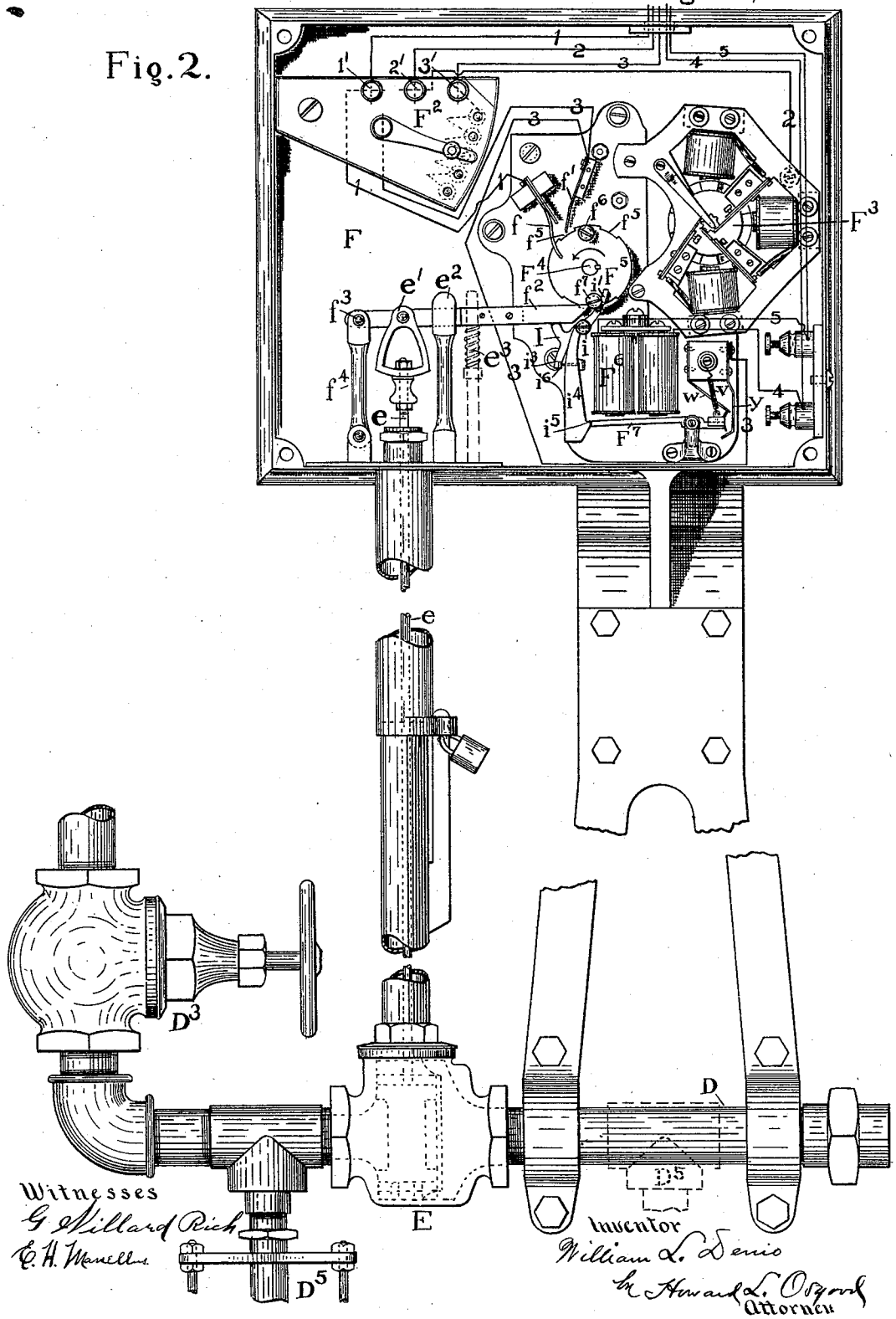
(No Model.) 5 Sheets—Sheet 2.

W. L. DENIO.

SMOKE CONSUMING DEVICE.

No. 588,405. Patented Aug. 17, 1897.

Fig. 2.



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W. L. DENIO.

SMOKE CONSUMING DEVICE.

No. 588,405. Patented Aug. 17, 1897.

Fig. 3.

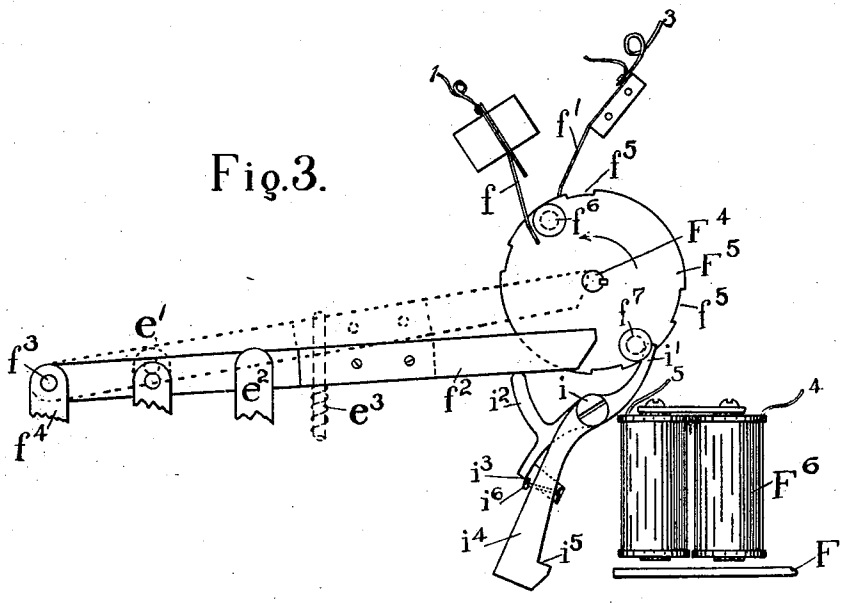


Fig. 4.

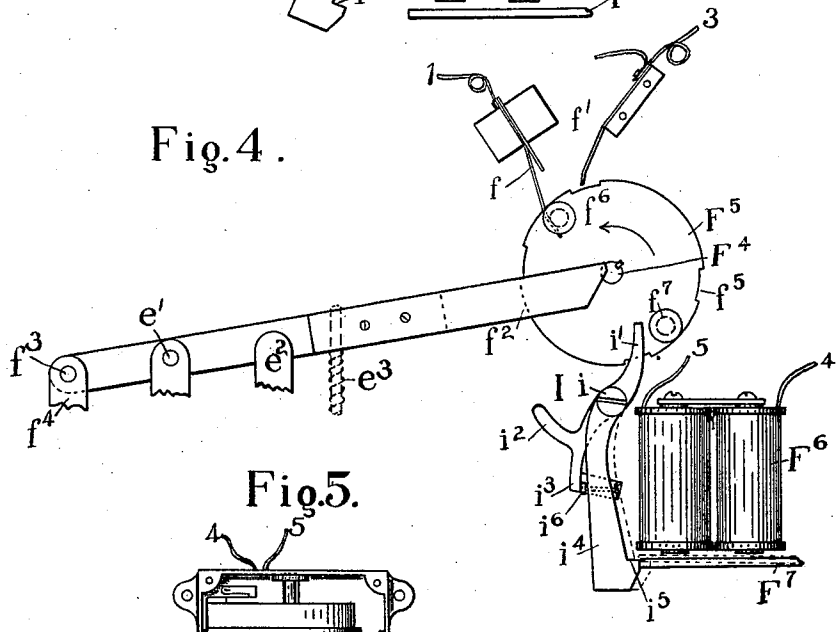
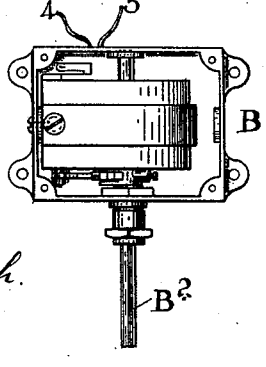


Fig. 5.



Witnesses

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(No Model.) 5 Sheets—Sheet 4.

W. L. DENIO.

SMOKE CONSUMING DEVICE.

No. 588,405. Patented Aug. 17, 1897.

Fig. 6

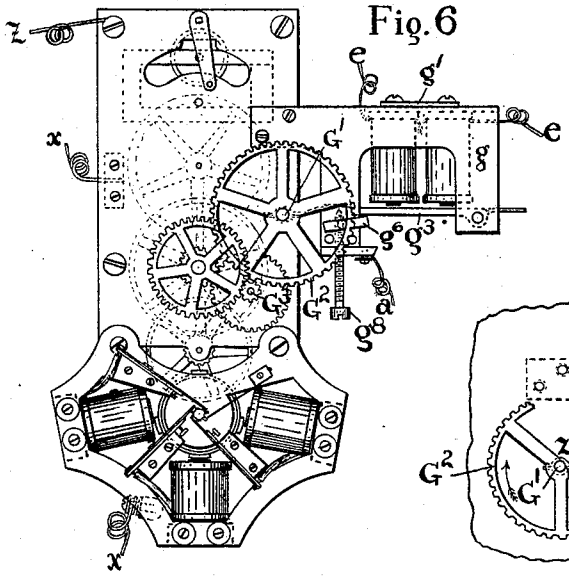


Fig. 7.

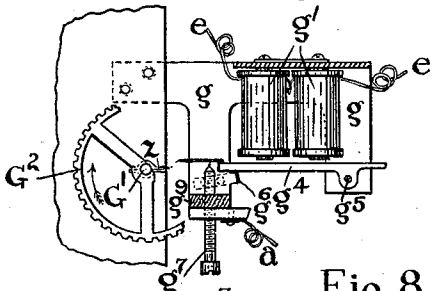


Fig. 8.

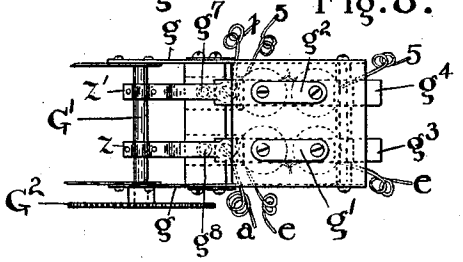


Fig. 9.

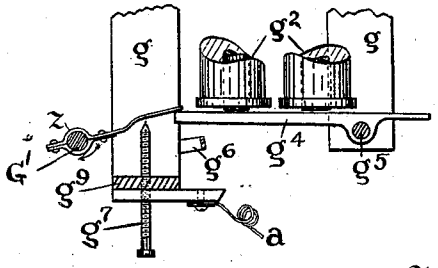
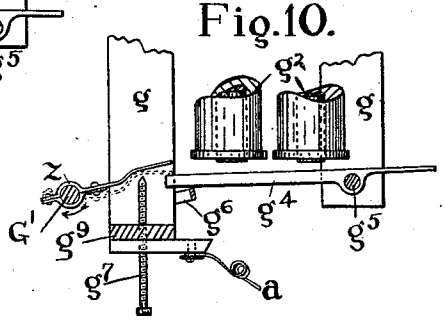


Fig. 10.



Witnesses

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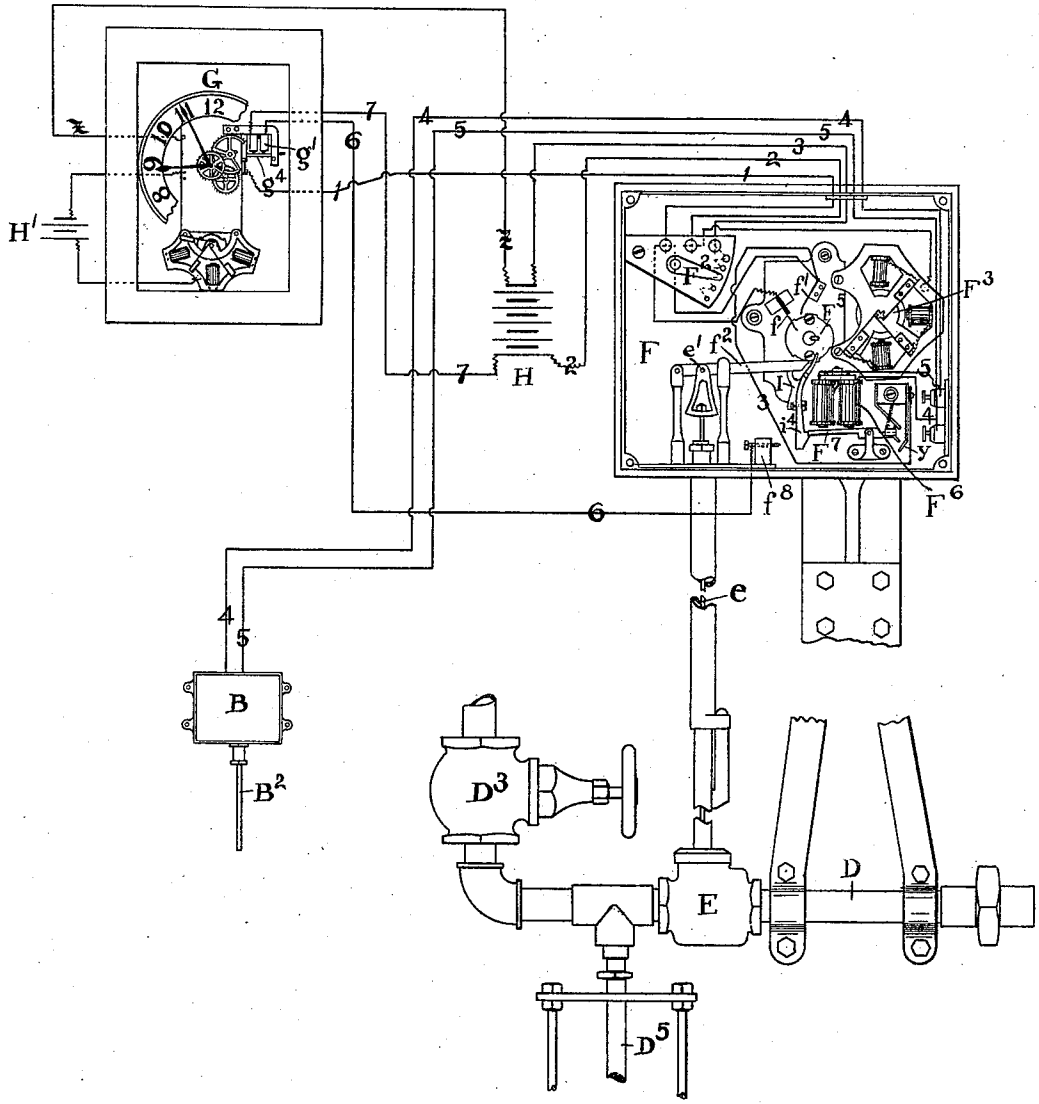
5 Sheets—Sheet 5.

W. L. DENIO.

SMOKE CONSUMING DEVICE.

No. 588,405. Patented Aug. 17, 1897.

Fig. 11.



Witnesses.
G. Willard Rich.
E. H. Marcellus.

Inventor:
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UNITED STATES PATENT OFFICE.

WILLIAM L. DENIO, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE DENIO SMOKE CONSUMER COMPANY.

SMOKE-CONSUMING DEVICE.

SPECIFICATION forming part of Letters Patent No. 588,405, dated August 17, 1897.

Application filed January 13, 1896. Serial No. 575,402. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM L. DENIO, a citizen of the United States, and a resident of the city of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Smoke-Consumers, of which the following is a specification, reference being had to the accompanying drawings, in which—

Figure 1 is a front elevation of a boiler-front, showing my device connected therewith, together with the electrical connections and the clock and valve operating mechanism, a portion of the face of the clock being broken away to exhibit internal construction. Fig. 2 is a front elevation of one of the valve-operating mechanisms of my device. Figs. 3 and 4 are diagrams of details of the valve-operator. Fig. 5 is a magneto forming part of my device with the front plate removed. Fig. 6 is a front elevation of a portion of the clock or time mechanism of my device. Figs. 7, 8, 9, and 10 are detail views thereof, and Fig. 11 shows a modified arrangement.

My invention relates to that class of devices in which, when the furnace-door is opened for firing, a blast of oxidizing vapor or gas—such as steam or air, or both—is injected into the fire-space for a predetermined period in order that there may be supplied to the fresh coal a sufficient quantity of oxygen to produce a complete combustion of those particles emitted from the roasting coal, which would without sufficient oxygen form a heavy smoke. A patent, No. 510,631, was granted to me December 12, 1893, for a device of this class, and in some respects my present invention is an improvement upon that described in said patent. In my present device I provide, among other things, means whereby a time mechanism for regulating the predetermined period during which the oxidizing vapor or gas is injected is placed at a distance from the boiler—say in the main office of a factory, or more or less remote from the boiler-room—in order that said predetermined interval may not be interfered with or changed by the fireman. I also provide means whereby said interval may be changed or regulated according to the character of the fuel used or according to the other circumstances of the case. I also provide other regulating devices, one for each grate, for determining the period of injection by operating a valve. I also provide means whereby the injection to each grate in a factory is independently controlled from a central point—such as the superintendent's room or other point remote from the boiler-room, as above mentioned.

My invention consists in the devices and combinations hereinafter described and claimed.

In the drawings, A^0 is a boiler-front.

A A′ are the fire-doors, as usual.

B B′ are magnetos, each attached to a fire-door—as, for instance, to the hinge thereof—by means of a connecting-rod B^2 B^3. Each magneto is so adjusted as to give an electrical impulse through connecting-wires whenever the fire-door A A′ is opened sufficiently to permit the fuel to be placed upon the grate.

C is the main steam-pipe, extending from the steam-dome of the boiler. From this steam-pipe, by any suitable connection, there extends a pipe D D′ to the boiler-front and into the fire-space, whereby a jet of steam may be blown into said fire-space in order to produce the oxidation of the soot and smoke particles, as above mentioned. There is an ordinary valve D^2 D^3 in each of these last-mentioned pipes and also a water-trap D^4 D^5. The water-trap catches any condensed water which may accumulate in the pipe D or D′ and permits it to pass out of the pipe without allowing any reduction of steam-pressure or escape of steam. In each pipe D D′ and between the trap and the boiler is a second controlling-valve E E′, which I prefer to make as a balanced valve, (see Fig. 2,) for reasons hereinafter explained. This controlling-valve E E′ is operated by a valve-operating mechanism F F′, which operates to open it, to hold it open during a predetermined interval, and then to close it.

At a point remote from the boiler-room, if so desired, is placed a clock device G, Fig. 1, and at any suitable point is placed a source of electrical energy H. A second battery or source of electrical energy H′ is also provided for operating the clock G.

The magneto B, the valve-operating mechanism F, and the clock G are connected by a

system of wiring, and the wires of this system are numbered, as shown in Fig. 1, 1 2 3 4 5. The magneto B′, the valve-operating mechanism F′, and clock G are connected by another system of wiring, the wires of which are lettered *a b c d e*, as shown in the same figure.

The magnetos B B′ are of any ordinary construction adapted to produce an electrical impulse of proper energy whenever the shaft or connecting-rod B^2 B^3 is turned to a proper degree. These magnetos, therefore, need no further explanation. From each magneto extends a pair of conducting-wires, as hereinafter explained. An equivalent for any of these magnetos is found in any device or arrangement capable of imparting a suitable electrical impulse to the electromagnets hereinafter described.

The clock G is any ordinary clock-movement, although I prefer to use for the same an electrical clock operated or wound by the battery H′ and connected thereto by the wires *x x*. To this ordinary clock-movement, which needs no further explanation, I add a shaft G′. (See Figs. 6 to 10, inclusive.) This shaft is geared to the clockwork, as by means of the gear-wheel G^2 and pinion G^3, so as to have a slow movement of revolution. To the clock-frame is attached a supporting-frame *g*, which bears one or more electromagnets g' g^2, each electromagnet being related to one of the wiring systems and to one of the steam-injection pipes D D′. In the present case I have shown two such pipes D D′ and two ordinary electromagnets, each provided with an armature. Each electromagnet is provided with a swinging armature g^3 g^4. These armatures are pivoted, as at g^5, to the supporting-frame *g*, and are so balanced as normally and when the electromagnet is not energized to rest against a suitable stop g^6, attached to the supporting-frame *g*.

On the shaft G′ there is placed a contact-piece *z z′*, relating to each electromagnet. This contact-piece or arm *z* (see Figs. 8, 9, and 10) is clamped upon the shaft G′, so that, notwithstanding the revolution of the shaft in the direction shown by the arrows in Figs. 7, 9, and 10, the arm *z* may be moved backward or in a direction contrary to the arrow, thus slipping upon the shaft in its backward movement. This movement is given to the arm whenever an electrical impulse passes through an electromagnet, raising its armature from the stop g^6, whereby the end of the armature in rising strikes the end of the arm *z* and lifts it into the position shown in Fig. 9. If now the armature g^4 falls back against the stop g^6, as shown in full lines in Fig. 10, and the revolution of the shaft G′ continues, the shaft carries with it the arm *z* (by reason of the friction of the bearing of the arm upon the shaft) toward the position shown in dotted lines in Fig. 10. To the frame *g* and underneath each arm *z* or *z′* is fastened an independent adjustable contact-point g^7 g^8, the contact-points being insulated from the frame *g* by the insulating-block g^9. Each contact-point is in the drawings a screw which may be raised or lowered, and thus the period of injection into the fire-space may be varied for any fire, and the different fires may have injections of different periods. When the armature g^4 (see Figs. 9 and 10) rises to its extreme upper position, (shown in Fig. 9,) the arm *z* is raised to its extreme upper position, and this upper position is a fixed position, which cannot be varied. The stop-block g^6 may be raised and lowered, so as to determine the lowest operative position of the armature g^4, and the arm *z* may turn these limits—namely, the extreme upper position shown in Fig. 9 and the extreme lower position to which it may move before striking the armature g^4 in its lowest position. Between these limits the contact-point or screw g^7 may determine the extent of movement of the arm *z* and thereby determine, as hereinafter shown, the time during which the injection of the steam shall occur into the boiler. When the arm *z* is raised to the extreme upper position of Fig. 9 and the armature g^4 drops away from it, the shaft G′ begins to move the arm in the direction of the arrows as soon as the arm is released. The slow movement of the shaft continues until the arm strikes the contact-point g^7, whereupon it is held against further movement, and the shaft G′ continues to revolve within the bearing of the arm *z* until the armature is again raised.

Each valve-operating mechanism F or F′ consists of an electrical motor, which is normally stationary and is only operated when a current from the battery H is permitted to pass through it. In each of these mechanisms I place a rheostat F^2, (see Fig. 2,) whereby the action of the motor is retarded to the desired degree. In combination with the motor I provide the following devices for operating the valve E, which are shown in Figs. 2, 3, and 4. The motor F^3, Fig. 2, is of any suitable type and operates a shaft F^4, bearing a disk F^5. This disk has a series of notches f^5 on its periphery, for which notches there may be substituted as equivalents pieces of insulating material. Upon the disk F^5 are also two studs f^6 f^7. To suitable insulating-blocks in the regulator and in suitable relation to the disk F^5 are fixed a pair of contact-springs *f f′*, the springs *f* being adapted for contact with the studs f^6 f^7 and the spring *f′* being adapted for contact with the periphery of the disk F^5, but being so adjusted, as shown in Figs. 2 and 4, that when in the revolution of the disk the notches f^5 come opposite to said spring *f′* the contact between the disk and spring is broken. The studs f^6 and f^7 are arranged in a diameter of the wheel and the notches or insulating-spots f^5 are arranged in pairs, one on each side of the studs f^6 f^7 and about thirty degrees in arc from said studs, measured upon the periphery of the disk F^5.

Each valve E is connected to the regulator

by a stem e, which is pivoted at e' to a lever f^2. This lever is pivoted at one end f^3 to one end of a link f^4, the other end of which is pivoted to the case of the regulator. The pivotal point e' of the rod e is intermediate the pivotal point f^3 at one end of the lever f^2 and the other end of such lever. A suitable guide e^2 serves to prevent sidewise movement of the lever, and, if desired, an adjustable spring e^3 upon a suitable post serves to normally tend to raise the lever f^2 and open the valve E.

Each valve-operating mechanism F F' bears an electromagnet F^6, adapted to actuate an armature F^7, which latter is pivoted to the regulator-frame and is normally drawn away from the magnet either by gravity or by a spring v, as shown in Fig. 2. Near to the disk F^5 is pivoted, as at i, a swinging lever I, having three branches i' i^2 i^3. The branch i' is adapted to be engaged by either of the studs f^6 or f^7 in the course of their revolution and to be depressed by said stud, so that the arm i^2 on the other side of the pivotal point i shall rise and engage the lower side of the lever f^2 and raise the same to open the valve E. Upon the same pivot i is hung a gravity-latch i^4, provided with a notch or ledge i^5 in position to engage the armature F^7 when the armature is raised and to hold the same in its elevated position. The latch i^4 is heavily weighted at its lower end and is provided with an adjusting-screw i^6, which engages the arm i^3, before mentioned, and so tends to return the lever I to its normal position ready to be engaged by either of the studs f^6 or f^7.

I now proceed to describe the circuits by means of which my device is operated. It may first be stated that the clock or motor G runs continuously and that the motor or clock-movement of each regulator F or F' runs intermittently.

When a fire-door A or A' is opened, the connecting-rod B^2 or B^3 of one of the magnetos B or B' is turned, operating the magneto and creating a current which passes through the wires 4 (d) and 5, (e,) connected to the magneto. The current in the wire 5 (e) passes to the magnets g' g^2 in the clock G, energizing these magnets, which raises the armature g^3 or g^4 and lifts the arm z or z' away from the contact-piece g^7 or g^8, as hereinbefore explained. The same current passes through the wire 5 (e) to the valve-operating mechanism F into the magnet F^6, energizing the same and raising the armature F^7 so that the latch i^4 engages said armature and holds it in the extreme upper position. The tail of this armature F^7 makes contact with the spring or plate y, and a current from the battery H passes through the armature F^7, through its supporting-bracket into the motor-frame, through the magnets of the motor F^3, and out through the wire 2 (b.) The wire 2 or b is connected to the magnets of the motor, but is insulated from the clock or motor frame and from the action of the regulator. Thus the action of the magneto is to disconnect the contact between the arm z or z' and its corresponding contact-piece g^7 or g^8 in the clock G, but to connect the wires 2 (b) and 3 (c) in the regulator to start the motor therein. This causes the disk F^5 to revolve, and as soon as this revolution has continued for a short time the spring f' comes in contact with the periphery of the disk F^5 and a current from the wire 3 passes into the disk, into shaft F^4, thence into the frame of the motor F^3, through the motor, and out through the wire 2, continuing the connection of the battery H therewith.

The first movement of the disk F^5 from the normal position of rest shown in Fig. 2 moves the lever I and the latch i^4 to disconnect the latch from the armature F^7, whereby the armature drops and the tail thereof is disconnected from the contact-piece y, breaking the circuit just mentioned through said contact-piece, but continuing the circuit through the spring f' and through the wire 2. By the time that the spring f' breaks contact with the periphery of the disk F^5 the arm f^2 has been lifted by the lever I and the valve E is opened, but now contact is made by the spring f with the stud f^6 and a current may pass through the wire I, spring f, stud f^6, disk F^5, shaft F^4, through the motor F^3, and out through the wire 2 to the battery H, thence to the clock-frame through the wire Z to the shaft G', through the arm z, and to the contact-piece g^7 as soon as the arm and contact-piece are brought in contact by the revolution of the shaft G'; but as no current can now pass through the motor F^3 until this contact is made the motor stops and the valve is held open with the parts in the position shown in Fig. 4. This contact occurs at the end of a predetermined period—say five minutes. The circuit just mentioned is established and the disk F^5 again begins to revolve. When the latch i^4 is released from the armature F^7 by the passage of the stud f^7 from the arm i', the tail of the armature F^7 makes contact with the spring-stop w, which simply acts to prevent the armature from being thrown too far by the spring v from the magnets F^6. As soon as the stud f^6 has passed from contact with the spring f the current through the wires 1, Z, and 2 is broken and a current is re-established through the motor by the wires 3 and 2 by reason of the contact of the spring f' with the periphery of the disk. The motor F^3 and the disk F^5 continue to revolve after the contact is made by the arm z with its contact-point g^7. The stud f^6 depresses the lever f^2, closes the valve E, and when the valve is closed the springs f and f' have the position relative to the disk F^5 shown in Fig. 2, whereupon, all circuits from the battery H being broken, the motor stops. It will be noticed that for each complete operation the disk F^5 makes a half-revolution. The period of time during which the lever f^2 is kept in its raised position, whereby the valve E is

kept open, depends upon rate of revolution of the shaft G' and the variable distance of the arm *z* from its contact-point. The rate of revolution of the disk F^5 determines the length of time which shall be occupied in opening and in closing the valve E, and this rate may be changed by means of the rheostat F^2, whose resistance-coils are placed in the circuit passing through the contact-spring *f'*.

The modification shown in Fig. 11 contains the same elements as the prior device, but with a different system of wiring and slightly-different method of operation. When the magneto B is operated by opening the furnace-door, an impulse is sent through the wires 4 5 to the electromagnet F^6 of the valve-operating device, the armature F^7 is raised, the disk F^5 begins to revolve, the lever I is tilted until it reaches its extreme position, and the latch i^4 is then brought into contact with the contact-point f^8. This contact completes a circuit through the wires 6 7 3, spring *f*, disk F^5, lever I, and latch i^4, through the battery H, and through the magnets *g'* of the clock G, raising the armature g^4 and disconnecting the contact *z* from the contact-pin g^7. The revolution of the clock G returns the arm *z* to make contact with the pin g^7. In all other respects the devices shown in Fig. 11 and those shown in the other figures are the same.

My invention involves the features that the operation of the valve and the consequent blast are independent of the closing of the furnace-door; that the valve is operated by positive mechanism, throwing it wide open at a predetermined rate of movement, holding it wide open during a predetermined interval, and then closing it at said predetermined rate, and that said rate and said interval may be varied and adjusted to the character of the fuel, the pressure and temperature of the steam, and other circumstances of the particular case. After the furnace-door is opened the remaining operations of my device occur automatically.

I do not limit the scope of my invention or the claims hereinafter set forth to the exact construction shown herein; but I intend that said claims shall be capable of such an application of the doctrine of equivalents as will retain to me the full benefit of the invention which I have made in view of the state of the art.

What I claim is—

1. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a valve-operating mechanism for opening and closing said valve including an electric motor therefor and provided with means for stopping said motor after a predetermined interval, a time mechanism independent of the valve-operating mechanism, means connected with said time mechanism for closing an electric circuit, a source of electrical energy in said circuit, a second circuit from said source of energy to said motor and means for breaking said second circuit after the valve is opened until said first circuit is closed, and an electric device connected with the furnace-door for starting said motor.

2. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a valve-operating mechanism, an electric motor for actuating said valve-operating mechanism for opening and closing said valve, means for stopping said motor after a predetermined interval by disconnecting it from its source of energy, a source of electrical energy, a mechanism connected with the furnace-door for connecting said source of energy with said motor, a time mechanism for reconnecting said source of energy with said motor after a predetermined interval, whereby the valve is opened by the valve-operating mechanism and is held open during said predetermined interval and is then closed.

3. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a valve-operating mechanism, an electric motor for actuating said valve-operating mechanism provided with means for varying its rate of motion and with means for disconnecting it from its source of energy after a predetermined interval, a source of electrical energy, an electrical mechanism connected with the furnace-door for connecting said source of energy with said motor, a time mechanism for reconnecting the source of energy and the motor after a predetermined interval, means for varying said interval, whereby the valve is opened and closed by the valve-operating mechanism at a predetermined rate of movement and is held open during a predetermined interval and means for starting said valve-operating mechanism when the valve is closed by disconnecting said motor from said source of energy.

4. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a source of electrical energy, an electrical motor, mechanical connections therewith for opening and closing said valve, an electromagnet having a movable armature and provided with means for connecting said motor and said source of energy when said armature is actuated, an electrical mechanism connected with the furnace-door for energizing said electromagnet, whereby the motor is started, a time mechanism having a circuit-closer movable thereby and in circuit with said motor and said source of energy, means for closing said circuit-closer after said valve is open for a predetermined interval, whereby said motor is stopped when said valve is open and during a predetermined interval and is started again at the end of said predetermined interval to close the valve, and means for automatically stopping said motor when the valve is closed.

5. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a source of electrical energy,

an electrical motor, mechanical connections therewith for opening and closing said valve and for stopping the motor after it has operated during a predetermined interval, an electromagnet having a movable armature provided with means for connecting said motor and said source of energy when said armature is actuated, an electrical mechanism connected with the furnace-door for energizing said electromagnet, whereby the motor is started, a time mechanism having a circuit-closer movable thereby and in circuit with said motor and said source of energy, means for closing said circuit-closer after said valve is open for a predetermined interval, whereby said motor is stopped when said valve is open and during a predetermined interval and is started again at the end of said predetermined interval to close the valve, means for automatically stopping said motor when the valve is closed, means for varying the rate of movement of said motor, and independent means for varying the interval between the stopping of the motor and the closing of said circuit through said circuit-closer.

6. The combination with a furnace, of an injection-pipe into the fire-space thereof, a valve in said pipe, a lever connected with said valve for opening and closing the same, a lever I for moving the lever f^2 to move the valve in one direction, a disk F^5 provided with means for engaging the lever f^2 and for moving it in the other direction and provided with means for actuating said lever I, a motor for operating said disk in one direction, a source of electrical energy, a mechanism for connecting said source of electrical energy with said motor, a time mechanism having a revolving shaft G′, an arm z moved in one direction by friction with said shaft, a contact-point for said arm, an electromagnet provided with means for actuating said arm in the other direction to break contact between said arm and said contact-point, means for energizing said electromagnet at or after the time when the furnace-door is open, means actuated by the furnace-door for connecting said motor with said source of electrical energy, connections with said arm z and said contact-point through said source of electrical energy and said motor, whereby the motor is stopped until said arm renews contact with said contact-point, and means for stopping the motor after the valve is closed.

WILLIAM L. DENIO.

Witnesses:
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CHAS. M. WILLIAMS.