(No Model.) 3 Sheets—Sheet 1.

J. HENDERSON.

REGULATING GAS FURNACES USED IN MANUFACTURING IRON AND STEEL.

No. 267,525. Patented Nov. 14, 1882.

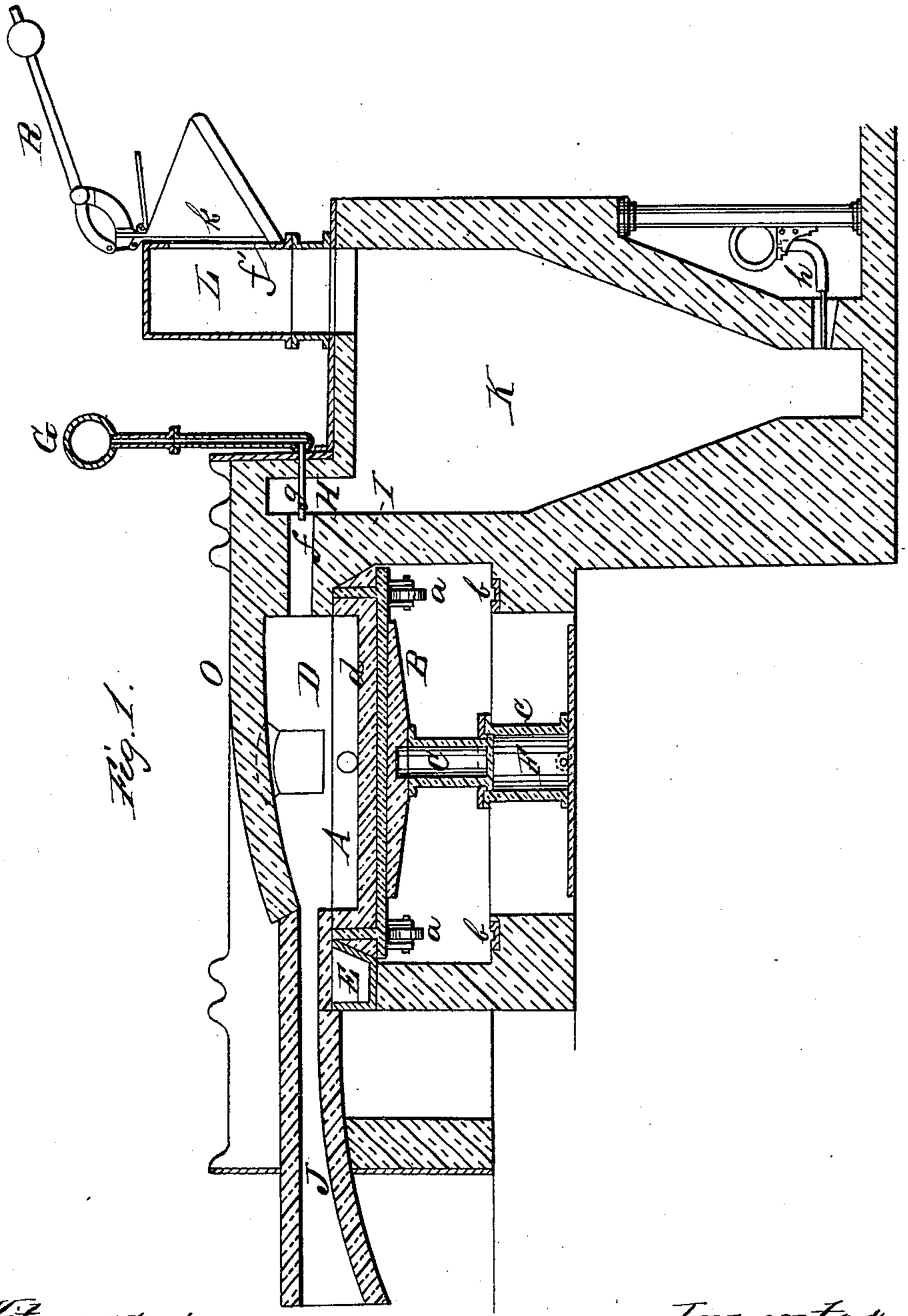

Fig. 1.

Witnesses.
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(No Model.) 3 Sheets—Sheet 2.

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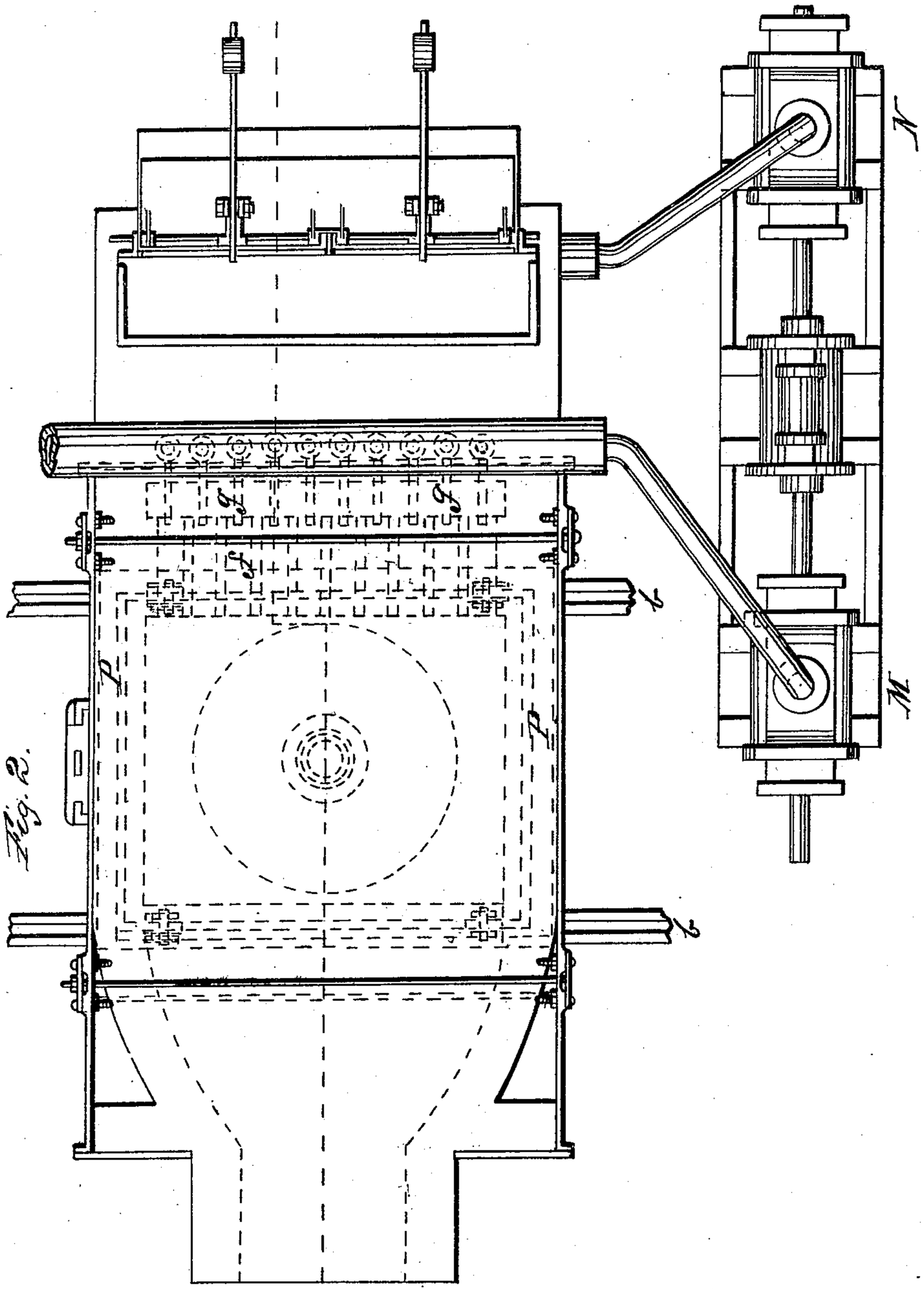

Witnesses.
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(No Model.) 3 Sheets—Sheet 3.

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REGULATING GAS FURNACES USED IN MANUFACTURING IRON AND STEEL.

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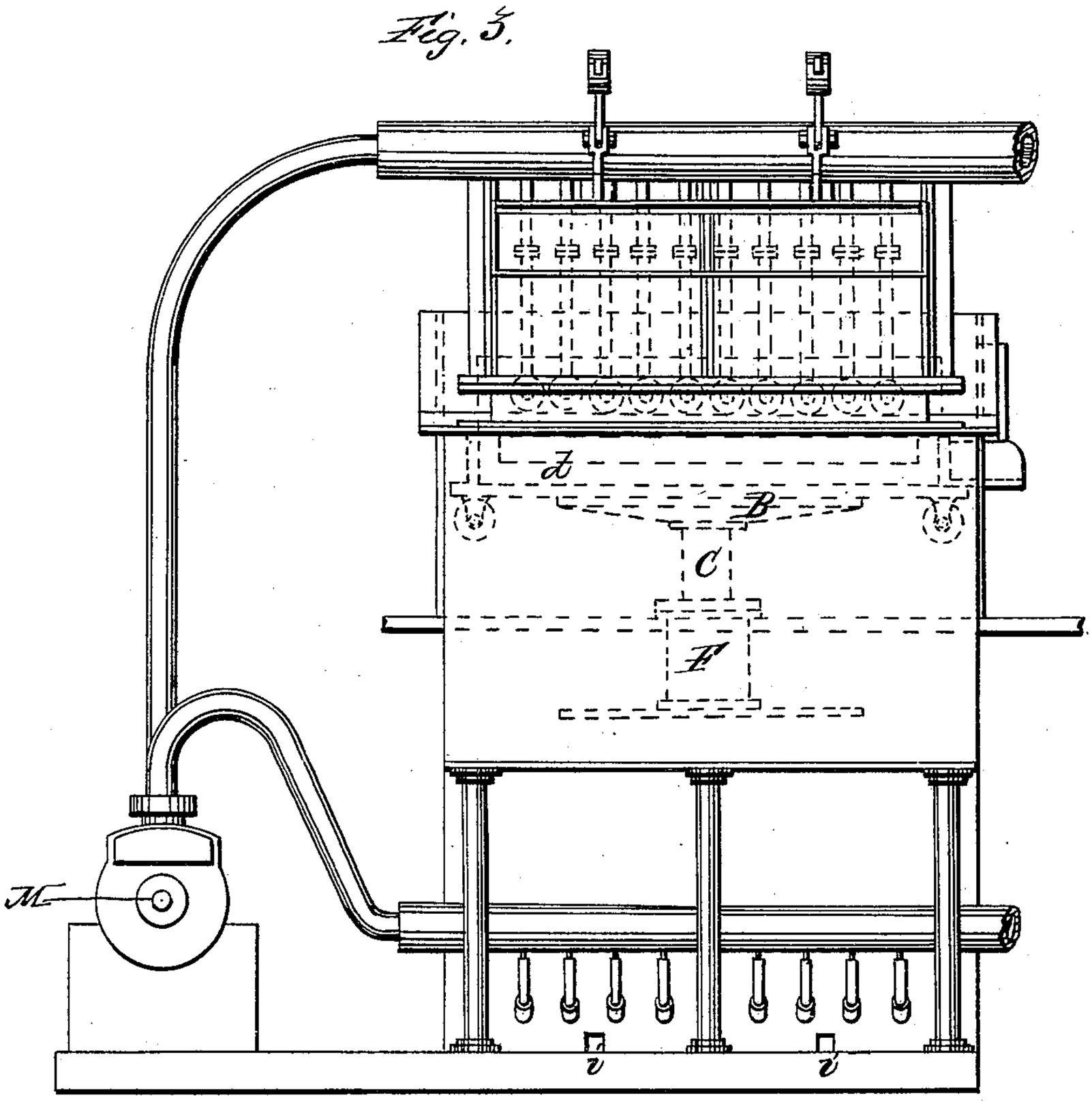
Fig. 5.



Witnesses.
H. L. Bennett
C. A. Graves.

Inventor.
James Henderson

UNITED STATES PATENT OFFICE.

JAMES HENDERSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO CHARLES G. FRANCKLYN, OF SAME PLACE.

REGULATING GAS-FURNACES USED IN MANUFACTURING IRON AND STEEL.

SPECIFICATION forming part of Letters Patent No. 267,525, dated November 14, 1882.

Application filed April 17, 1880. (No model.) Patented in England April 13, 1874, No. 1,267.

To all whom it may concern:

Be it known that I, JAMES HENDERSON, of the city, county, and State of New York, have made an invention in the Art of Regulating Gas-Furnaces for Manufacturing Iron and Steel, of which the following is a full, clear, and exact description.

The invention consists in the measuring the air supplied to feed to the fuel to generate gas and measuring the air supplied to feed to burn the gas so generated, and the addition of caustic lime to flux the ash of the fuel and assist the operation.

The drawings represent apparatus for carrying out the process, in which drawings Figure 1 is a longitudinal section. Fig. 2 is a top view of a reverberatory gas-furnace, showing many parts in broken lines. Fig. 3 is a view of the gas-producer end of said furnace.

The principal parts of the furnace represented in the said drawings are the reverberatory chamber D, the reverberatory arch or roof O, which surmounts the said chamber, the side walls, P P, the fire-bridge I, over which the flame enters the chamber D, the flue J, through which the spent gases escape, the hearth A, which holds the material to be treated, and the blast apparatus M and N, which supplies air for producing and air for burning the gases used in said furnace.

The hearth or bottom A of the furnace is movable vertically by being mounted on a table or platform, B, fixed to the upper end of a hydraulic ram, C, and also has wheels on the bottom, so that it may be moved away from or under the arch after being lowered. The ram C answers the purpose of a pivot, so that the hearth may be revolved. Beveled or inclined projections *c* are formed at opposite sides of the movable bottom A, which prevents leakage, and when the bottom is raised fit a corresponding inclined surface made in the brick-work of the furnace, and at the other end against the inclined side of a hollow water bridge or channel, E, as shown at Fig. 1. The movable hearth or bottom A is provided with a lining, *d*, of refractory material, such as fire-clay. The reagents are spread over this lining, the hearth being lowered and run out from the arch for that purpose.

The combustible gases employed to heat the crude iron in the reverberatory chamber D, in order that it may be converted into cast-steel or homogeneous malleable iron, enter the flue H. The combustible gases pass from this flue to the reverberatory chamber of the furnace through the flues or apertures *f*, wherein they are impinged upon and mixed with atmospheric air, preferably heated to from 1,400° to 2,000° Fahrenheit, whereby the gases are inflamed or ignited, and after passing over the bridge enter the reverberatory chamber D, where crude iron and reagents, having been placed, are acted upon by the flame, and the products of combustion are conveyed away by the flue J. The heated air passes into such flue or passage *f* from the tuyeres *g*, which communicate at their rear ends with a pipe, G, leading from an air-heating stove or apparatus, (not shown in the drawings,) which consists by preference of a Whitwells air-heating stove, or any other suitable air-heating apparatus, which is connected with a pipe leading to the blast of cylinder M.

The gas-generator K is constructed at one end of the reverberatory furnace, which generator is of sufficient size to generate gas sufficient for the furnace. The depth of the fuel contained in the generator should be sufficient to convert the carbonic acid formed by the combustion at the tuyeres *h*, where the blast for generating the gas is delivered, into carbonic oxide as it passes up through the superposed fuel, which with good bituminous coal may be about five to six feet or coke six to eight feet above the level of the tuyeres. When the furnace is in operation the fuel is charged into the generator at successive intervals through air-tight hoppers L, having the door *l* and lid *k* so arranged as to make air-checks, and air-tuyeres are introduced in it near the lower end, which are incased in the wall of the generator air-tight by means of fire-clay, so as to prevent escape of air or gases. The generator is arranged without a grate at its lower end, and air is supplied to the fuel to generate the gases through the air-tuyeres referred to. In order to run the generator continuously and remove the ash, caustic lime is charged with the fuel in the proportion of about two parts of lime to three parts of silica and one part of alumina contained in the ash of the fuel, the lime forming a flux whereby the ash is reduced to an easily-fusible slag, which is permitted to run from the gas-generator at intervals through the openings *i i*, Fig. 3, which are closed air-tight by

wet fire-clay when the slag is not being run off.

In order that the greatest amount of heat may be obtained from the fuel employed in the gas-generator, I use a measured volume of air to combine with and burn the gas produced, as an excess of air produces complete combustion; but the temperature of the gases is lowered thereby, and the volume or weight of the waste products of combustion is relatively larger, assuming that they escape into the atmosphere at the same temperature, than when burned with the exact amount of air required for perfect combustion, and the loss of heat will be in proportion to the excess. A deficiency of air to produce complete combustion of all the gases makes a hot flame; but a portion of the combustible gases are allowed to escape and become wasted. By the use of the exact quantity of air to produce complete combustion, without an excess of either air or gases, the greatest heat is obtained from the fuel consumed.

When the fuel employed in the gas-generator is coke practically free from hydrogen the greatest heat obtainable is produced by conducting through the tuyeres at the base of the gas-generator an amount of air sufficient to make carbonic oxide, and supplying at the tuyeres *g* a like amount of air to mix with and burn the gas generated.

To supply the measured air for producing the gas and for burning the gas so produced, there is provided a blast apparatus, which consists by preference of two air-forcing cylinders, M and N, of equal capacity, driven at equal speeds by one steam-cylinder direct or by an equivalent motor. The air from the cylinder N supplies the gas-generator, and that from the other cylinder, M, is mixed with the gases produced as they issue from the gas-generator, and are delivered to the furnace through the flues or passages *f*, whereby they are burned into carbonic acid.

Instead of using two air-compressing cylinders, one or more than two such cylinders or fans may be used, the quantity of air delivered to the gas-generator and the tuyere *g* being then regulated or measured by passing through air-meters placed one in each of the pipes leading to the gas-producer and tuyeres *g*.

When the fuel used in producing the gases contains hydrogen the resulting gases will require more air to burn them completely than is used in the gas-generator, the proportion of such increase of air being determined by the character of the gases and the nature of the flame desired.

The reverberatory chamber here shown may be provided with a damper in the flue, through which the waste products of combustion are conveyed away, in order to regulate the amount of combustible gases in the chamber.

The caustic lime added to the fuel in the generator enables ash to run off in the form of slag and keeps the generator clear from clogging, so that air can pass through.

It is not intended to claim the production of combustible gases and the burning of them when the air for producing the gases and for burning them is supplied from a single source, and is divided into two divisions solely by valves or registers, as they will not accomplish the purpose of this invention—that is, perfect combustion and economy of fuel combined with the highest temperature—as when the division of the air is made by valves alone there is either an excess or deficiency of air continually occurring, owing to the frequent variations in the resistance to be overcome in the generator on account of the constantly-varying amounts of clinker and ash and different sizes of fuel and different drafts of the chimney or stack. One pound of carbon burned with the exact amount of air (11.6 pounds) for producing perfect combustion yields about 4,300° Fahrenheit, and when one-half more is used (or 17.4 pounds of air) the temperature is 2,950° Fahrenheit, and when the air is deficient in the same relative proportion the temperature is about 3,650° Fahrenheit, and one-third of the fuel is wasted.

As the production of cast-steel in reverberatory furnaces requires a heat of about 4,100° Fahrenheit, the necessity of accuracy of measurement of the air and gas is apparent. The blast-cylinders are provided with sufficient power to force the air into the gas-generator at each stroke, and all the saving which theory indicates is accomplished by the use of two blast-cylinders acting simultaneously, as hereinbefore described, which serve as meters to measure the air and supply it to the fuel in the gas-generator, and to burn the gas according to the chemical laws involved.

I am aware that lime has heretofore been used in a gas-producer to form a slag to melt the clinker, and do not claim the same as new, excepting when used in combination with measured volumes of air, as claimed.

What I claim as new, and desire to secure by Letters Patent, is—

1. The process of producing heat which consists in fluxing the earthy matter of the fuel in a gas-generator by the addition of suitable flux, as described, and feeding a measured volume of air to incandescent fuel for generating gas, and at the same time supplying the gas thereby produced with a measured volume of air in the proper proportion to produce the flame desired, substantially as specified and set forth.

2. The process of producing heat which consists in feeding a measured volume of air to incandescent fuel for generating gas, and at the same time supplying the gas thereby produced with a measured volume of air in the proper proportion to produce the flame desired, substantially as specified and set forth.

JAMES HENDERSON.

Witnesses:
W. L. BENNEM,
E. B. RENWICK.