No. 690,431. Patented Jan. 7, 1902.

E. M. HUGENTOBLER.

FURNACE FOR BURNING BITUMINOUS COAL.

(Application filed Apr. 30, 1901.)

(No Model.) 5 Sheets—Sheet 1.

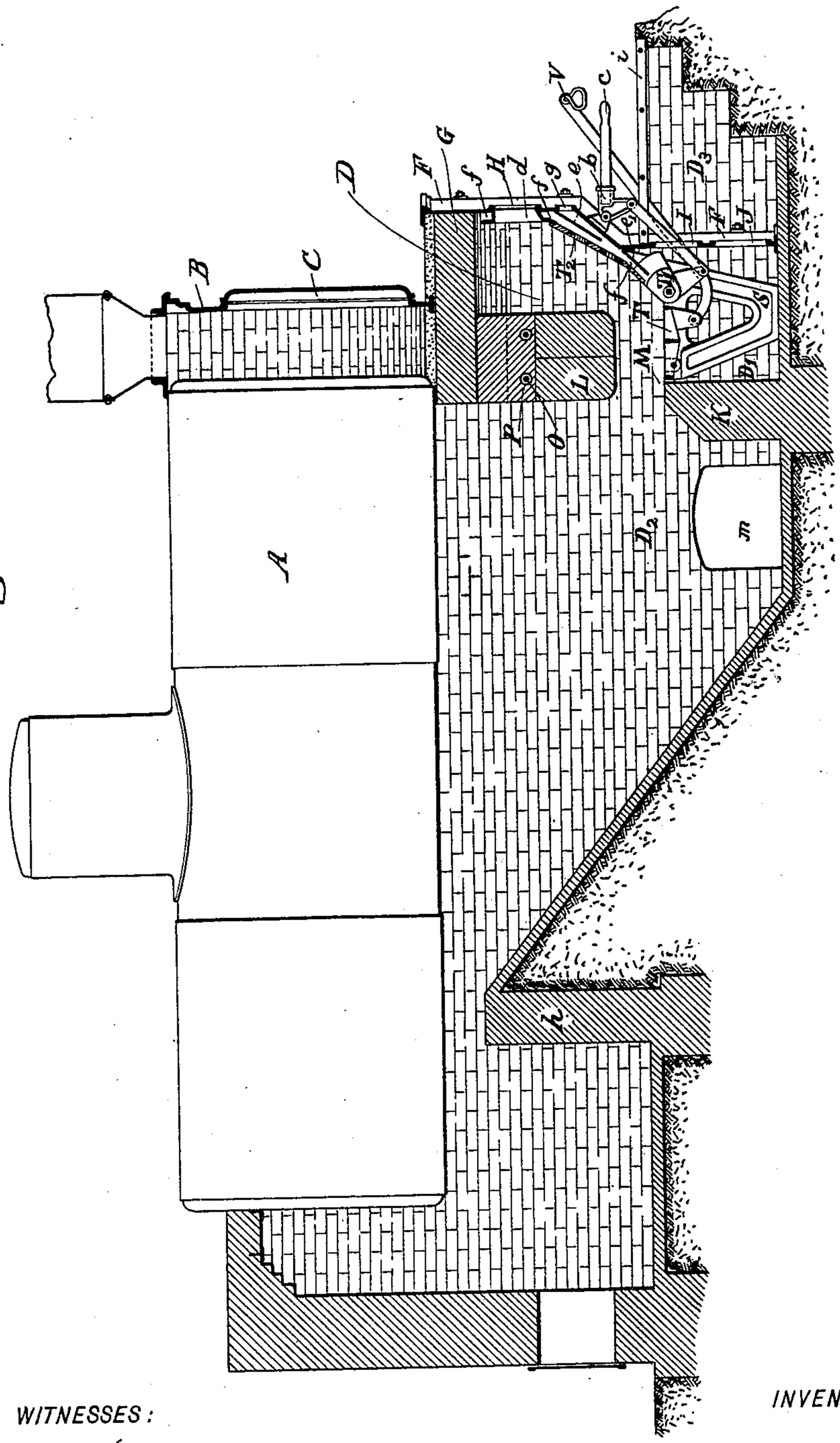

Fig. 1.

WITNESSES:

Henry Kirchner.
John J. Cavaguaro.

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FURNACE FOR BURNING BITUMINOUS COAL.

(Application filed Apr. 30, 1901.)

(No Model.) 5 Sheets—Sheet 2.

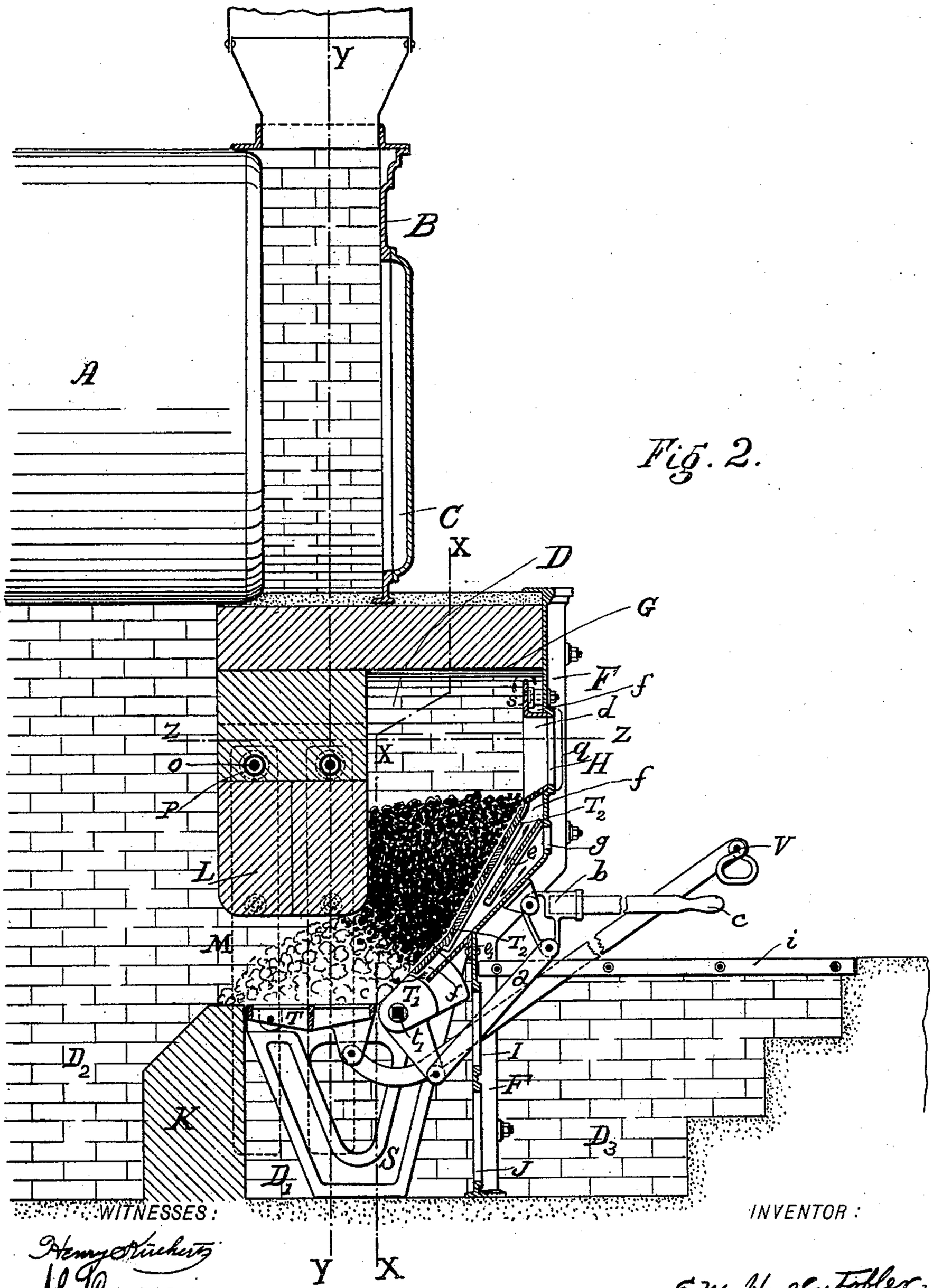

Fig. 2.

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FURNACE FOR BURNING BITUMINOUS COAL.

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(No Model.) 5 Sheets—Sheet 3.

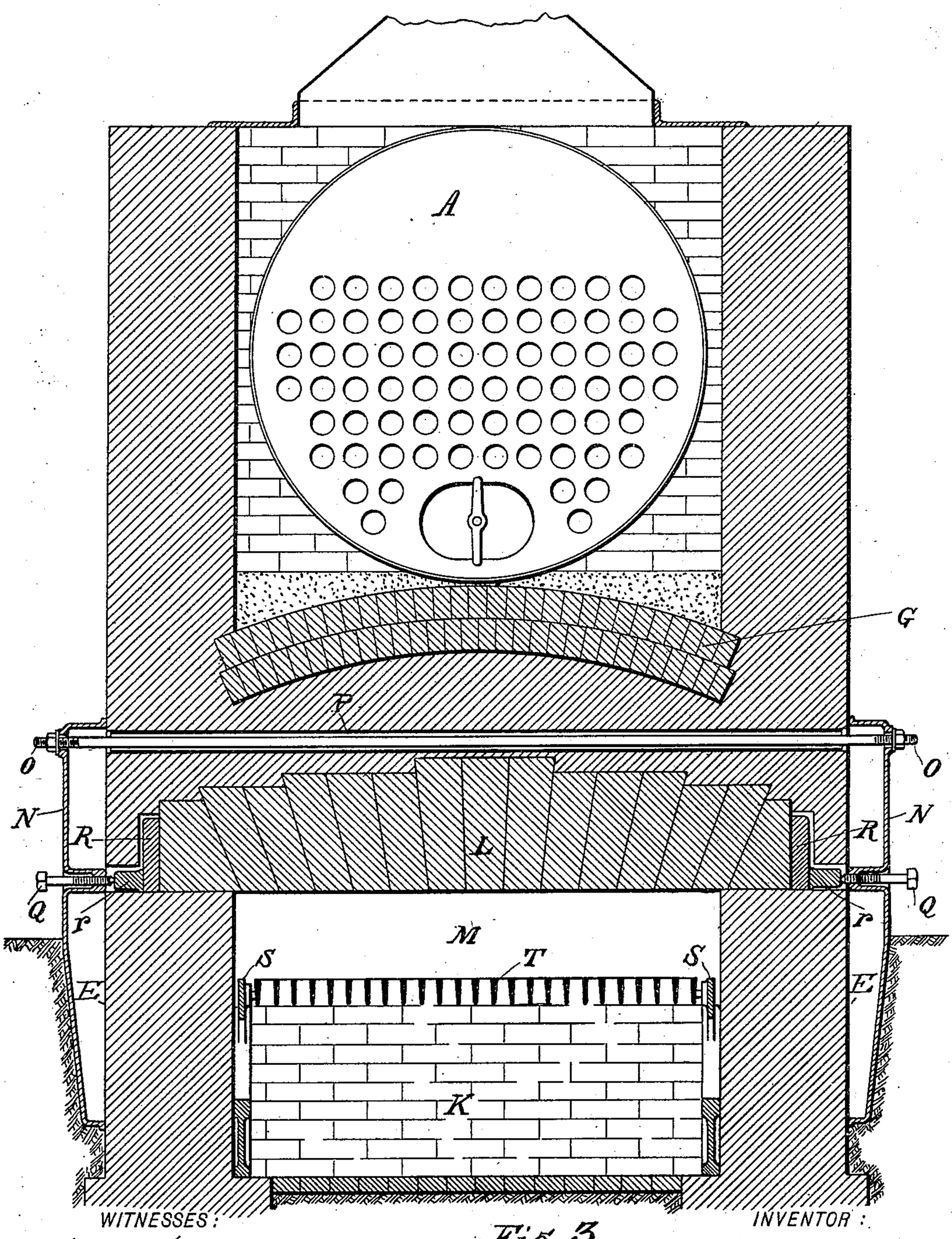

Fig. 3.

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FURNACE FOR BURNING BITUMINOUS COAL.

(Application filed Apr. 30, 1901.)

(No Model.) 5 Sheets—Sheet 4.

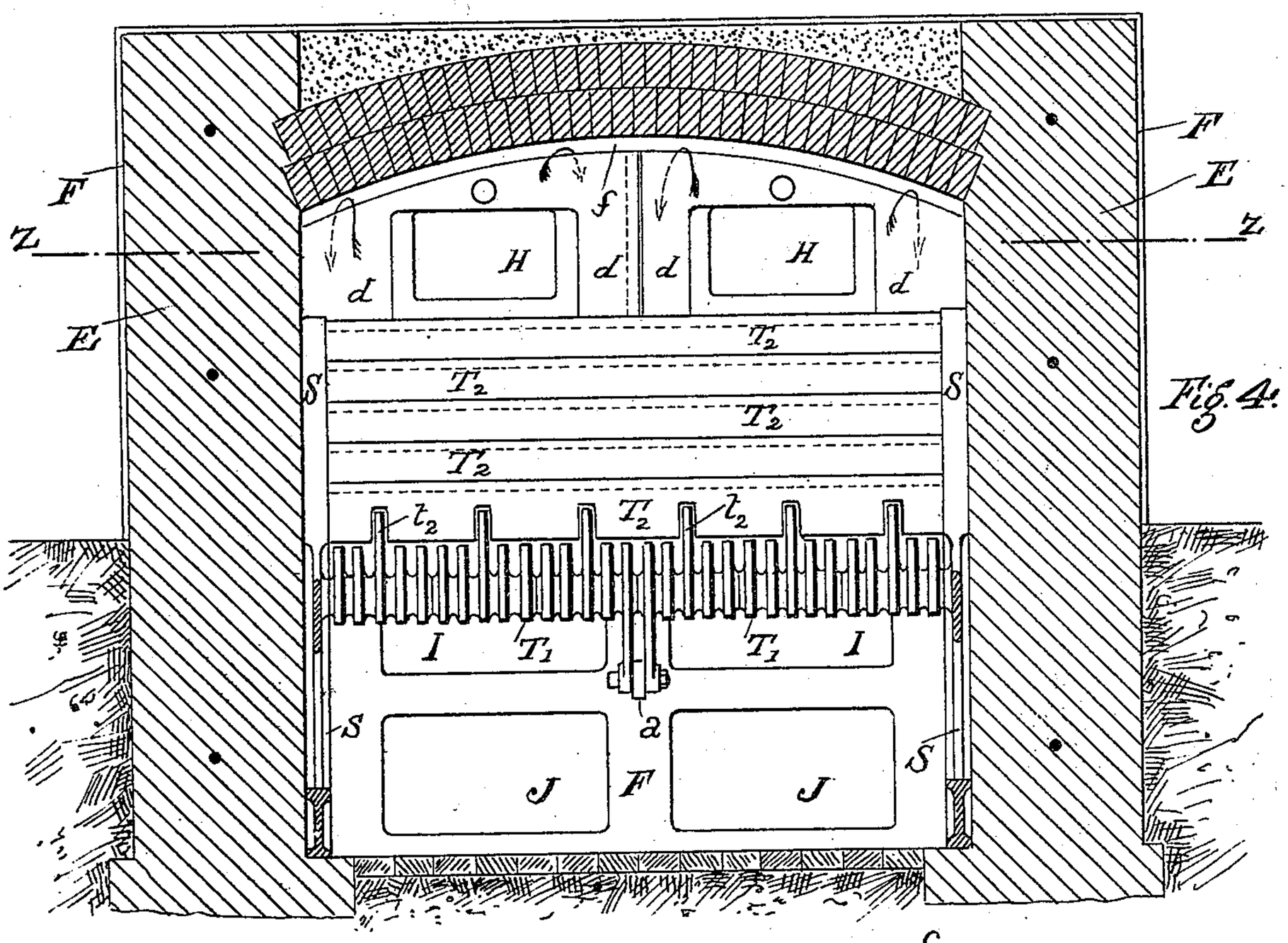

Fig. 4.

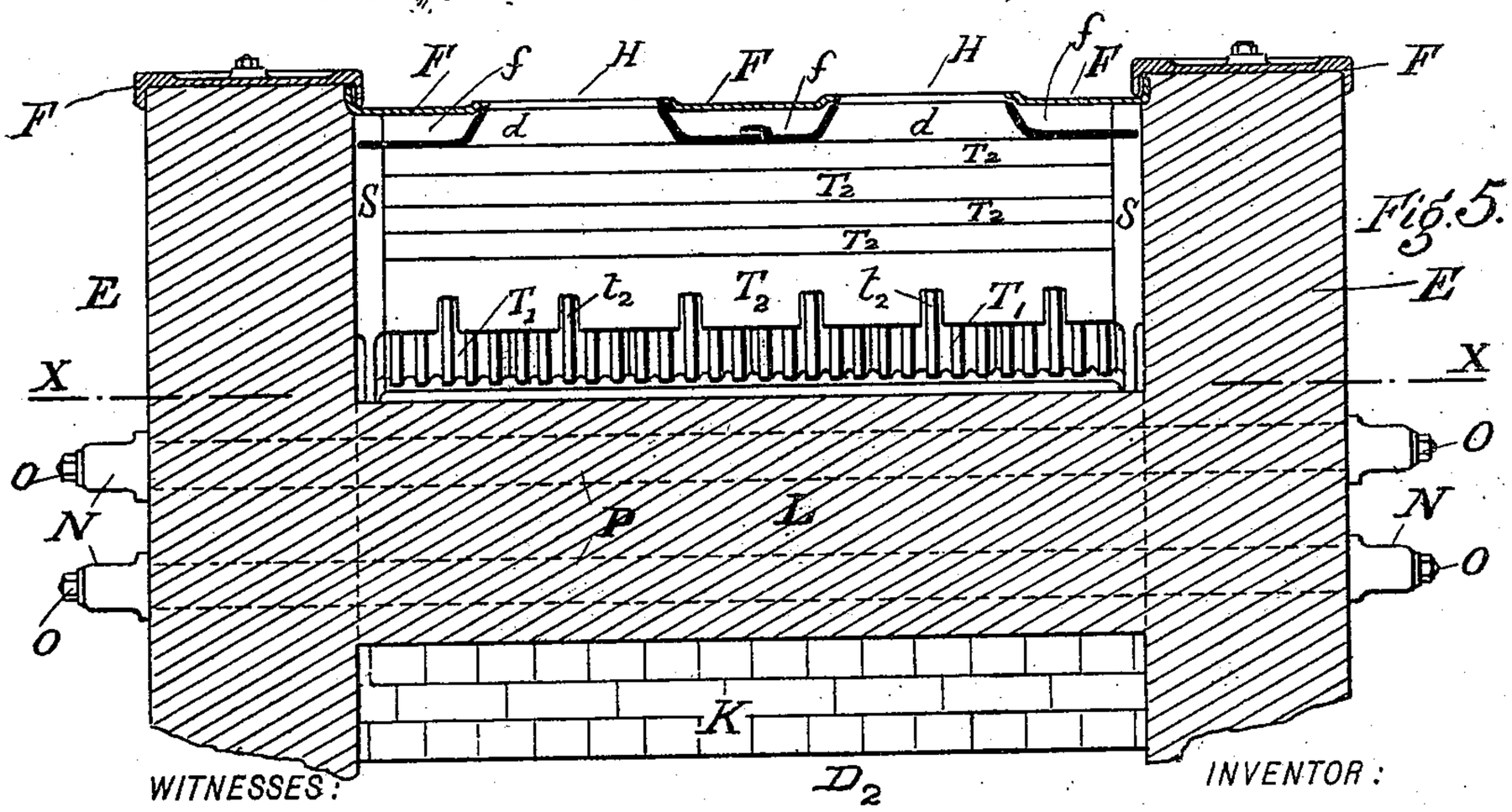

Fig. 5.

WITNESSES:

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FURNACE FOR BURNING BITUMINOUS COAL.

(Application filed Apr. 30, 1901.)

(No Model.) 5 Sheets—Sheet 5.

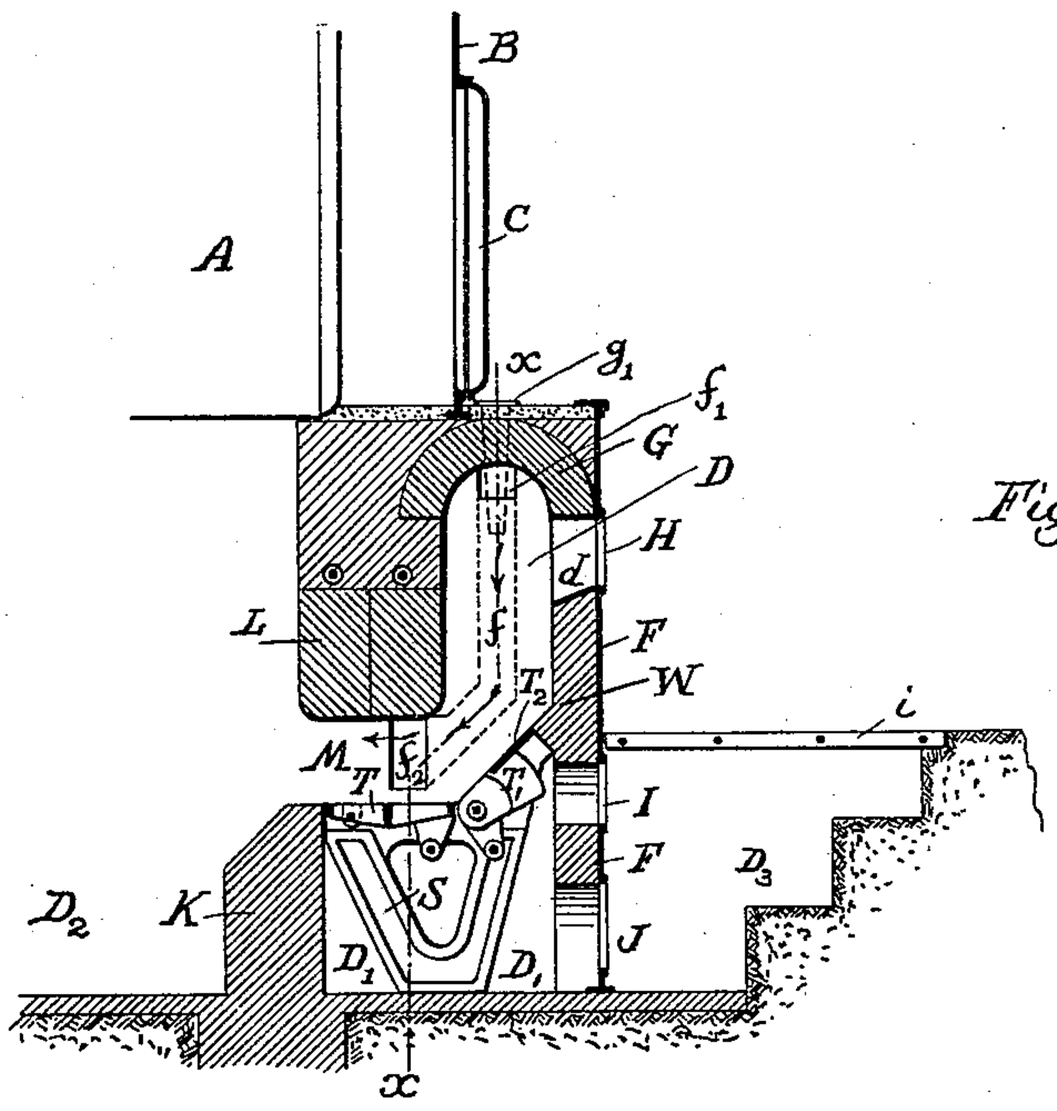

Fig. 6.

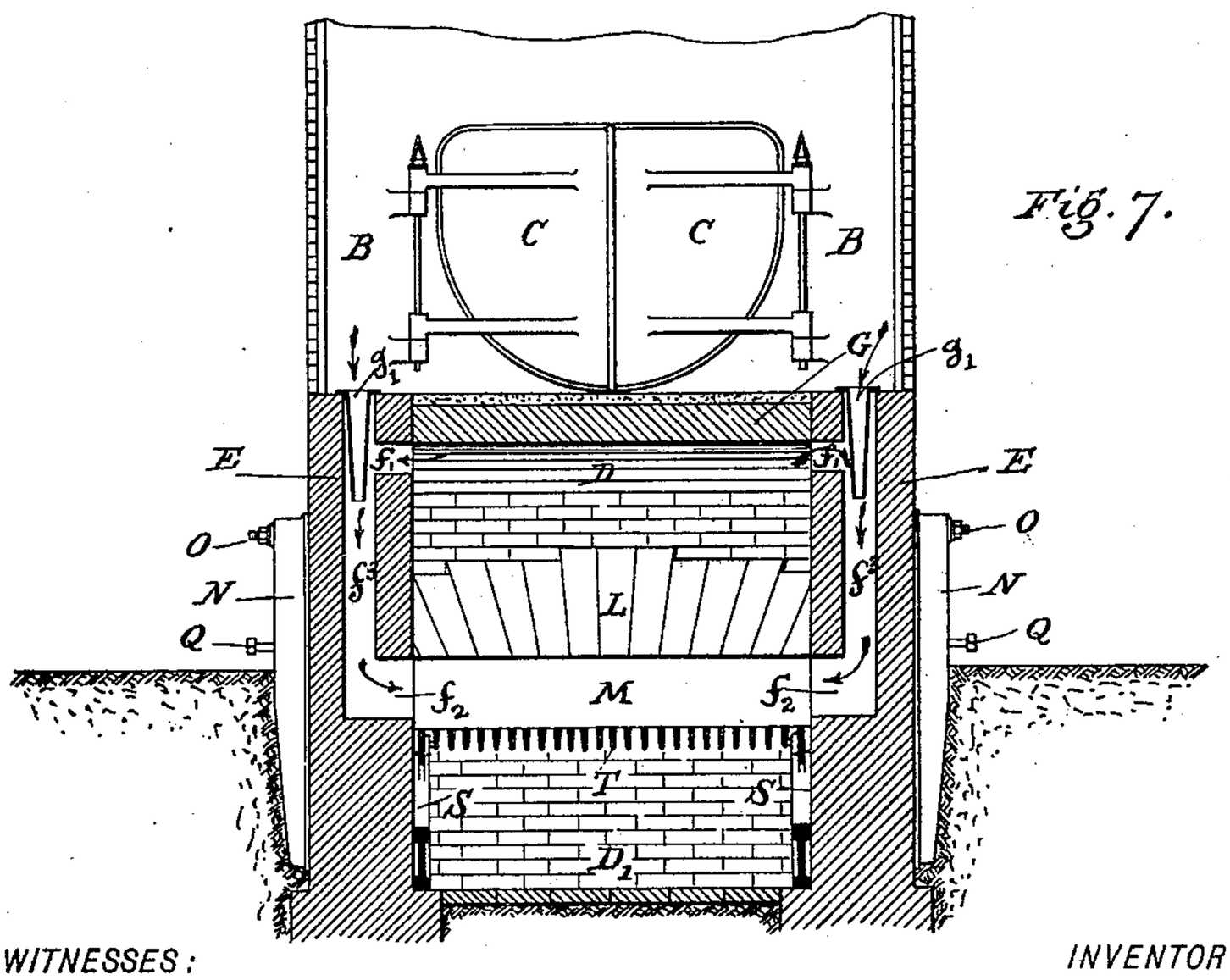

Fig. 7.

WITNESSES:

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John J. Cavaguaro.

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UNITED STATES PATENT OFFICE.

EMIL M. HUGENTOBLER, OF NEW YORK, N. Y., ASSIGNOR TO WILLIAM DE LANCEY WALBRIDGE, OF NEW YORK, N. Y.

FURNACE FOR BURNING BITUMINOUS COAL.

SPECIFICATION forming part of Letters Patent No. 690,431, dated January 7, 1902.

Application filed April 30, 1901. Serial No. 58,186. (No model.)

To all whom it may concern:

Be it known that I, EMIL M. HUGENTOBLER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Furnaces for Burning Bituminous Coals; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same

My invention relates to apparatus for burning bituminous coals, particularly those of the most volatile grades.

Its object is to effect the thorough and complete combustion of all the combustible components of such coals, both solid and volatile, thereby gaining the economy of such combustion and also obviating the wasteful nuisance caused by the sending of these incompletely-burned products into the stacks or flues to foul and pollute the atmosphere. This object I accomplish, primarily, by providing means whereby the operation of disengaging the volatile elements of such fuels is carried on in a distinct and separate part of the furnace from that in which the actual process of combustion takes place, in wholly preventing such volatile elements from entering the exit-flues without first encountering a means for their complete combustion, and, lastly, in providing means whereby such elements are compelled on their way out of the furnace to percolate or seep through a mass or bed of incandescent coke in company with a thorough and sufficient admixture of air, whereby their complete combustion is effected.

In the accompanying drawings, forming a part of this specification, in which my improved furnace is represented as applied to a horizontal return tubular boiler for purposes of illustration, Figure 1 is a longitudinal sectional elevation through the center of the furnace. Fig. 2 is an enlarged view of the front portion of the same sectional elevation. Fig. 3 is a vertical cross-section through line Y Y of Fig. 2 looking to the left. Fig. 4 is a vertical cross-section through line X X of Fig. 2 looking to the right. Fig. 5 is a horizontal cross-section through line Z Z, Fig. 2. Fig. 6 is a view similar to Fig. 2, on a reduced scale, showing a modified arrangement; and Fig. 7 is a vertical cross-section of the same modification, through line $x\ x$ of Fig. 6, looking to the left.

A is a horizontal return tubular boiler. Its front B, instead of reaching to the ground and being provided with fire-doors and ash-pit doors as for an ordinary setting, is stopped off below the cleaning-doors C at about the level of the bottom of the shell.

D is the furnace, located below and in front of the boiler. It consists of a fuel-supply chamber having a downward chute or passage, hereinafter more fully described, a transverse or lateral passage adjoining said downward passage at the bottom, forming the combustion-chamber, and suitable fuel-openings, air-openings, grates, and other appliances. Its sides E are extensions of the side walls of the boiler-setting. Its top is formed by the brickwork-arch G. Its front F, represented in Figs. 1 and 2 as made of metal, is provided with firing or fuel-charging openings H, air-openings I, and ash-pit openings J. The said openings H I J are all provided with doors in the usual manner, that of H being indicated at q, Fig. 2; but the others are left off to avoid complications in the drawings. The fuel-supply openings H are located above the grates and fuel support or chute, to be hereinafter described, while the openings I and J open into the ash-pit chamber D′ below the grates.

The rear wall of the furnace is formed of a bridge-wall K at the rear of the ash-pit and a refractory arch or inverted bridge-wall L, having its lower face preferably horizontal, and between the two the fire-outlet gap or space M, which forms the only communication between the furnace and the boiler-setting. Through this gap all products of combustion must pass on their way to the chimney-stack or exit-flues. To strengthen and support the refractory arch L, which is subjected to an intense heat on its lower face, I employ the expedient illustrated in Fig. 3, where N are buckstays outside the side walls E, having their lower ends firmly secured by being deeply embedded in the ground, while their upper ends are connected by the through tie-rods O, passing through protecting-sleeves

P, embedded in the masonry above the arch L. Pressure-screws Q, tapped through the metal buckstays, abut against pressure-blocks *r*, metal plates R being interposed between the blocks *r* and the voussoirs of the arch, which screws serve to set up and compress and sustain said voussoirs at their lower edges against disintegration under the intense heat to which they are subjected. The voussoirs are carefully matched and fitted in their contacting joints by being ground together or otherwise and are set without intervening cement or mortar of any kind. When the arch is set up, the bolts Q are tightened up, so as to bring the arch blocks or voussoirs into perfect contact, so that the expansion of the arch has to take place upwardly above the horizontal plane of the bolts Q.

Beneath the lower face of the arch or inverted bridge-wall L and immediately in front of the bridge-wall K, at a level with the top thereof, is the horizontally-placed grate T, forming with the arch above a laterally-extending transverse passage terminating in the gap or fire-outlet M, in which passage the combustion takes place, as indicated by the light lines of the fuel shown charged therein. In front of the grate T is the inclined rocking grate T′, provided with means for reciprocating the same and forcing the descending fuel forward into the said combustion-chamber or fire-outlet passage as it feeds downward. The level grate T is also preferably pivoted and furnished with means for tilting it when necessary in the hooked lever V. Both these grates have ample provision for admitting a large supply of air through them for combustion purposes. Beneath them is located the ash-pit D′, provided with the openings I and J, as before said, and having the pit D^3 in front for convenience in removing ashes, said pit being covered by a removable grating *i*, through which air is freely admitted to said openings I and J.

The grates T and T′ are carried on the metal supports or bearings S S, located on each side of the furnace area and extending upward to the fuel-supply opening H. Said supports also carry the inclined or partially-inclined fuel-support forming the front wall of the fuel-supply chamber, which is composed of imperforate elements T^2 for sustaining and guiding the fuel in its descent toward the place of combustion and forming with the front of arch L a downward passage or chute for that purpose. By its imperforate character it practically excludes atmospheric air from the mass of fuel in the fuel-supply chamber, whereby combustion is prevented in said chamber, while coking and the liberation of the volatile combustible products goes freely on. The access of these unconsumed products to the smoke-flues is cut off by the suspended wall L, the lower edge of which is always below the fuel-supply. These volatile products would accumulate in the upper portion of the fuel-supply chamber D but for a provision for burning them presently to be described.

The rocking grate T′ is represented as composed of a series of sections or segments strung on a square shaft *t′*, the ends of which are journaled in the supports S. Said rocking grate is operated by means of the link *a*, bell-crank *b*, and lever *c*. It is toothed or serrated at the upper edge, and at intervals long teeth t^2 are introduced. The imperforate front wall or fuel-support T^2 of the fuel-chamber D is preferably composed of a series of metal plates or slats resting by their ends in the supports S and overlapping each other, so as to form a continuous imperforate surface. The lowermost slat reaches close to the short teeth of the rocking grate T′ and is serrated or slotted to admit the passage of the long teeth t^2 above mentioned.

The fire-door openings H in the front are provided with fire-mouths *d*, bolted to the front plate and carrying shields *s*, which when in place reach laterally from one side to the other of the furnace, downward to the upper slat of fuel-support T^2, and upward almost, but not quite, to the arch G, to the outline of which they conform. These shields *s*, with the fuel-support wall T^2 on one side and the front plate F on the other side, form a continuous passage-way *f* around the outside of the fire-mouths *d* from the uppermost part of the furnace or fuel-supply chamber under the arch G to the bottom or lowermost plate of the fuel-support T^2, terminating directly in front of the rocking grate T′. This forms a conduit for the escape of the volatile products and combustible gases accumulating in the upper part of the furnace, which have no other exit, and conducts them directly to the entrance of the combustion-chamber through grate T′, where there is a strong draft of air through the incandescent fuel, conveying these products with it into the midst of the fire, where they are consumed. To aid in the proper aeration of these products and promote their complete combustion, one or more openings *g* are provided in the metal front F, (said openings being furnished with regulating-doors, which are omitted in the drawings for the sake of greater clearness,) which openings admit air to passage-way *f*. In said passage-way a plate *e* is inserted, secured to the front F above the openings *g*, extending from side to side of the furnace, and reaching downward in the passage-way *f* some distance below the opening, as shown in Fig. 2. This partition secures the admission of a current of air to the current of volatile matter flowing through *f*, which both aerates it and facilitates its movement on the injector principle. The passage-way is continued and prolonged to the proper point by means of a plate *e′*, forming an extension of front F, down to grate T′.

h is the usual bridge-wall in the boiler-setting. The space between the two bridge-walls *h* and K forms a secondary ash-pit D^2, to which access may be had through the door *m*.

In Figs. 6 and 7 the arch G is shown with its axis at right angles to that of the boiler. The fuel-support wall is modified so that only the lowermost slat T^2 is used, which is inclined, as in the other figures, and serrated or slotted to admit of the movement of the toothed rocking grate T'. In place of the other metallic slats the fuel is confined by the vertical front wall W of the furnace, a portion of which has an incline or offset adjoining metal slat T^2. The arrangement of flue *f* is slightly modified. Instead of at the front the gases escape through ports *f'* in the side walls at the top of the furnace, thence downward through flues f^3 in the side walls, which communicate by ports f^2 with the fire-outlet passage or combustion-chamber, into which the volatile products are discharged. The aeration is accomplished by twyers *g'*, inserted into the downward flues f^3, thus performing the same function as the equivalent passages formed by the plate *e*, Fig. 2, and opening *g*.

In place of the return tubular boiler shown in the illustrations I may use any known type of boiler or any other device used in the arts for any purpose wherein the complete combustion of the bituminous coals is a desideratum.

Operation: From the foregoing description it is evident that when the furnace is in operation charged with fuel, as shown in Fig. 2, the fire-doors *q* being closed, no air practically has access to that part of the fuel which lies above a plane passing through the lower edge of the imperforate fuel-support T^2 and the lower front corner or edge of the arch L, and consequently no combustion of the fuel takes place above said plane, while that portion of the fuel which lies below and to the rear of said plane, receiving a supply of air freely through grates T' and T, is maintained in a state of intense combustion and becomes incandescent. The fuel is thus divided into two distinct portions, one in the draft and fire outlet passage maintained in a state of intense combustion and the other lying above said imaginary plane, to which no air has access and in which combustion does not take place. As this latter portion, however, is in direct contact with the incandescent portion in the combustion-chamber, a part of which lies in front of the arch-wall and directly beneath the supported column of non-burning fuel, the latter receives heat from the incandescent mass both by radiation and convection in sufficient quantity to disengage the volatile constituents of the coal, which expand in part into the upper portion of the fuel-chamber, while the solid portion is reduced to the condition of coke. The products thus released by distillation, having no outlet to the smoke-stack except through the burning fuel in the fire-outlet passage, seek this path by percolation downward, to some extent induced by the draft setting through the combustion-chamber by way of grates T' and T, and are consumed, while the strong draft setting through openings *g* into the passage below plate *e* when the doors thereof are opened draws by induction a current of volatile products through passage *f* from the space above the fuel, which current joins the main current of air flowing into the combustion-chamber and the fire-outlet through grates T' and T, passing the combustible components through the mass of burning fuel therein in conjunction with a sufficient supply of air, where they are wholly consumed. The smoke and volatile products being thus entirely disposed of by conversion into invisible gas are robbed of their noxious character, and their heat value is at the same time availed of. The travel of the incandescent mass through the combustion-chamber and the due descent of the fuel in the fuel-chamber are promoted by the rocking grate T', the function of which is to force rearwardly the burning mass, which consumes and diminishes in volume on the grate T, the incombustible ashes and clinkers being pushed over the bridge-wall K into the ash-pit D^2. The function of the long teeth l^2 of the rocking grate is to move into the non-burning portion of the fuel-bed near the incandescent line to break it up and prevent caking, so that it will feed properly downward.

It is essential to the successful operation of this furnace that the fuel-supply shall while in operation always be sufficient to completely cover and bar the entrance to the combustion-chamber, so that no volatile matter may pass through the fire-outlet gap M by way of said chamber without being compelled to traverse a mass of incandescent fuel. As the elimination of the volatile matter and the coking of the fuel takes place above the imaginary plane dividing the burning from the non-burning mass, it follows that the fuel in combustion on grates T and T' is a bed of incandescent coke. Now air passes much more freely through burning coke than through bituminous coal, and in consequence I find in practice that my furnace will burn as much coal as could be otherwise burned on a flat grate of two and one-half times the combined area of grates T and T' with the same percentage of air-space and intensity of draft. This is a feature of economy, as it is a well-known principle that the more concentrated and intense the combustion the more perfect the consumption and the smaller the relative demand for excessive air-supply.

The operation of the modified form of furnace shown in Figs. 6 and 7 is substantially the same as that above described and needs no special elucidation.

Heretofore fairly good results with skilful firing have been obtained in burning bituminous coals on ordinary grates by firing the fresh fuel upon the front part of the grate and as the volatile products escape pushing the resultant coke formation to the rear. This gives a bed of incandescent fuel at the rear, where the combustion is more intense

and through which the air percolates more freely than through the mass of crude coal in front, thus affording a means for the more complete combustion of the volatile products as they pass over the incandescent mass on their way to the exit-flues. The true principle of complete combustion is herein indicated; but skilled labor is necessary, and the best results are only approximate. By my improved construction of furnace I not only am enabled to dispense with the element of skilled firing, but gain absolute and complete results by compelling the volatile products to traverse the mass and substance of an incandescent bed of coke before they can find any exit to the external air.

I claim and desire to secure by Letters Patent—

1. In a furnace for burning bituminous coal, a fuel-supply chamber, a fuel-supply opening therein, a downwardly-directed fuel passage or chute below said opening, a transverse passage adjacent to said chute, at the bottom thereof, a horizontal grate beneath said transverse passage, an inclined rocking grate at the junction of said passages, with means for rocking the same to feed forward the fuel from the downward passage into the adjacent transverse passage, and means for supplying air freely through said grates to the fuel in the transverse passage while excluding it from the fuel in the downward passage, whereby combustion is maintained in the transverse passage and the fuel is coked in the downward passage, substantially as specified.

2. In a furnace for burning bituminous coal, a fuel-supply chamber, a fuel-supply opening therein, a downwardly-directed fuel passage or chute below said opening, a transverse passage adjacent to said chute at the bottom thereof, a horizontal grate beneath said transverse passage, an inclined rocking grate at the junction of said passages, with means for rocking the same to feed forward the fuel from the downward passage into the adjacent transverse passage, means for supplying air freely through said grates to the fuel in the transverse passage while excluding it from the fuel in the downward passage, and means for conducting the volatile products from the fuel-supply chamber to the air-currents supplied to the fuel in the transverse passage, whereby said volatile products are wholly consumed along with the fuel in said passage, substantially as specified.

3. In a furnace for burning bituminous coal, an arch or inverted bridge-wall, having a fire-outlet passage beneath the same, a fuel-supply opening opposite said wall, above the level of the fire-outlet passage, an imperforate fuel-support extending from said supply-opening to a point opposite the fire-outlet passage, inclined at the bottom toward said passage, an inclined rocking grate opposite the fire-outlet passage provided with means for rocking the same to cause the descending fuel to feed toward the fire-outlet, a horizontal grate beneath the fire-outlet passage, and means for supplying air freely through said grates to the fuel in the fire-outlet passage while excluding air from the fuel-supply in the downward passage, substantially as specified.

4. In a furnace for burning bituminous coal, a fuel-supply chamber, a fuel-supply opening therein, a downward discharge-passage in said chamber, for holding a supply of fuel, a transverse passage for incandescent fuel, leading laterally from said downward passage below the level of the supply-opening, an inclined rocking grate at the junction of said passages, with means for rocking the same to feed the fuel forward into said transverse passage, a horizontal grate at the bottom of said transverse passage, and means for supplying air freely through said grates to the fuel in said transverse passage, while excluding air from said downward passage, whereby the fuel is burned in the transverse passage and is caused to coke in the downward passage by the heat communicated from the burning fuel in the adjacent transverse passage, substantially as specified.

5. In a furnace for burning bituminous coal, an arch or inverted bridge-wall, a bridge-wall below said arch, forming a constricted passage or fire-outlet between said arch and wall, a fuel-supply opening opposite said arch, above the level of the fire-outlet, an imperforate fuel-support extending from said supply-opening to a point opposite the fire-outlet, inclined at the bottom toward said outlet, an inclined rocking grate opposite the fire-outlet provided with means for rocking the same to cause the supported fuel to feed toward said outlet, a horizontal grate beneath said arch, adjacent to said bridge-wall, forming a bridge connection between said inclined grate and said bridge-wall, means for supplying air freely through said grates to the fuel thereon, and gas-passages leading from the closed space above the fuel-supply to the inclined rocking grate, for conducting the volatile components of the fuel around the non-burning portion and into the incandescent portion on said grates, whereby said volatile components are completely consumed, substantially as specified.

6. In a furnace for burning bituminous coal, a fuel-supply chamber, having a downwardly-directed fuel chute or passage, a combustion-chamber laterally adjacent to said downward passage at its bottom, an inclined imperforate fuel-support at the front of said downward passage, an inclined rocking grate at the junction of said passages, with means for rocking the same to feed the fuel forward into the combustion-chamber, a horizontal grate beneath said combustion-chamber, means for feeding air freely to the fuel in the combustion-chamber while excluding it from the fuel-supply chamber, gas-passages leading from the space above the fuel in the fuel-sup-

ply chamber around the body of fuel therein, to the entrance to the combustion-chamber, whereby the volatile products pass from the closed fuel-supply chamber into the incandescent fuel in the combustion-chamber to be consumed, and air-injector passages leading into said gas-passages, for aerating the volatile products therein prior to combustion, and promoting their movement, substantially as specified.

7. In a furnace for burning bituminous coal, an arch or inverted bridge-wall, buckstays outside the abutments of said arch embracing the same, tie-rods connecting the buckstays, and compression-screws passing through the buckstays, applied against the voussoirs of the arch on either side, for compressing and setting up the latter, to restrain disintegration, substantially as specified.

8. In a furnace for burning bituminous coal, the inverted bridge-wall L, a fuel-supply chamber D, having a supply-opening H opposite the fire-wall, a fire-outlet passage beneath said wall, below said supply-opening, an inclined imperforate fuel-support at the front of said fuel-supply chamber extending from the supply-opening to a point opposite the fire-outlet passage, forming a fuel-chute, a pivoted reciprocating inclined grate adjacent to said inclined fuel-support, means for operating the reciprocating grate to feed forward the fuel descending from the supply-chamber, a horizontal grate beneath the fire-outlet passage, means for tilting the same, means for supplying air freely through said grate to the fire-outlet passage while excluding it from the fuel-supply chamber, gas-passages leading from the upper part of the fuel-supply chamber around the fuel-chute to the entrance of the fire-outlet passage, and auxiliary injector air-passages opening into said gas-passages for aerating the volatile products in the latter before their admission into the fire-outlet passage, and for promoting their movement, substantially as specified.

9. In a furnace for burning bituminous coal, a fuel-supply chamber, having a downward extension or chute, an imperforate front wall to said chute, inclined at the bottom toward the combustion-chamber, a fuel-supply opening above said front wall, a lateral combustion-chamber adjoining said chute at the bottom thereof, draft-openings for admitting air freely to said combustion-chamber while excluding it from the fuel-supply chamber, gas-passages leading from the upper part of the fuel-supply chamber to the vicinity of said draft-openings, and air-injector passages leading from the external air into said gas-passages, for aerating the volatile products and promoting their movement, substantially as specified.

10. In a furnace for burning bituminous coal, a fuel-supply chamber, having an arch or inverted bridge-wall at its rear, a metallic front to said chamber, fire-door openings in said front, fire-mouths secured around said openings, an inclined fuel-support within said front, extending from said fire-mouths to below the bottom level of the inverted bridge-wall, shields secured to said fire-mouths at a short distance from said front, extending laterally from side to side of the chamber, downward to the top of the inclined fuel-support, and upward nearly to the top of the chamber, forming a gas-passage around the fire-mouths connecting with the downward passage between the metallic front and the inclined fuel-support, openings *g* in the metallic front into said downward passage, and a partition *e* between the metallic front and the fuel-support, substantially as and for the purposes specified.

In testimony whereof I affix my signature in presence of two witnesses.

EMIL M. HUGENTOBLER.

Witnesses:
HENRY KIRCHEAT,
JOHN J. CAVAGNARD.