

(No Model.)

4 Sheets—Sheet 1.

F. H. RICHARDS.
FURNACE.

No. 535,409.

Patented Mar. 12, 1895.

Fig. 1.

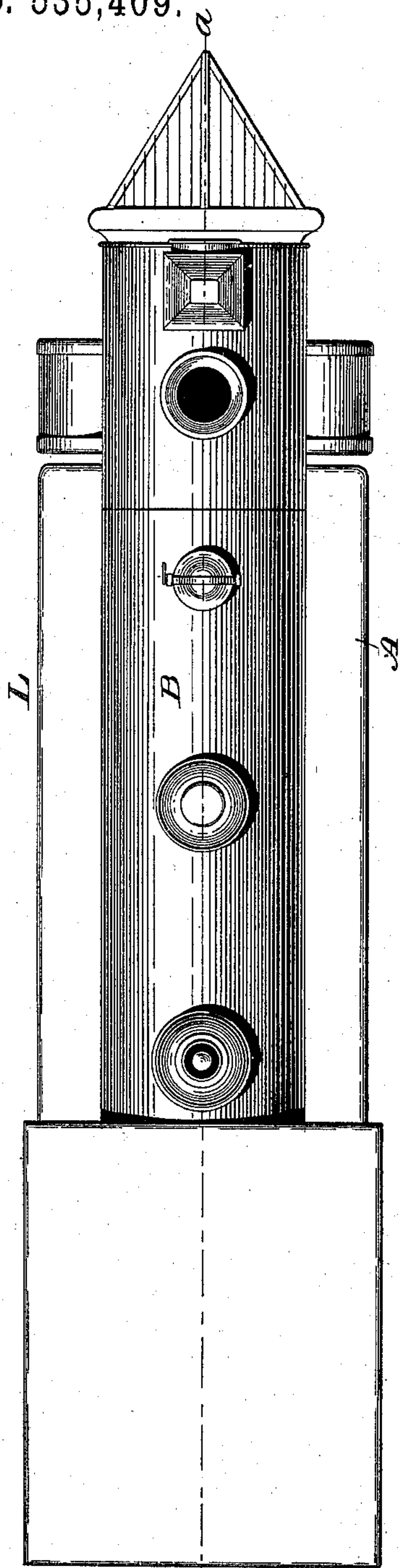
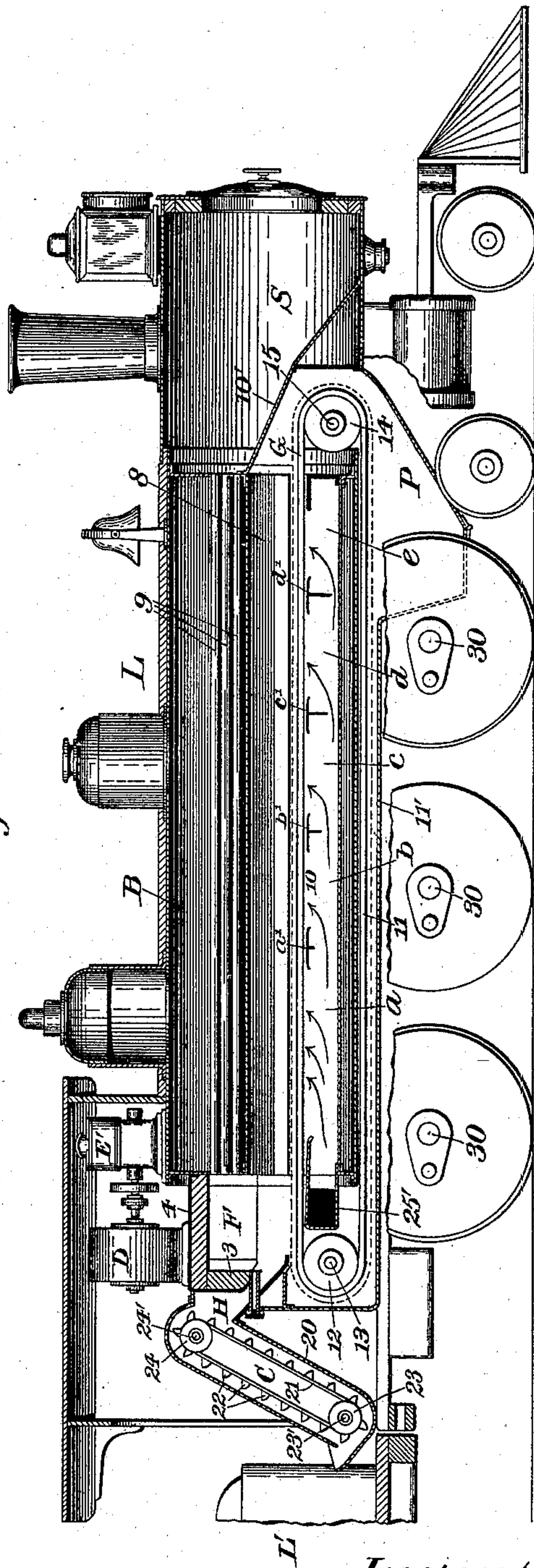


Fig. 2.



Witnesses.

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(No Model.)

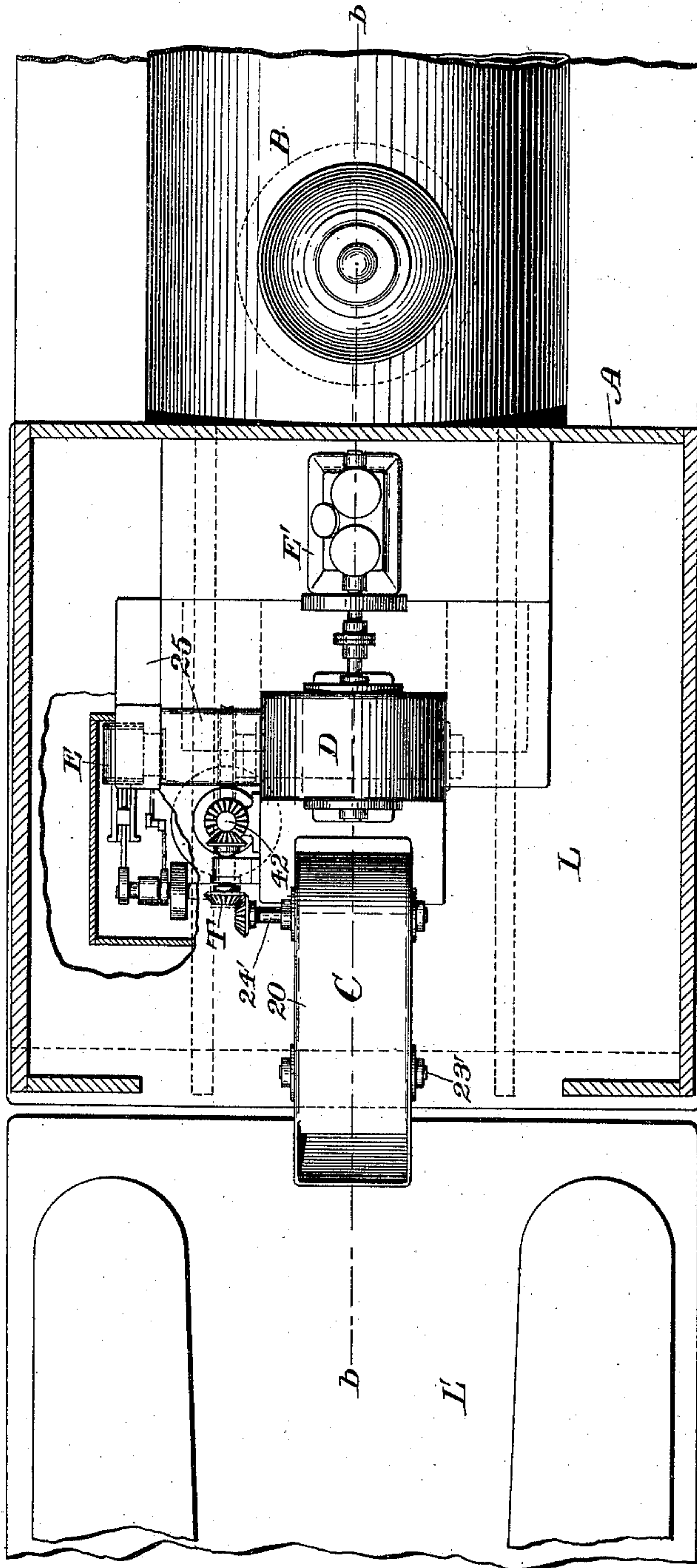
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Fig. 3.



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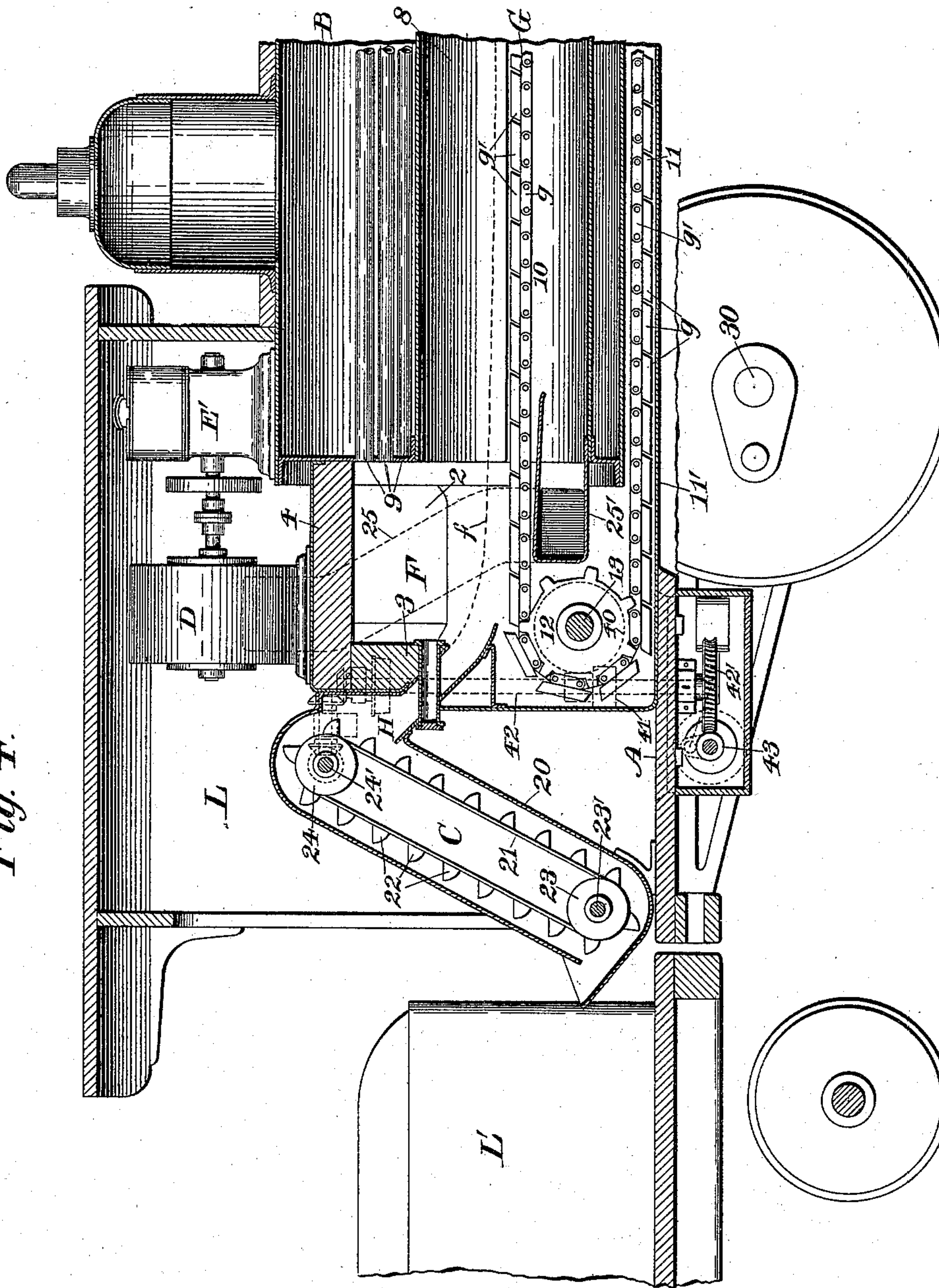
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Fig. 4.



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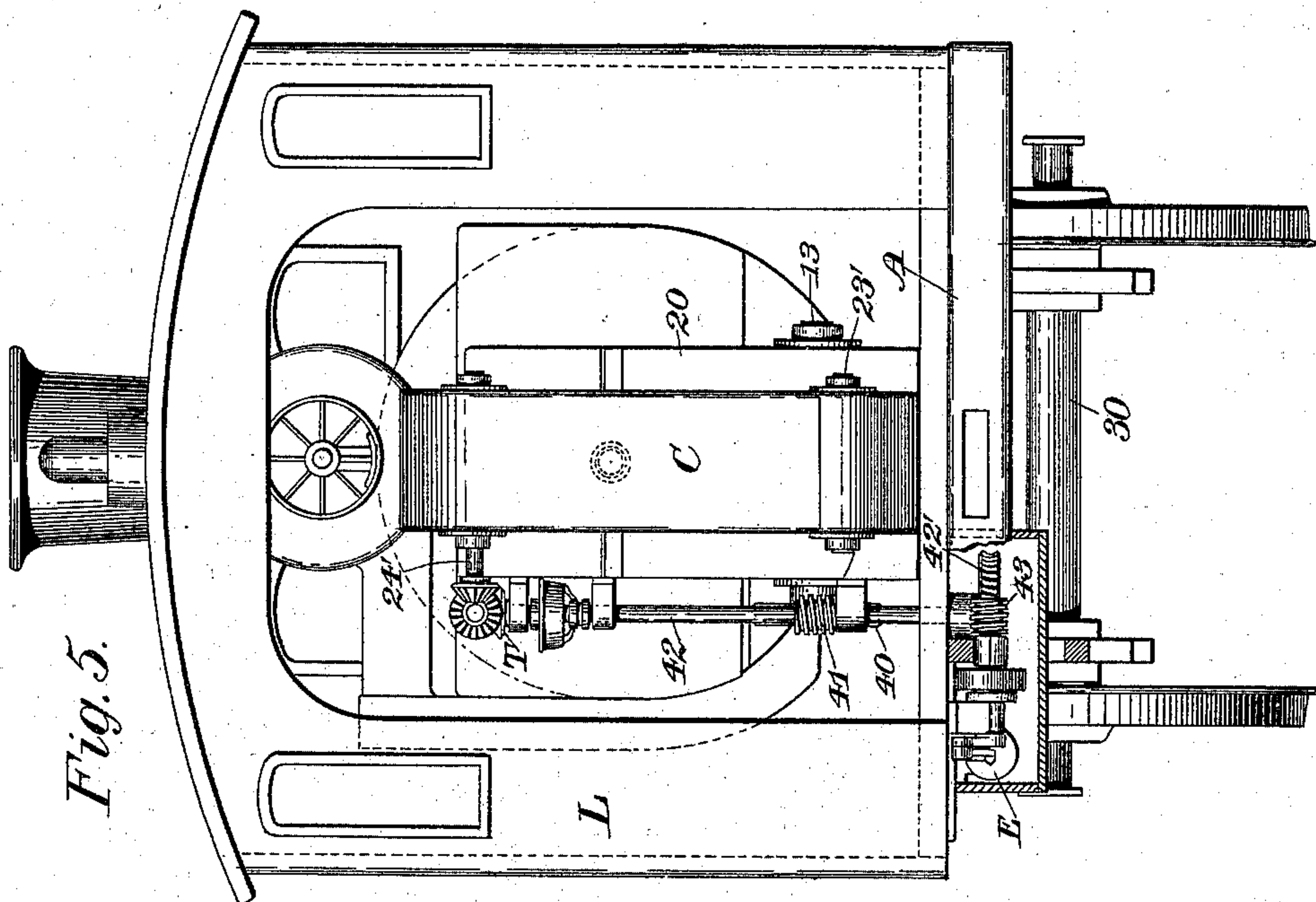
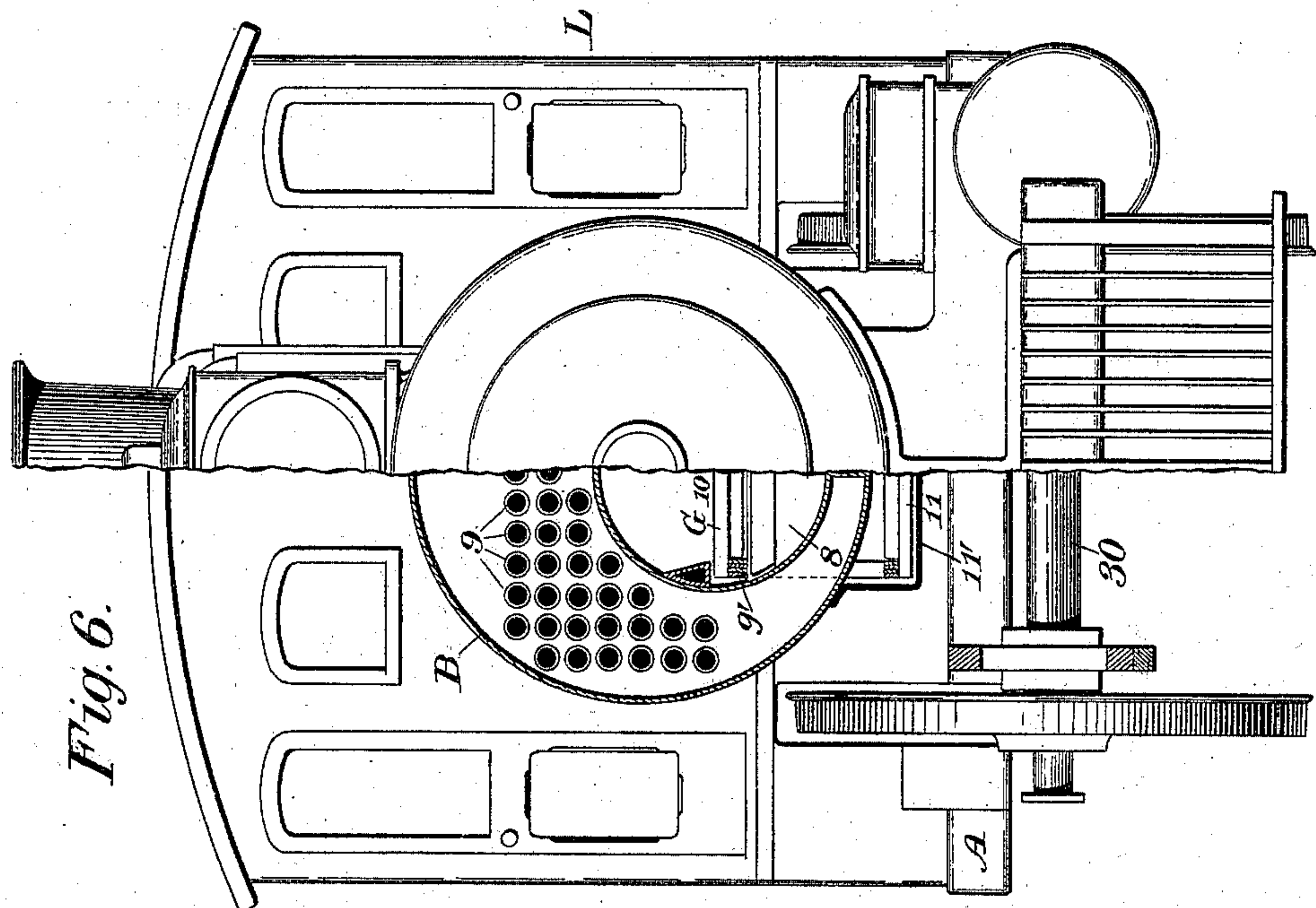
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4 Sheets—Sheet 4.

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UNITED STATES PATENT OFFICE.

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FURNACE.

SPECIFICATION forming part of Letters Patent No. 535,409, dated March 12, 1895.

Application filed October 11, 1894. Serial No. 525,570. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS H. RICHARDS, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

This invention, which appertains to locomotive-engines, relates particularly to those features of the engine which effect the combustion of the fuel and upon which the effective generation of steam is dependent.

The object of my present invention is, primarily, to provide in connection with a locomotive-engine an improved steam-boiler, having a fire-box or reverberatory-chamber located below the flues thereof, and to provide in connection with said boiler improved grate-mechanism, including an air-blast apparatus, especially adapted for facilitating the combustion of the fuel and for insuring a maximum liberation of effective energy for steam-generation from a minimum amount of fuel and in the shortest possible length of time; also to so construct and organize said grate mechanism and the incorporator air-blast apparatus, that the fuel will have a continuous and progressive movement in the fire-box or combustion-chamber; will be maintained substantially *in statu quo* on the grate during the successive stages of the combustion period, and will be subject to successive air-blasts at varying pressures at successive points in the length of the traveling movement thereof, corresponding to the successive varying stages of the combustion period, and also to provide in connection with the fuel-traveling furnace-floor (which constitutes a component part of the grate-mechanism) means for automatically feeding the fuel to said furnace-floor.

Another object of the invention is to provide means whereby the gaseous products accruing from the later stages of combustion are reverberated and carried backward toward the rear end of the boiler and there mingle with the products of the first stages of the combustion period at the ignition area of the fire-box, and in the rear of the boiler, to thereby bring the gases, smoke and air into such close contact as to secure the best

possible results in combustion, and also to provide means for preventing the lighter particles of the fuel, or the residuum of the later stages of combustion, from being drawn into the flues of the boiler.

In the drawings accompanying and forming part of this specification, Figure 1, is a plan view, on a relatively small scale, of a portion of a locomotive-engine embodying my improvements. Fig. 2 is a central longitudinal section of the same taken in line *a—a*, Fig. 1, looking from the under side in said figure, certain elements thereof being shown in side-elevation. Fig. 3 is a sectional plan view, on a relatively large scale, of a portion of a locomotive-engine and tender showing certain constituents of my present improvements in connection therewith. Fig. 4 is a central longitudinal section of the same taken in line *b—b*, Fig. 3, looking from the under side in said figure, certain of the elements being shown in the side elevation. Fig. 5 is a rear-end elevation of the locomotive-engine as seen from the left hand in Fig. 3, the tender being removed, and parts being broken away to more clearly show certain of the details, and Fig. 6 is a front elevation of said locomotive partially in vertical cross-section.

Similar characters designate like parts in all of the figures.

In the drawings, only so much of the locomotive-engine and its tender are shown as is deemed to be necessary for clearly illustrating the application and mode of operation of my improvements. The locomotive-engine is designated in a general way by L, and its tender by L'.

All of the parts of the locomotive-engine, L, with the exception of the boiler, designated in a general way by B; the fire-box or combustion-chamber F; the smoke-box S; the furnace-floor or grate G, and those elements, which are in operative connection with said grate and which have a direct influence upon the combustion of the fuel, are, or may be, in general construction and organization, substantially the same as like parts in any ordinary locomotive-engine, and it is, therefore, deemed unnecessary, for a full comprehension of my invention, to give a detailed description of those parts of the locomotive-engine which

have no operative connection with, or in no way effectively contribute to the results attained by, the elements comprised in my invention.

5 In the present instance, the boiler B, which is of the multi-flue variety, but of peculiar construction, and which is supported in the usual manner by a suitable frame-work A, (which frame-work is carried upon the driving-wheel axles 30 in the usual manner and is only partially shown) is provided at a point preferably in vertical alignment with the longitudinal axis thereof, with a tube or flue, 8, of relatively large diameter, which extends from end to end of the boiler and constitutes, practically, a forward extension of the fire-box and is adapted for reverberating the products of the later stages of the combustion period causing them to move backward and intermingle with the products of the first stages of the combustion period, as will be hereinafter more fully described.

Located at the rearward end of the boiler B, with the lower portion thereof in communication with the flue 8 (which flue will be hereinafter referred to as the reverberatory-chamber) is the fire-box or furnace-chamber proper F, and at the forward end of the boiler B, said boiler is provided with a cylindrical extension, without flues, which constitutes the smoke-box S, said smoke-box, S, being in communication with the relatively small flues 9 of the boiler, but being cut off from communication with the reverberatory chamber by the upper wall 10', of an ash-pan, P, which is herein shown secured to the shell and forward flue-sheet of the boiler B at the lower side thereof and in position for receiving the ashes and cinders as these are discharged over the forward end of the furnace-floor G.

The fire-box, F, may be constructed in any suitable manner and may, if desired, form a part integral with the boiler B, it being shown inclosed by the two side-walls 2, rear end-wall 3, and roof 4, which roof is herein shown of the incandescent or composite type.

In the form herein shown the reverberatory-flue is secured within the shell of the boiler with its periphery remote from the shell and remote from the relatively small flues 9 of said boiler. Said flue 8 is rendered heat-resistant by being surrounded by water in the same manner as the small flues 9 of the boiler.

55 In the form thereof herein shown, the fuel-traveling grate is of the endless grate variety and will, preferably, be of a construction similar to the grate shown and described in my prior application, Serial No. 519,730, filed August 8, 1894, to which reference may be had. It will be obvious, however, that the construction and organization of the grate may be varied within the scope and limits of my present invention.

65 The endless grate G, (which comprises the upper and lower runs 10 and 11, respectively, the upper run of which constitutes the fur-

nace-floor proper and is supported for traveling movement within, and approximately midway of the height of, the reverberatory-chamber or flue 8) is shown carried at one end of its circuit in the rear of the boiler, and at the other end of its circuit, in advance of the boiler by chain-wheels 12 and 14, respectively, carried upon shafts 13 and 15, respectively, journaled in suitable bearings at their ends, as most clearly shown in Figs. 2, 4 and 5 of the drawings.

As a convenient means for imparting a traveling movement to the grate G, I have shown the shaft 13 provided at one end thereof with a worm-wheel, 40, which meshes with a worm, 41, upon a driving-shaft 42, herein shown as vertically disposed and carried at opposite ends thereof in suitable bearings, and as a means for rotating the driving-shaft I have shown the said driving-shaft provided with a worm-wheel, 42', which meshes with a worm, 43, upon a cranked shaft which is herein shown as driven by a small reciprocating-engine, designated in a general way by E, which is shown as supported below the floor of the locomotive cab. At the rearward end of the fire-box is a fuel-supply hopper, H, the delivering end of which extends through the rear wall 3 of said fire-box and terminates in close proximity to the upper face of the fuel-carrying run of the grate. As a convenient means for supplying fuel to the grate or furnace-floor through the hopper, H, I have provided, in connection with the receiving end of said hopper, a fuel-feeding apparatus, designated in a general way by C, which apparatus consists of a suitable feed trough, 20, which is secured to and practically forms a downward extension of the hopper, H, and an endless conveyer-belt, 21, provided with suitable conveyer-buckets, 22, and carried upon wheels 23 and 24, the one 23 of which is carried upon a shaft, 23', journaled in bearings in the side-walls of the trough 20 at the lower end of said trough, and in close proximity to the floor of the cab, and the one 24 of which is carried upon the shaft 24' journaled in bearings in the side-walls of the trough 20 near the upper end of said trough, and at the upper end of the hopper H. The trough 20 has a receiving boot at the lower end thereof into which the fuel is thrown to be fed to the hopper H, said fuel being carried upward by the buckets of the conveyer-belt and dumped into the receiving end of the hopper, from whence it is delivered to the fuel-carrying run of the grate. The receiving end of the trough 20 extends over the forward end of the floor of the tender L' as shown in Figs. 2, 3 and 4 of the drawings.

As a means for actuating the conveyer-belt, the shaft 24' at the upper end thereof is shown operatively connected with the driving-shaft 42 by means of a train of gearing including a clutch, which train of gearing is designated in a general way by T, and may be of any suitable construction and organization for imparting a traveling movement to the con-

veyer-belt and for maintaining a comparative velocity of a requisite variation between the conveyer and fuel-traveling furnace-floor.

It will be obvious that means other than that shown in the drawings for imparting a traveling movement to the fuel-traveling furnace-floor G, and the fuel-feeding mechanism may be employed for this purpose without departure from my invention.

As a means for supplying air to the fuel upon the upper run of the traveling-grate at varying pressures at successive points in the length thereof, which fuel is represented by a dotted line, *f*, in Fig. 4, I have provided an air-blast apparatus which is located, in part, underneath the fuel-carrying run of said grate. This air-blast apparatus, in the form thereof herein shown, comprises a series of communicating air-supply chambers or compartments, *a*, *b*, *c*, *d* and *e*, having outlets contiguous to the upper run of the traveling-grate; a blower, D, having an air-conduit, 25, communicating with said chambers and means (herein shown as an engine, E') in connection with and adapted for actuating said blower. As a convenient means for constructing these air-supply chambers, the lower portion of the reverberatory flue 8, or that portion of the flue below the furnace-floor, is shown transversely divided at successively remote points by partitions *a'*, *b'*, *c'* and *d'*, respectively, the successive partitions being of successively increased lengths, as illustrated in Fig. 2 of the drawings, the lower ends of said partitions being remote from the lower edge of the reverberatory-flue so as to not only limit the supply of air to the successive chambers, but also secure free access to the chambers at the lower sides thereof, for facilitating the removal of ashes or cinders which may accidentally fall into said chambers from the fuel-carrying run of the grate.

The blower for supplying air to the successive air-supply chambers is shown located upon the roof of the fire-box, the air-conduit, 25, thereof extending downward and through the side-wall of the fire-box, slightly in the rear of the boiler B and communicating with the first air-supply chamber, *a*, of the series, said air-supply chamber having a rearward extension 25', contiguous to the delivering end of the conduit 25.

In the drawings I have shown the blower as driven by a small engine E', which may be of the high-speed Westinghouse variety, said engine being shown located with its shaft in alignment and operatively connected with the blower-shaft. I do not desire to limit this invention to the particular means shown in the drawings for supplying air to the fuel-carrying run of the grate as these may be slightly modified without departure from my invention, as long as they are adapted for supplying air to the upper run of the traveling-grate at varying pressures at successive points in the length thereof.

As will be seen by reference to Figs. 2, 4

and 6 of the drawings the lower run 11 of the traveling-grate is carried outside of and below the boiler B; it being shown (see Fig. 2) supported for the major portion of its length upon a slide-way 11' which is connected at one end with the rear wall of the fire-box and at its opposite end with the front wall of the ash-pan P. In some cases, however, it may be desirable to have both the upper and lower runs of the grate located within the reverberatory-flue, 8. Therefore, I do not desire to limit this invention to the exact organization of traveling-grate shown in the drawings.

In the preferred form thereof herein shown, the endless traveling-grate will comprise a series of grate-sections, *g*, transversely-disposed with relation to the fire-box and reverberatory-chamber and pivotally connected together and carried by the links of endless chains, *g'*, at opposite ends of said sections.

In operation, the fuel is fed to each section of the grate at, or before this section reaches the outlet of the first air-supply chamber, *a*, of the series of air-supply chambers located under the fuel-carrying run of the grate as before described. The fuel is then carried forward, maintained substantially *in statu quo*, over the succeeding air-supply chambers *b*, *c*, *d* and *e*, during which traveling movement the combustible material of the fuel is consumed and the resultant cinders or ashes are afterward carried forward over the end of the circuit of the grate and delivered into the ash-pan P. In practice, the combustion goes on at one stage or another during the entire length of the fire-box and reverberatory-chamber, 8, or throughout the entire length of the fuel-carrying run of the grate and consequently throughout the entire length and below the relatively small flues 9 of the boiler. The ignition of the fuel takes place at the extreme rearward end of the grate or that area thereof immediately adjacent to the delivering end of the hopper H. During the successive stages of the combustion period, the gaseous products of the later stages of said combustion period will rise within the reverberatory chamber 8 and, owing to the direction of draft, will be carried backward toward and intermingled with the gaseous products of the first stages of the combustion period in the fire-box F at the extreme rearward end of the fuel-traveling grate. This process of intermingling the products of the later stages of combustion with those of the first stages of the combustion period consummates a perfection in combustion practically impossible with locomotive-engines having fire-boxes of ordinary construction, and secures the maximum percentage of liberated energy, effected for steam generating purposes, from the minimum consumption of fuel.

As shown in the drawings (see Figs. 2, 5 and 6) the slide-way 11' for the lower run 11 of the grate G is in the nature of a trough open at its upper side, the rear wall thereof being formed by the rear wall of the fire-box F,

and the forward end thereof being connected with the front wall of the ash-pan P. This ash-pan is connected at its forward end with and extends below the boiler B, the front end thereof being shown extended a short distance into, but separated from, the smoke-box S of the boiler.

The rear-wall of the fire-box F will, in practice, have a sight opening therethrough for the purpose of inspecting the interior of said fire-box.

Having thus described my invention, I claim—

1. In a locomotive-engine, the combination with the wheel-axles and with the boiler-supporting frame carried by said axles, of a flue-boiler, a reverberatory-chamber located within said boiler and extending below and from end to end of the flues thereof, a fuel-traveling grate supported for traveling movement within and extending from end to end of the reverberatory chamber, means in connection with and adapted for actuating said grate, and means for supplying air at varying pressures to successive fuel-supporting areas of said grate, substantially as described and for the purpose set forth.

2. In a locomotive-engine, the combination with the locomotive-wheel axles, and with the boiler-supporting frame carried upon said axles, of a flue-boiler having a reverberatory-chamber, of relatively large diameter, located within the shell thereof, a fuel-traveling grate supported for traveling movement within the reverberatory-chamber below the boiler-flues, means in connection with and adapted for actuating said grate to impart a traveling movement to the fuel thereon, and means for supplying air to the fuel at varying pressures at successive points in the length of the traveling-grate, substantially as described and for the purpose set forth.

3. The combination with the wheel-axles of a locomotive, of a flue-boiler supported above said axles having a reverberatory-chamber, of relatively large diameter, located within the shell and below the flues of said boiler, a fire-box located at the rearward end of and communicating with the said reverberatory-chamber, a smoke-box located at the forward end of the boiler and communicating with the flues thereof, a fuel-carrying grate supported for traveling movement within the fire-box and reverberatory-chamber and extending from end to end of said boiler, means in position and adapted for supplying fuel to said grate, and means for supplying air at varying pressures to successive fuel-supporting areas, respectively, of said grate, substantially as described and for the purpose set forth.

4. In a locomotive-engine, the combination with the locomotive-wheel axles and the boiler-supporting frame carried upon said axles, of a flue-boiler having a reverberatory-chamber, of relatively large diameter, located within the shell and extending from end to end of said boiler, an endless grate supported for

traveling movement with its upper run within and extending from end to end of the said reverberatory-chamber, means in connection with and adapted for imparting a circuitous movement to said grate, means for supplying fuel to said grate during the traveling movement thereof, and means for supplying air to the fuel at varying pressures at successive points in the length of the reverberatory-chamber during the traveling movement of said fuel, substantially as described and for the purpose set forth.

5. In a locomotive-engine, the combination with the locomotive-wheel axles and with the boiler-supporting frame carried upon said axles, of a flue-boiler having a multiplicity of relatively small flues, and a relatively large flue located below said relatively small flues, a fire-box located at the rearward end of said boiler and communicating with the flues thereof, a smoke-box located at the forward end of the boiler and communicating with the small flues thereof, an ash-pan located at the forward end of the boiler and communicating with the relatively large flue thereof, a fuel-traveling grate supported for traveling-movement within the relatively large flue and having its receiving end within the fire-box and having its delivering end extended into the upper portion of the ash-pan, means located at the rearward end of the fire-box and adapted for supplying fuel to the traveling-grate, means in connection with and adapted for actuating said traveling-grate for imparting a traveling movement to the fuel, and means in position and adapted for supplying air to successive fuel-supporting areas of the grate at varying pressures, respectively, during the traveling movement of the fuel, substantially as described and for the purpose set forth.

6. In a locomotive-engine, the combination with the locomotive-wheel axles and with the boiler-supporting frame carried upon said axles, of a fire-box and smoke-box located at opposite ends of the frame, a flue-boiler supported intermediate to said fire-box and smoke-box and having a reverberatory-chamber, of relatively large diameter, in communication with the fire-box at one end and cut off from communication with the smoke-box at the opposite end by means of an ash receptacle, means for imparting a circuitous movement to said endless grate, means for automatically feeding fuel to said grate within the fire-box and means for supplying air to successive fuel-supporting areas of the grate at varying pressures successively, substantially as described and for the purpose set forth.

7. In a locomotive-engine, the combination with the locomotive-wheel axles and with the boiler-supporting frame carried upon said axles, of a flue-boiler carried by said frame and having a reverberatory-chamber, of relatively large diameter, located within the shell and below the flues of said boiler, a fire-box located at the rearward end of said boiler and

communicating with said combustion-chamber, a fuel-traveling grate supported for traveling-movement within said reverberatory-chamber and fire-box, a fuel-supply hopper
 5 adjacent to the rearward end of the fuel-traveling grate, a fuel-conveyer having its receiving end extended beyond the rearward end of the frame-work and in position to receive the coal from the tender, and having its discharge
 10 end above and in vertical alignment with the receiving end of the hopper, means in connection with and adapted for actuating said grate to impart a traveling movement to the fuel, means in connection with and adapted for
 15 actuating said conveyer and means for supplying air to the fuel-supporting area of said grate, substantially as described and for the purpose set forth.

8. In a locomotive-engine, the combination
 20 with the locomotive-wheel axles, and with the boiler-supporting frame carried upon said axles, of a flue-boiler carried by said frame and having a reverberatory-chamber of relatively large diameter located within the shell
 25 and below the flues of said boiler, a fire-box located at the rearward end of said boiler and communicating with said combustion-chamber, a fuel-traveling grate supported for traveling movement within said reverberatory-chamber and fire-box, a fuel-supply hopper
 30 adjacent to the rearward end of the fuel-traveling grate, a fuel-conveyer having its receiving end extended beyond the rearward end of the frame-work and in position to receive the
 35 coal from the tender, and having its discharge end above and in vertical alignment with the receiving end of the hopper, means in connection with and adapted for simultaneously actuating the fuel-conveyer and the traveling-grate at relatively different velocities, and
 40 means for supplying air to the fuel-supporting area of the grate, substantially as described and for the purpose set forth.

9. In a locomotive-engine, the combination
 45 with the flue-boiler, of a fuel-traveling grate supported for movement longitudinally of and below the flues of said boiler, an endless fuel-conveyer located adjacent to the fuel-receiving end of and adapted for supplying fuel to the grate, and means in connection with and
 50 adapted for simultaneously actuating the endless conveyer and the grate at different velocities, substantially as described and for the purpose set forth.

10. In a locomotive-engine, the combination
 55 with the flue-boiler, of a reverberatory-chamber located within said boiler below the flues thereof, a fire-box in communication at one end with said reverberatory-chamber, a traveling grate located within said reverberatory-chamber, and an endless traveling fuel-conveyer supported in the rear of the fire-box with its receiving-end substantially in alignment with the floor-line of said fire-box and
 60 with its delivering-end above and in communication with the receiving-end of the grate, and means in connection with and adapted

for actuating said fuel-conveyer to supply fuel to said grate, substantially as described.

11. The combination with the locomotive- 70 engine having a flue-boiler and with the tender of said engine, of a fire-box in communication with said boiler, an endless traveling grate located within said boiler below the flues thereof and extending from end to end of said 75 flues, and a traveling fuel-conveyer supported intermediate to said chamber and the fire-box of the locomotive-engine and having its receiving-end projected into the rear of the forward end of the tender and having its delivering-end extended into the fire-box above the grate, and means in connection with and adapted for actuating said conveyer to carry fuel from the tender and deliver the same into the fire-box upon the grate, substantially as 85 described.

12. The combination with the locomotive-engine and its tender and with the fire-box and the flue-boiler, of an endless fuel-traveling grate supported for traveling movement within 90 the fire-box and boiler and extending below and from end to end of the flues of said boiler, a traveling fuel-conveyer supported intermediate to said tender and fire-box and having its receiving-end projected into the rear of the forward end of the tender and having its discharge-end above and adjacent to the receiving-end of the grate, and means in connection with and adapted for simultaneously actuating said conveyer and grate 100 to impart a continuous traveling movement to the fuel from a point outside and in the rear of the fire-box to a point inside and to the extreme forward end of said fire-box and boiler, substantially as described. 105

13. In a locomotive-engine, the combination with the fire-box and tender and with the locomotive flue-boiler having a reverberatory-chamber located within the walls thereof, of a fuel-conveying apparatus substantially 110 such as described extending from a point immediately adjacent to the tender and outside of the boiler to and through the reverberatory-chamber of the said boiler and adapted for automatically conveying fuel from the 115 tender, with a progressive uniform movement, throughout the space intermediate to the tender and fire-box and through and from end to end of said fire-box and boiler, and means for actuating said conveying apparatus, substantially as described and for the purpose 120 set forth.

14. In a locomotive-engine, the combination with the fire-box and tender and with the flue-boiler having a reverberatory-chamber located within the walls thereof, of two endless fuel-conveyers one supported for traveling movement inside of the fire-box and extending through the reverberatory-chamber of the boiler, and the other supported for traveling 125 movement outside of the fire-box with its delivering-end adjacent to and above the receiving-end of the first-mentioned conveyer, and means in connection with and adapted for 130

actuating said conveyer to automatically impart a continuous traveling movement to the fuel from the outside of and entirely through the fire-box and boiler, substantially as described and for the purpose set forth.

15. In a locomotive-engine, the combination with the boiler and fire-box thereof, of two traveling fuel-conveyers, one of which is supported for traveling movement within the fire-box, and the other of which is supported for traveling movement outside of, but is in communication with, said fire-box at a point above the receiving end of the conveyer located within said fire-box, and means in connection with and adapted for simultaneously imparting a traveling movement to the two conveyers at proportionate velocities, to continuously feed the fuel forward from the outside of and through the fire-box, substantially as described and for the purpose set forth.

16. In a locomotive-engine, the combination with the locomotive-wheel axles, and with the boiler-supporting frame carried upon said axles, of a flue-boiler, a fuel-traveling grate supported for traveling movement below the boiler flues and between said flues and the frame-supporting axles, a series of air-supply chambers having outlet openings contiguous to the fuel-supporting run of said grate, a blower having an air-conduit in communication with said chambers, means for varying the pressures of air in the successive air-supply-chambers, means in connection with and adapted for actuating said grate and means in connection with and adapted for actuating said blower, substantially as described and for the purpose set forth.

17. In a locomotive-engine, the combination

with the locomotive-wheel axles and with the boiler-supporting frame carried upon said axles, of a flue-boiler, a fuel-traveling grate supported for traveling movement below the boiler flues and between said flues and the frame-supporting axles, means in connection with and adapted for actuating said grate, a series of air-blast chambers supported below and having outlet openings contiguous to the fuel-supporting run of said grate, a blower supported above said grate and having an air-conduit in communication with the air-blast chambers and an independent engine supported above said grate, and in operative connection with, and adapted for actuating, said blower, substantially as described and for the purpose set forth.

18. In a locomotive-engine, the combination with the boiler and its fire-box, of an endless grate supported for traveling movement within said fire-box and boiler, and having a series of air-supply chambers supported below and having outlet openings contiguous to the fuel-carrying run thereof, means for imparting a traveling movement to said grate and means for supplying fuel thereto, a blower supported upon the roof of the fire-box and having an air-conduit extending through the side-wall of the fire-box and communicating with one of the air-supply chambers, and an auxiliary engine supported above the boiler and in operative connection with, and adapted for, actuating the blower, substantially as described and for the purpose set forth.

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