

(No Model.)

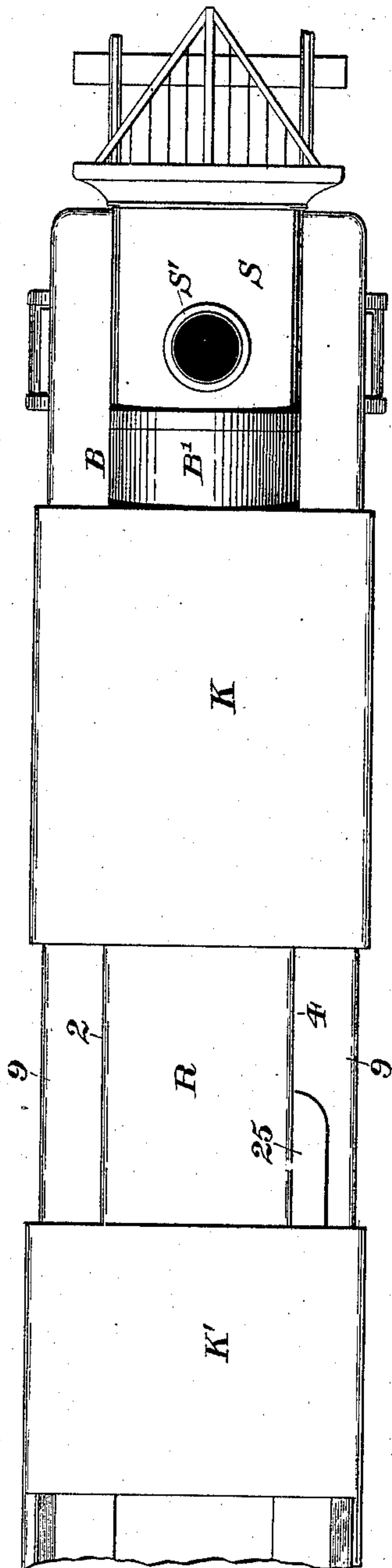
4 Sheets—Sheet 1.

F. H. RICHARDS.  
LOCOMOTIVE ENGINE.

No. 535,414.

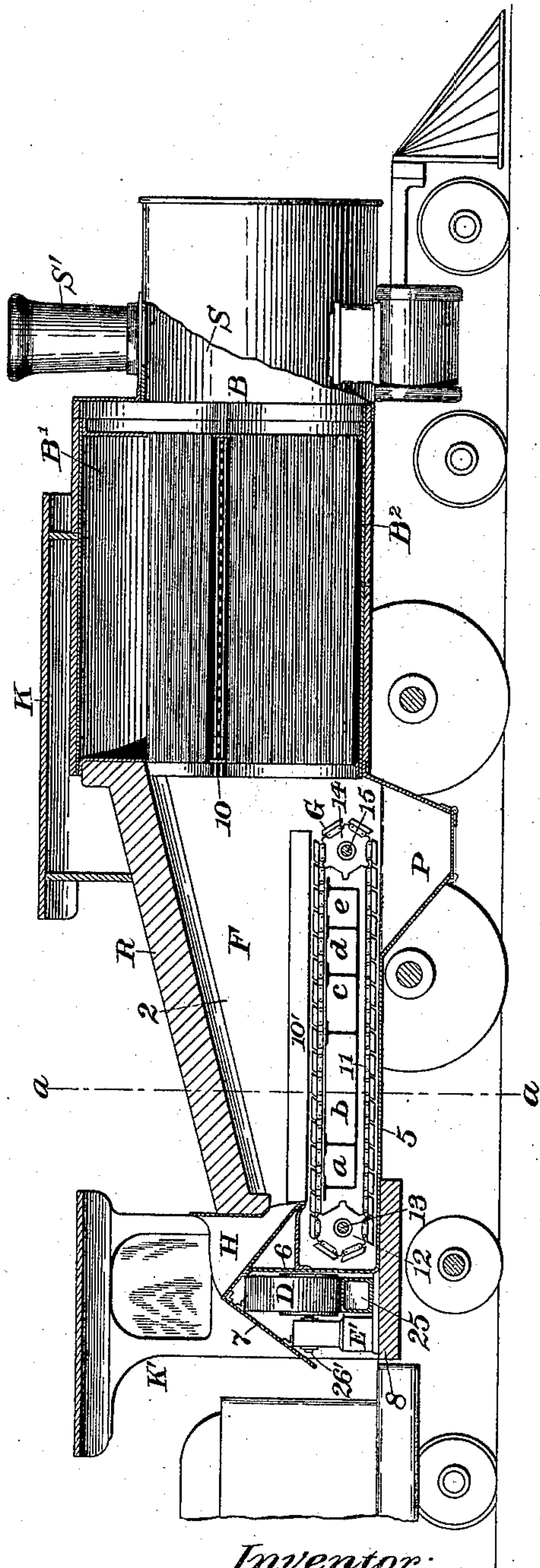
Patented Mar. 12, 1895.

Fig. 1.



Witnesses:  
J. L. Edwards Jr.  
Fred. J. Dole.

Fig. 2.



Inventor:

F. H. Richards.

(No Model.)

4 Sheets—Sheet 2.

F. H. RICHARDS.  
LOCOMOTIVE ENGINE.

No. 535,414.

Patented Mar. 12, 1895.

Fig. 4.

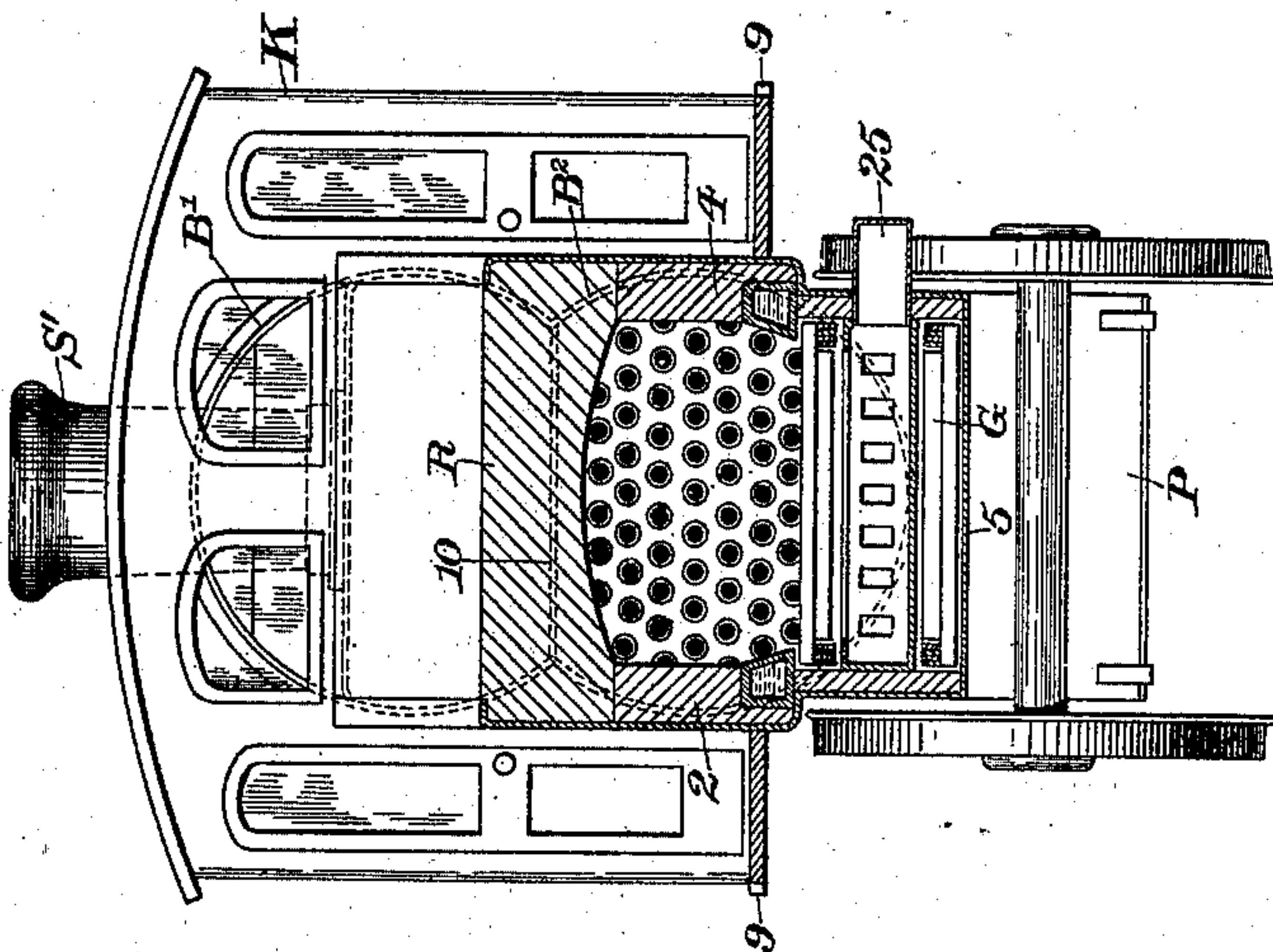
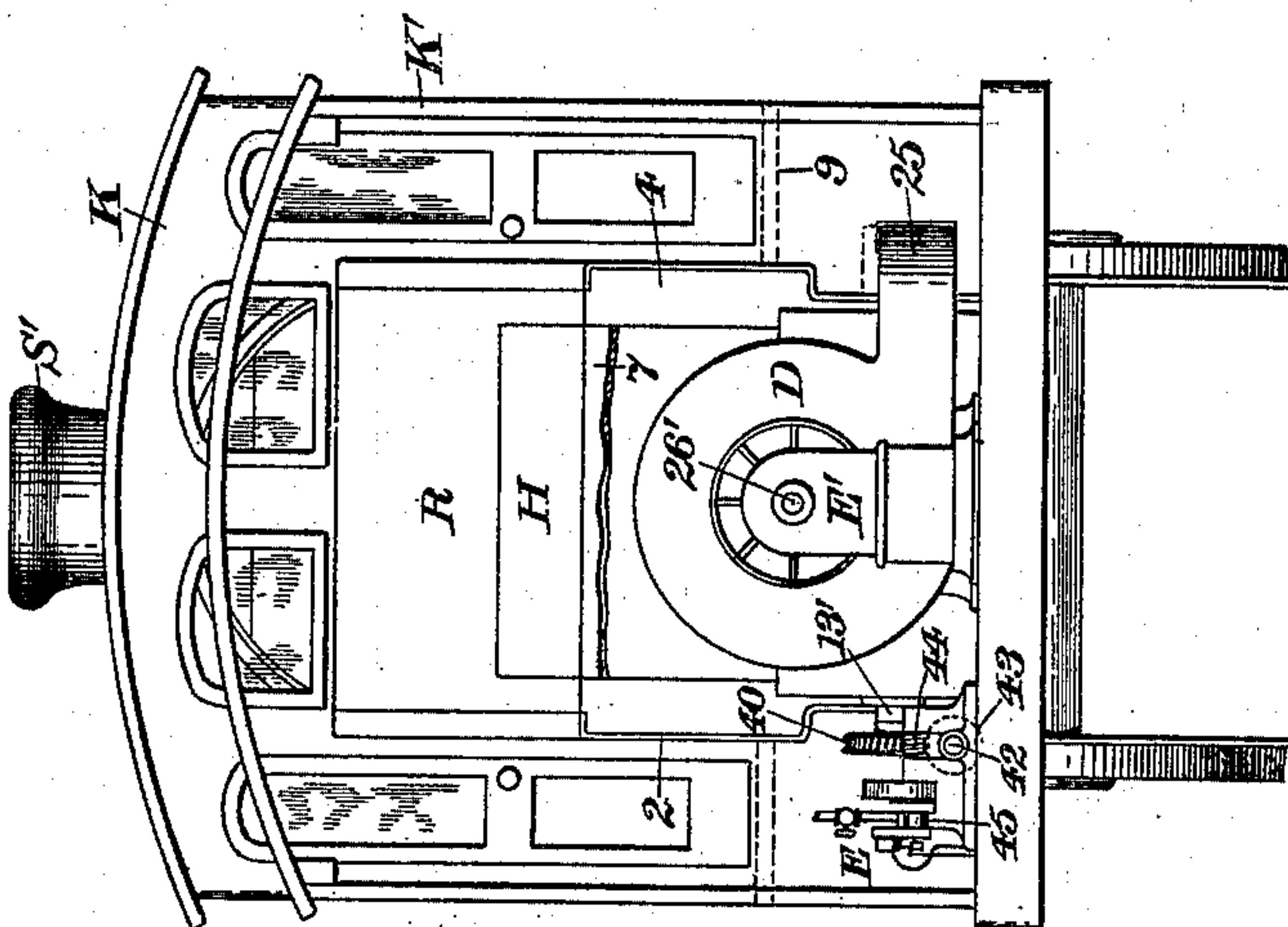


Fig. 3.



Witnesses:

H. L. Edwards Jr.  
Fred. J. Dole

Inventor:

F. H. Richards



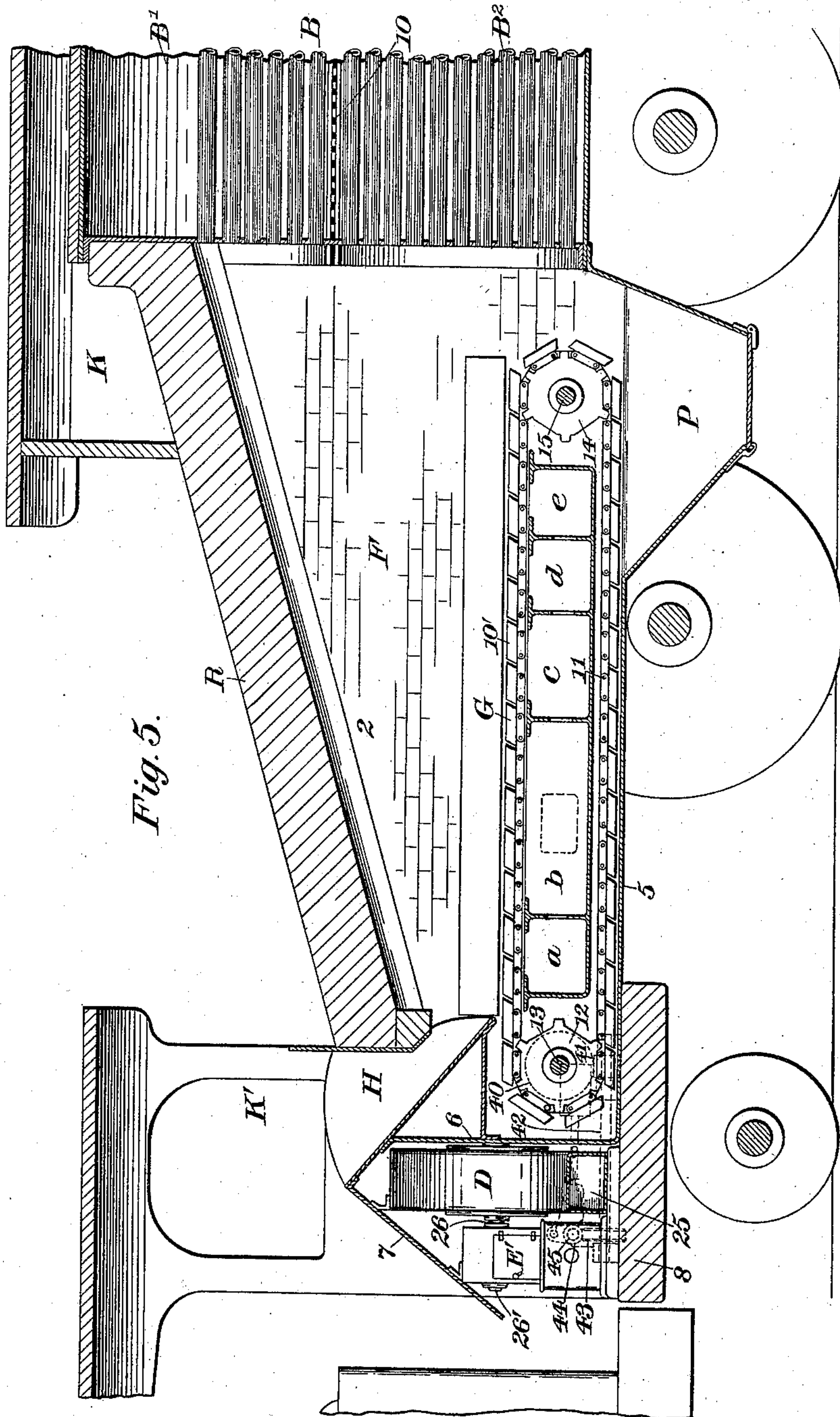
(No Model.)

4 Sheets—Sheet 3.

F. H. RICHARDS.  
LOCOMOTIVE ENGINE.

No. 535,414.

Patented Mar. 12, 1895.



*Witnesses:*

J. L. Edwards Jr.  
Fred. J. Dole.

*Inventor:*

F. H. Richards

(No Model.)

4 Sheets—Sheet 4.

F. H. RICHARDS.  
LOCOMOTIVE ENGINE.

No. 535,414.

Patented Mar. 12, 1895.

Fig. 6.

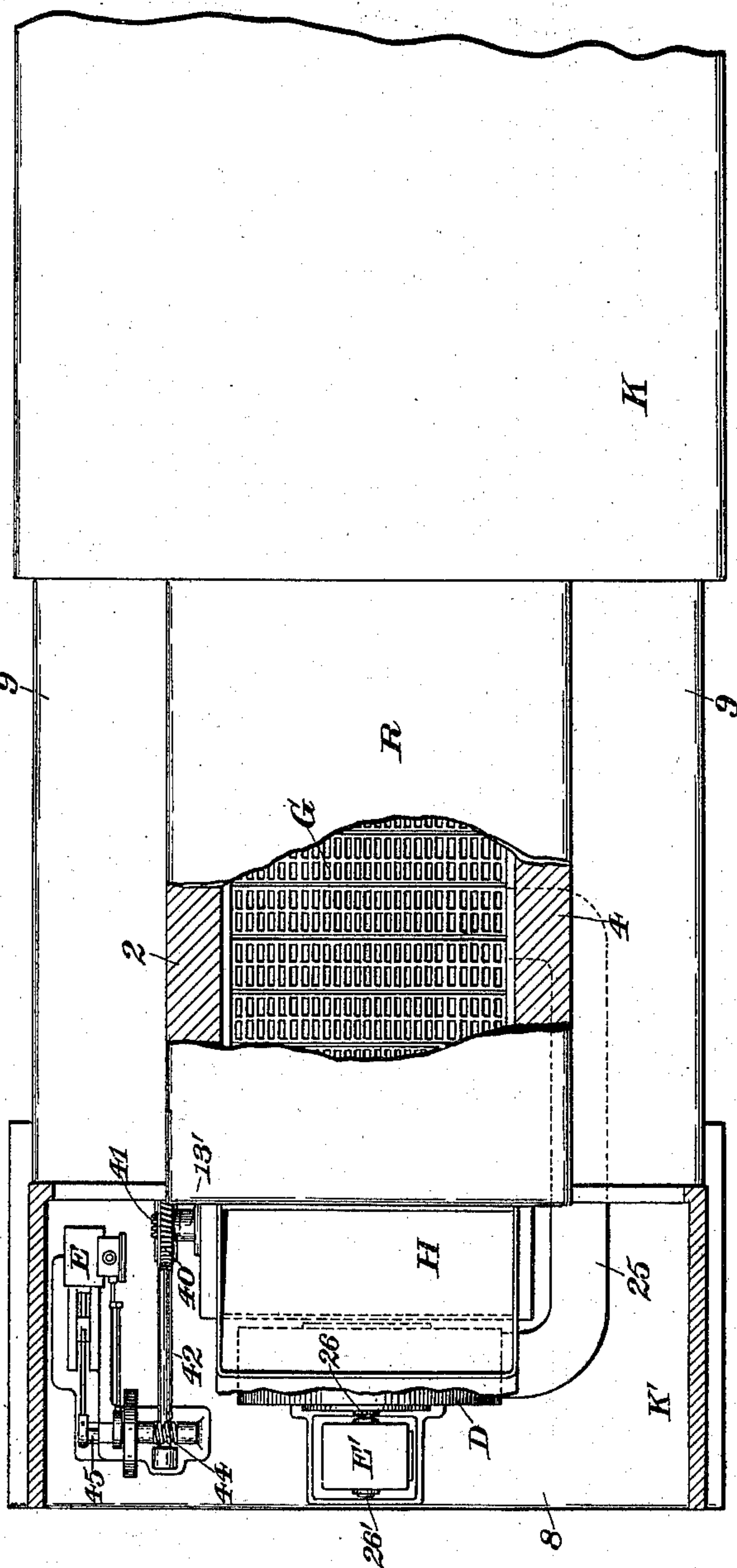
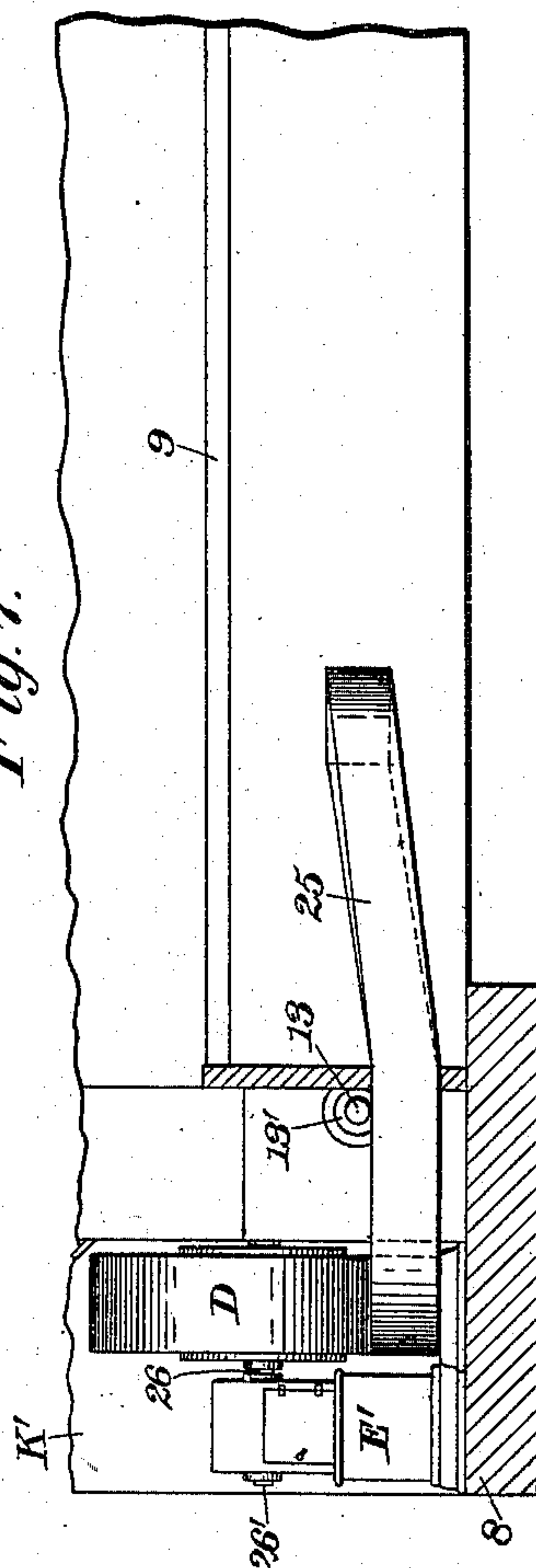


Fig. 7.



Witnesses:

H. L. Edwards Jr.  
Fred. J. Dole.

Inventor:

F. H. Richards.



# UNITED STATES PATENT OFFICE.

FRANCIS H. RICHARDS, OF HARTFORD, CONNECTICUT, ASSIGNOR TO ECKLEY  
B. COXE, OF DRIFTON, PENNSYLVANIA.

## LOCOMOTIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 535,414, dated March 12, 1895.

Application filed November 5, 1894. Serial No. 527,862. (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 Locomotive-Engines, of which the following is a specification.

This invention relates to locomotive-engines, and has special reference to those elements which have a direct influence upon the combustion of the fuel and which determine the efficiency in steam generation.

The object of my present invention is to furnish a locomotive-engine of improved construction and organization especially adapted for burning the smaller sizes and lower grades of fuel, and for securing the maximum generation of steam from a given quantity of fuel in the shortest practicable length of time.

Another object of the invention is to provide in connection with a locomotive-engine a relatively short flue-boiler having a relatively large flue-area and to provide a furnace or fire-box in connection therewith, which shall have a grate of relatively large area, and which shall, in so far as structural organization is concerned, be practically independent of the boiler, to thereby enable the boiler and fire-box to be placed in working position, each separately and in an assembled condition.

In the drawings accompanying and forming part of this specification, Figure 1 is a plan view, on a relatively small scale, of a locomotive-engine constructed in accordance with my present invention and embodying my improvements, parts of said locomotive not relating directly to my invention being omitted. Fig. 2 is a sectional side-elevation of the same. Fig. 3 is a rear-elevation of the locomotive-engine as seen from the left hand in Fig. 2, on a somewhat larger scale, parts thereof being broken away. Fig. 4 is a vertical cross-section of the locomotive-engine taken in line *a—*a**, Fig. 2, looking toward the right hand in said figure, this Fig. 4 being drawn on the same scale as Fig. 3. Fig. 5 is a sectional side-elevation, on a relatively large scale, of a portion of the rear end of the locomotive-engine, showing the fire-box, and the grate-mechanism. Fig. 6 is a sectional plan view of the locomotive drawn upon the same

scale as Fig. 5, parts being broken away to more clearly illustrate certain of the details. Fig. 7 is a sectional side-elevation of a portion of the rear end of the furnace-chamber, showing the blower for supplying air to the furnace-floor or grate and the actuating-mechanism therefor.

Similar characters designate like parts in all of the figures.

In the drawings only so much of a locomotive-engine and its tender is shown as is deemed necessary for clearly illustrating the application and mode of operation of my present improvements.

All of the parts of the locomotive-engine, with the exception of the steam-generator, designated in a general way by B, the fire-box or furnace-chamber, designated by F, the furnace-floor or grate G, and those elements which are in operative connection with the said furnace-floor or 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 to enter into a detailed description of those parts that in no way effectively contribute to the results attained by the elements comprised in my invention.

In the preferred form thereof herein shown and described, the steam-generator B, which may be supported in the usual manner by the frame-work (not shown) of the locomotive-engine, is, in general construction and organization, similar to two duplicate, cylindrical flue-boilers (as B' and B<sup>2</sup>) connected together in longitudinal-disposition, one above the other, and having communicating water-ways. These communicating water-ways will preferably be formed through a transverse strain-sheet, 10, which constitutes the division wall between the upper and lower water-spaces of the steam-generator and also constitutes a rigid connection between the side-sheets or walls of the steam-generator, as will be readily understood by reference to Figs. 2 and 4 of the drawings. Located in advance of and in communication with the flues of the steam-generator is a smoke-box, S, which may be of the same general construction as smoke-



boxes of ordinary locomotives, which smoke-box is provided with a smoke-stack, S'. This smoke-box, which practically constitutes a forward extension of the steam-generator, will, in practice, be supported by the forward truck (not shown) of the locomotive-engine.

Located in the rear of the steam-generator is a fire-box or furnace-chamber, F, which fire-box is inclosed at its sides by the side-walls 2 and 4 which abut at their forward ends against the rear flue-sheet of the steam-generator B, said furnace-chamber being covered by a reverberatory roof, R, which, in the form thereof herein shown, slopes downward from its forward to its rearward end. These side-walls and the roof, will, in practice, be constructed of heat-resistant material, such as fire-brick, and will be adapted to be heated to a high state of incandescence. The side-walls of the furnace-chamber will be supported by the frame-work (not shown) of the locomotive, in any suitable or well known manner.

As shown in the drawings, the furnace-chamber F is provided with a furnace-floor, which, in the preferred form thereof herein shown and described, is in the nature of an endless chain grate, designated in a general way by G, the upper run, 10', thereof constituting the furnace-floor proper. This endless grate is carried at its opposite ends upon chain-wheels 12 and 14, which are carried upon shafts 13 and 15, respectively, journaled in suitable bearings, as 13', secured to the side-walls of the furnace-chamber.

As a 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, which shaft 42 is provided with a worm-wheel, 43, which is driven by a worm, 44, carried by the power-shaft, 45, of an independent engine, E, supported at one side, and in advance of, the rearward end of the furnace-chamber, as most clearly shown in Figs. 3, 5 and 6 of the drawings. It will be understood that other grate-actuating mechanism than that herein shown and described may be employed without departure from my invention.

As a means for covering the lower portion of the furnace-chamber F, and also to provide a suitable support for the lower run, 11, of the endless grate, I have herein shown the furnace-chamber provided with a bottom plate, 5, which extends transversely and longitudinally across the bottom of said furnace-chamber, said plate constituting a suitable support for the lower run of the grate, as will be readily understood by reference to Figs. 2, 4 and 5 of the drawings. At the forward end of this plate 5 is located a suitable ash-pan, P, which depends below and in vertical alignment with the forward end of the circuit of the endless grate, and in position to receive the discharge from this end of the grate. This bottom-plate 5 is shown bent upward at its rearward end at a point in the rear of the rearward end of

the fire-box or furnace-chamber, as shown at 6, and constitutes practically the rear end-wall for the lower portion of said furnace-chamber, and a suitable housing for the rear end of the endless grate.

Located at the rearward end of the furnace-chamber F is a fuel-supply hopper, H, the discharge end of which is located in close proximity to the ignition area or rearward end of the upper run of the fuel-traveling grate, in position for supplying fuel to said rearward end of the grate. The bottom wall of the hopper H is shown supported upon the rear end-wall, 6, of the furnace-chamber and projects somewhat in the rear of this wall, and is furnished at its rearward end with a depending inclined plate, 7, which constitutes a guard or covering roof for certain actuating-mechanism, hereinafter described.

At the extreme rearward end of the furnace-chamber F and adjacent to the receiving end of the fuel-supply hopper, I have provided a fireman's cab, K', in which cab, and upon the floor, 8, thereof, is located the engine which actuates the grate, and also in which is located other actuating-mechanism, hereinafter described. The engineer's cab, K, is located near the forward end of the engine, contiguous to the steam-generator B, as is shown in Figs. 1, 2 and 5, and the usual running-boards, 9, are provided, one at each side of the furnace-chamber F, and extending from the engineer's cab, K, to the fireman's cab, K', as shown in Figs. 1, 3, 4, 6 and 7.

As a means for supplying air to the fuel-carrying run of the endless grate, at varying pressures at successive points in the length thereof, I have provided an air-supply apparatus, which, in the form thereof herein shown, consists of a series of air-blast chambers (herein shown as five in number, and designated as *a*, *b*, *c*, *d* and *e*, respectively) located below and having outlet openings contiguous to the fuel-carrying run of said grate; a blower, D, located in the rear of the furnace-chamber upon the floor 8 of the cab K', and having a conduit, 25, in communication with one of the air-blast chambers, herein shown as the one *b*, and an engine, designated by E', for actuating said blower. The blower D, through the medium of which air is supplied to the successive air-blast chambers, is supported in the rear of the end-wall, 6, of the furnace-chamber, F, upon the floor, 8, of the cab, K', and has its driving-shaft, 26, in operative connection with the driving-shaft 26', with the engine E', which engine will preferably be of the well known Westinghouse high-speed variety, and is shown, together with the blower D, covered by the roof or inclined plate 7 of the hopper H, which constitutes a protection therefor.

In practice, the engine E, which actuates the traveling grate, and the engine E', which actuates the blower, will be provided with steam from the steam-generator B, by suitable supply-pipes (not shown).

In operation fuel is supplied, through the



medium of the hopper H, to the ignition area or rearward end of the fuel-traveling grate and is carried forward with a uniform movement during the successive stages of the combustion period, throughout the length of the furnace-chamber F, and is subjected to successive air-blasts at varying pressures at successive points in the length of the traveling movement thereof, after the manner described in Letters Patent of the United States No. 499,715, granted to Eckley B. Coxe June 20, 1893, and the volatile products of combustion arising from the successive fuel-areas are thoroughly intermingled within the combustion-chamber F and, owing to the high incandescent condition of the walls of said combustion-chamber, the oxidation of the gases of the successive stages of the combustion period is completed and, owing to the inclination of the reverberatory roof, the resultant products are deflected in their course of travel and are directed into the flues of both the upper and lower portions of the steam-generator, where the liberated energy of said products are utilized for steam generating purposes; after which these non-combustible or utilized products are delivered into the smoke-box S and are discharged through the smoke-stack, S', into the outer atmosphere.

It will be seen by reference to Figs. 2 and 5 that the steam-generator is divided transversely, at about midway of its height, into, practically two water-compartments, each of which compartments has a multiplicity of flues, which communicate at their rearward end with the combustion-chamber F, and at their forward end with the smoke-box S, and the division-wall between the two chambers is shown in the nature of a strain-sheet, having a series of perforations, which constitute water-ways between the two compartments. It will be obvious, however, that a series of transversely-disposed stay-bolts might be employed in lieu of the strain-sheet shown.

Having thus described my invention, I claim—

1. In a locomotive-engine, the combination with a multi-flue boiler having its rear end contiguous to and closing the forward end of the fire-box, and having its flues communicating directly with the fire-box; of a structurally-independent fire-box or furnace-chamber supported in the rear of the boiler, and having its forward end contiguous to and closed by the rear end of said boiler and adapted thereby to direct all of the products of combustion through the flues of said boiler, and also having heat-resistant inclosing walls adapted to be heated to a high state of incandescence; a fuel-traveling grate supported for movement within and longitudinally of the furnace-chamber and in the rear of the boiler; means for supplying fuel to the rearward end of said grate; means for actuating said grate to impart a traveling movement to the fuel; and an air-blast apparatus in connection with and adapted for supplying air to and below

the fuel-carrying run of said grate, substantially as described.

2. In a locomotive-engine, in combination a multi-flue boiler, a furnace-chamber supported in the rear of said boiler, and structurally-independent of said boiler, a fuel-traveling grate supported for movement within and longitudinally of the furnace-chamber, with its forward end remote from the rear end of said boiler, a fuel-supply hopper, supported at the rearward end of said furnace-chamber with its rearward end in close proximity to the rearward end of the grate, means in connection with and adapted for actuating said grate to impart a traveling movement to the fuel, and means in connection with and adapted for supplying air to the successive fuel-supporting areas of said grate, at successively varying pressures, substantially as described and for the purpose set forth.

3. In a locomotive-engine, a fire-box and a boiler structurally-independent of each other, and adapted to be assembled together or disassembled in a unitary condition and located in longitudinal alignment with the boiler in advance of the fire-box, in combination with a fuel-traveling grate supported within, and adapted for movement longitudinally of, the fire-box, actuating mechanism in connection with said grate, and an air-blast apparatus in position and adapted for supplying air to the fuel-supporting area of said grate from points below said fuel-supporting area, substantially as described and for the purpose set forth.

4. In a locomotive-engine, a steam-generator divided midway of its height into two water-compartments each of which has a multiplicity of longitudinally-disposed flues therein, and having water-ways connecting said two compartments, in combination with a fire-box supported in the rear of said boiler and having a reverberatory, heat-resistant roof, adapted for deflecting the products of combustion and directing them into the flues of the two compartments of the steam-generator, substantially as described and for the purpose set forth.

5. In a locomotive-engine, in combination, a steam-generator comprising two longitudinally- and vertically-disposed water-compartments, separated from each other by a perforated strain-sheet, and each having a multiplicity of longitudinally-disposed flues, a structurally-independent fire-box in communication with the flues of the upper and lower compartments of the steam-generator and having a heat-resistant reverberatory roof, an endless grate supported for traveling movement within the fire-box in the rear of, and in alignment with, the lower compartment of the steam-generator, means in connection with and adapted for imparting a traveling movement to said grate, and means in connection with and adapted for supplying air to the fuel-carrying run of said grate, substantially as described and for the purpose set forth.

6. In a locomotive-engine, in combination,



a steam-generator comprising two longitudinally- and vertically-disposed water-compartments separated from each other by a perforated strain-sheet and each having a multiplicity of longitudinally-disposed flues, a structurally-independent fire-box in communication with the flues of the upper and lower compartments of the steam-generator, and having a vertically inclined heat-resistant reverberatory roof, an endless grate supported for traveling movement within the fire-box in the rear of and in alignment with the lower compartment of the steam-generator, means in connection with and adapted for imparting a traveling movement to said grate and an air-blast apparatus in connection with and adapted for supplying air to the fuel-carrying run of said grate at varying pressures at successive points in the length thereof, substantially as described and for the purpose set forth.

7. In a locomotive-engine, the combination with the steam-generator, of a furnace-chamber located in the rear of said steam-generator, and of gradually reduced area from the forward to the rearward end thereof, a fuel-traveling grate supported with its rearward fuel-receiving end adjacent to the contracted

end of the furnace-chamber and with its discharge end adjacent to the enlarged end of the furnace-chamber and in the rear of the steam-generator, means for actuating said grate, and means for supplying air to the fuel-supporting areas thereof at a point below said areas, substantially as described and for the purpose set forth.

8. In a locomotive-engine, the combination with the fire-box and with the fuel-traveling grate supported therein, of an independent engine supported in the rear of the furnace-chamber and in operative connection with and adapted for actuating said grate, an air-blast apparatus comprising a series of air-blast chambers located below the fuel-supporting area of said grate, and a blower supported in the rear of the furnace-chamber and having a conduit communicating with said air-blast chambers, and an independent engine operatively connected with and adapted for actuating said blower, substantially as described and for the purpose set forth.

FRANCIS H. RICHARDS.

Witnesses:

FRED. J. DOLE,  
S. W. POTTS.