(No Model.)

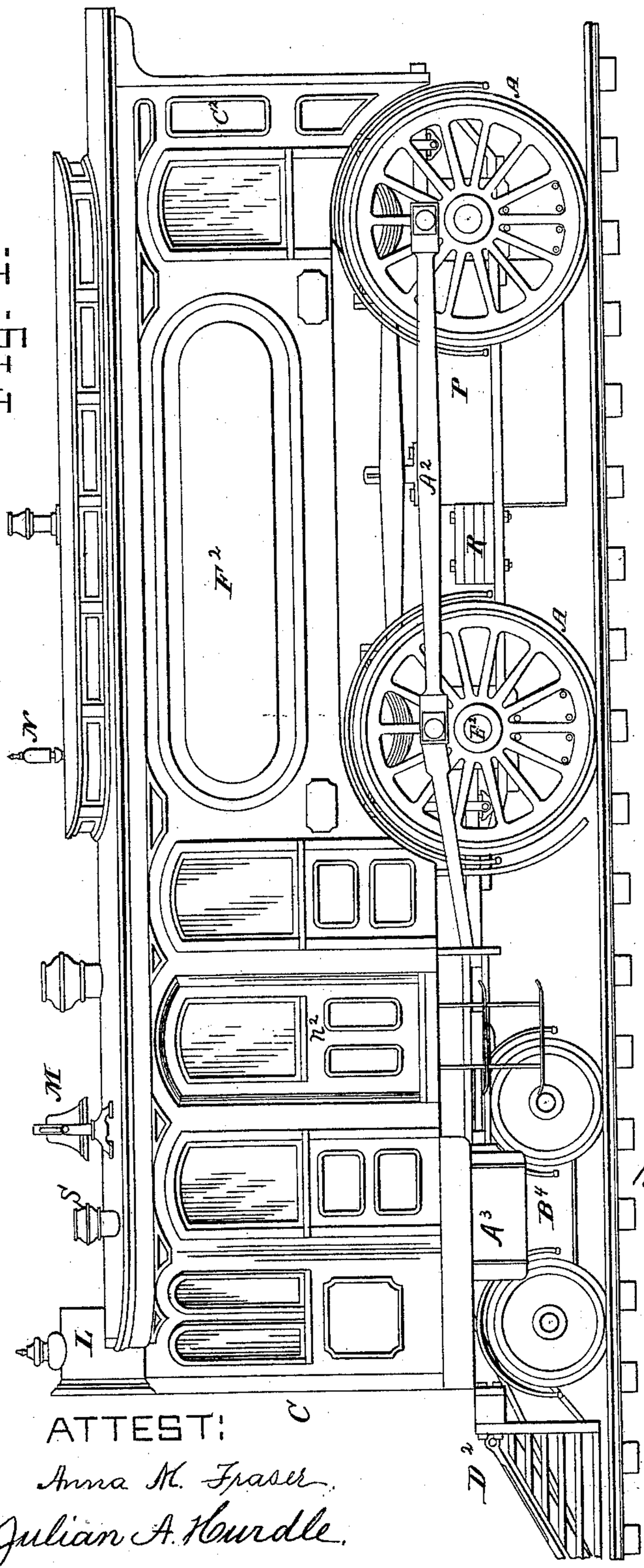
6 Sheets—Sheet 1.

F. M. STEVENS.

Locomotive.

No. 232,776. Patented Sept. 28, 1880.

Fig. 1.



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(No Model.) 6 Sheets—Sheet 2.

F. M. STEVENS.

Locomotive.

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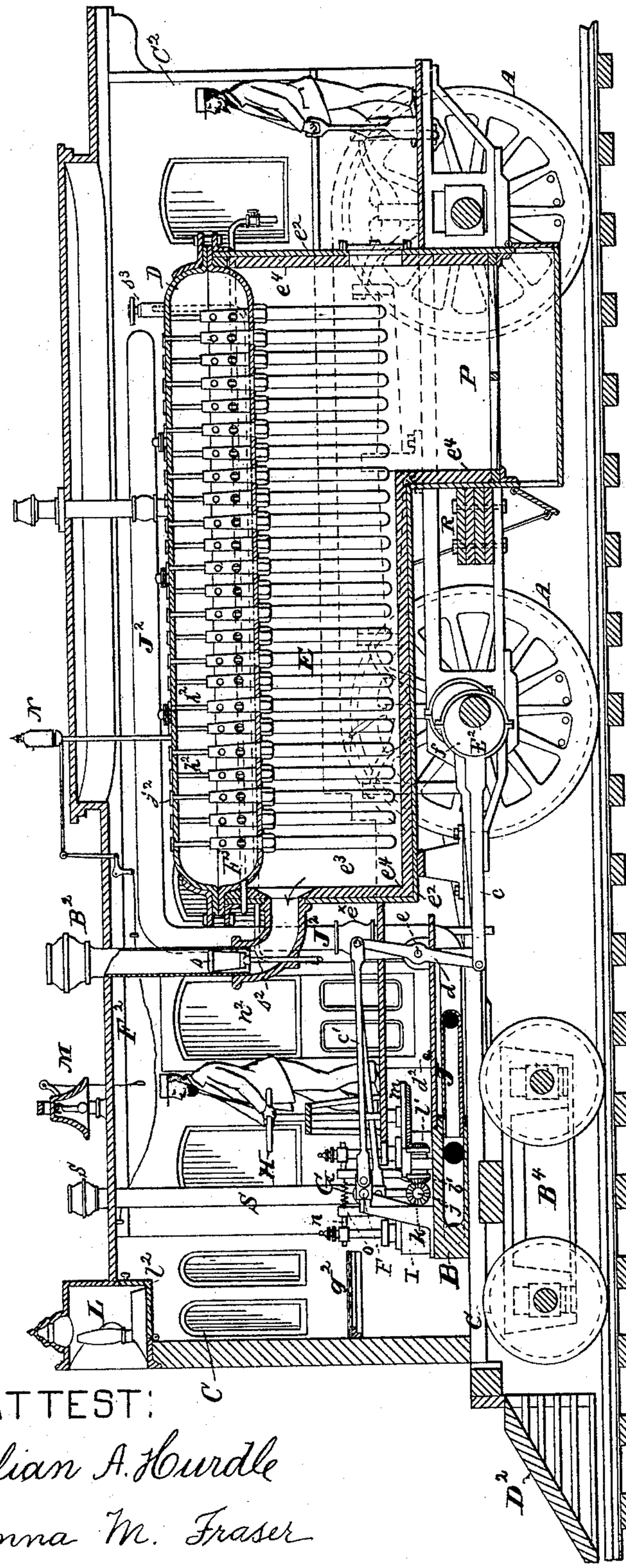
Fig. 2.



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(No Model.) 6 Sheets—Sheet 3.

F. M. STEVENS.

Locomotive.

No. 232,776. Patented Sept. 28, 1880.

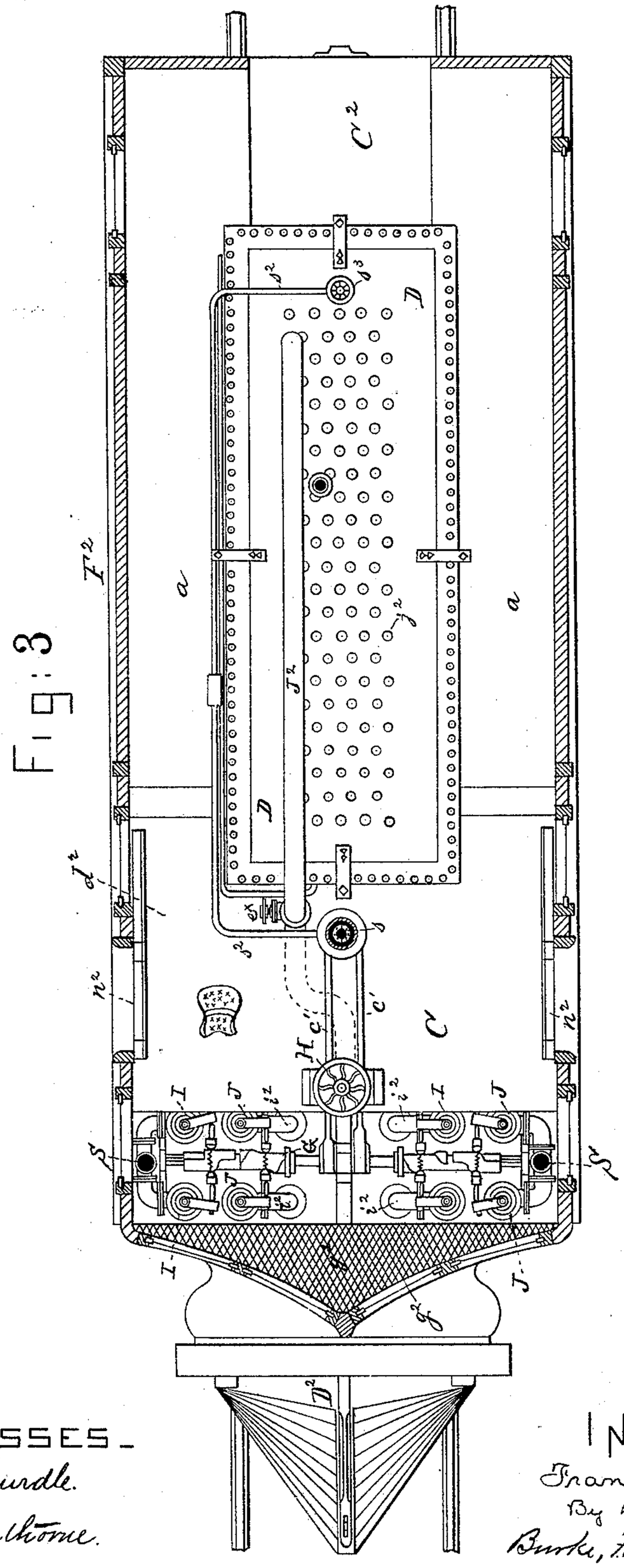

FIG. 3

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(No Model.)

6 Sheets—Sheet 4.

F. M. STEVENS.

Locomotive.

No. 232,776. Patented Sept. 28, 1880.

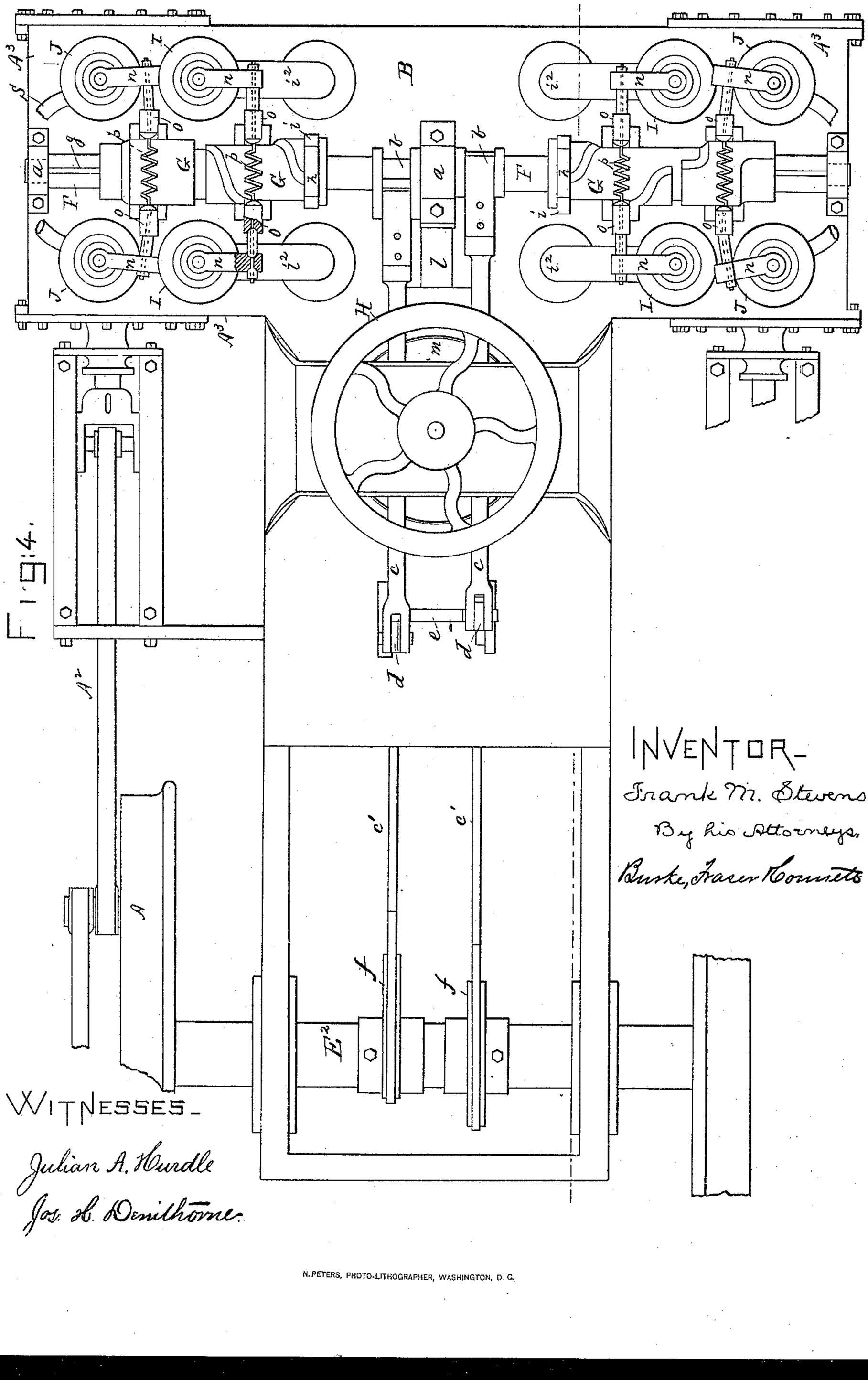

FIG. 4.

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(No Model.)

6 Sheets--Sheet 5.

F. M. STEVENS.

Locomotive.

No. 232,776.

Patented Sept. 28, 1880.

Fig: 5.

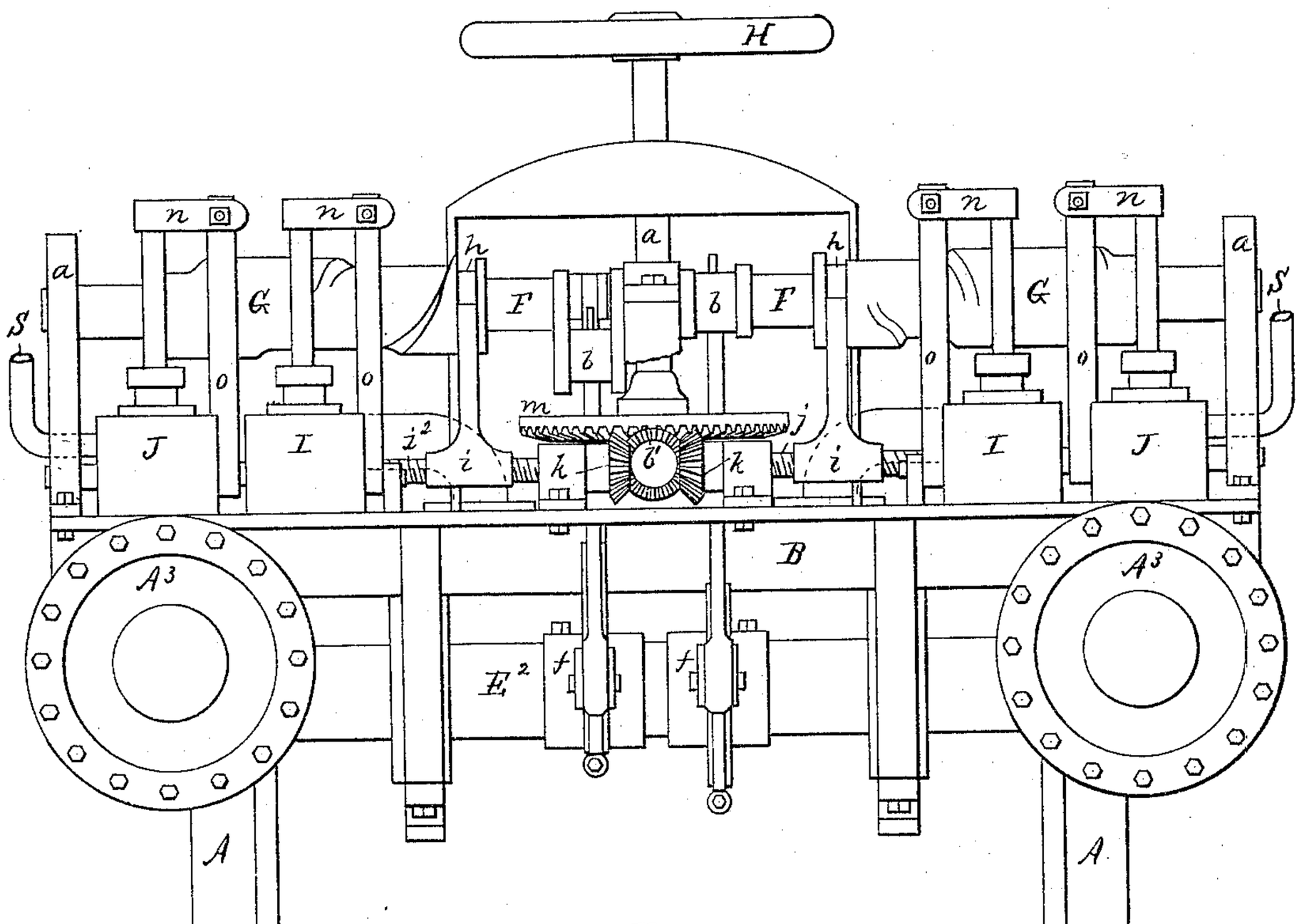


Fig: 6.

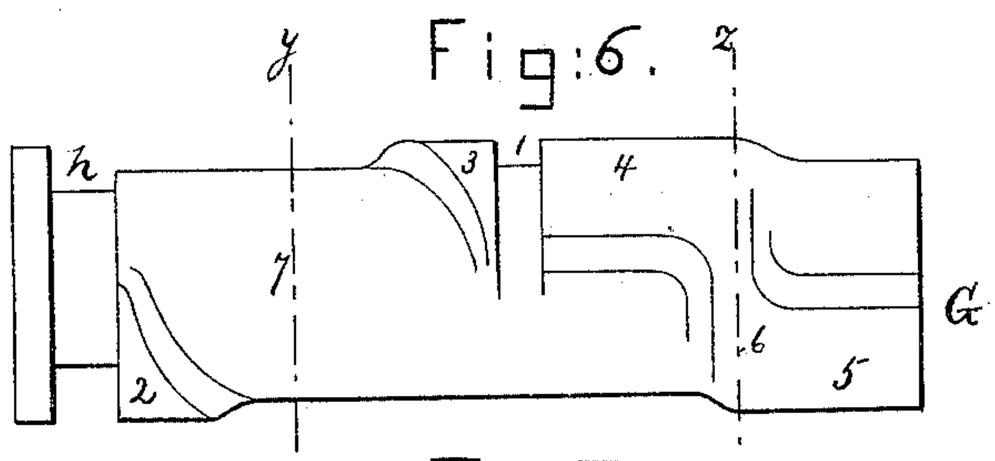
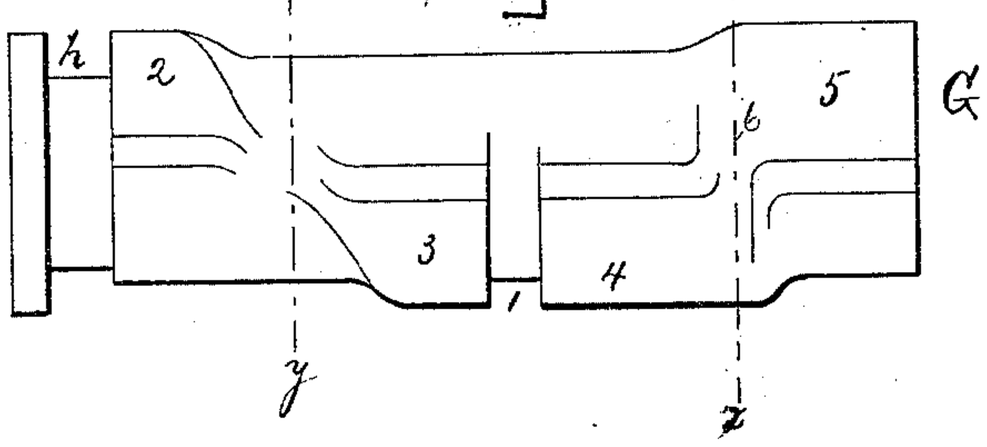


Fig: 7



WITNESSES-

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(No Model.)

6 Sheets—Sheet 6.

F. M. STEVENS.

Locomotive.

No. 232,776. Patented Sept. 28, 1880.

Fig: 8.

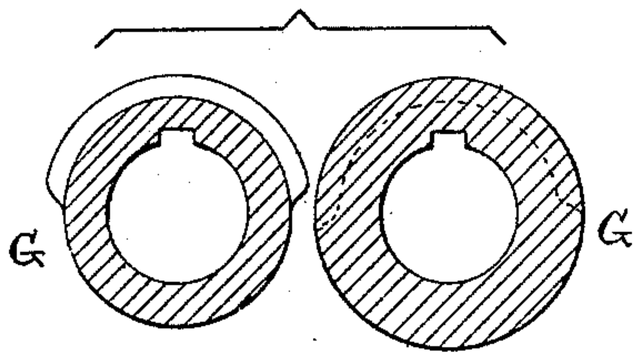


Fig: 9.

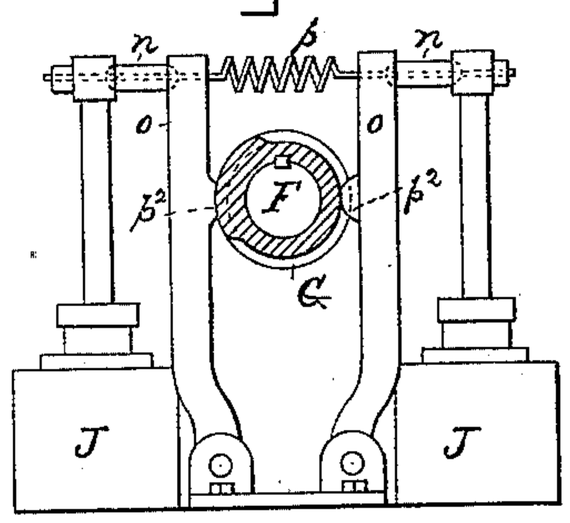


Fig: 10.

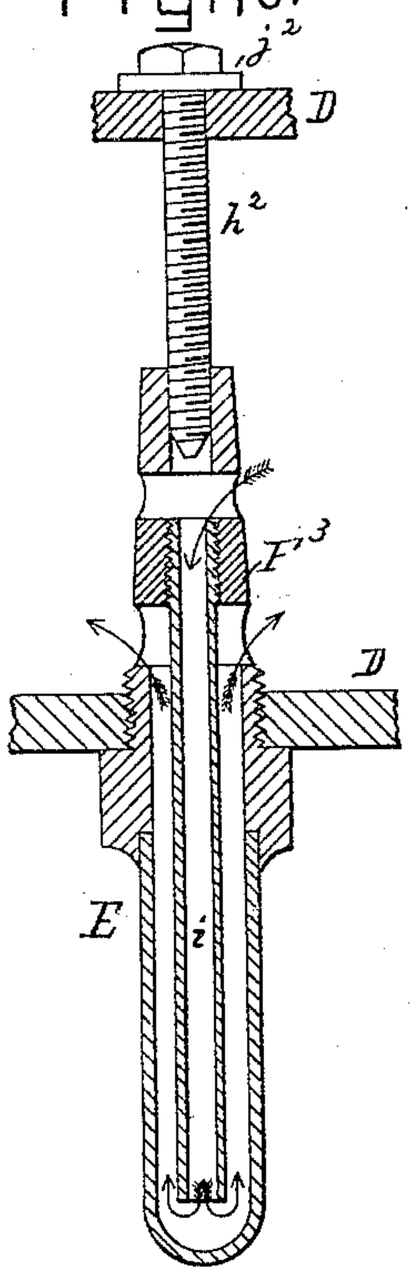


Fig: 11.

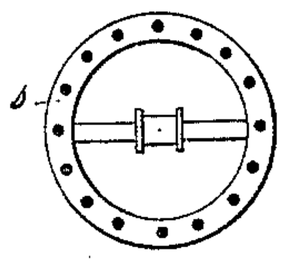
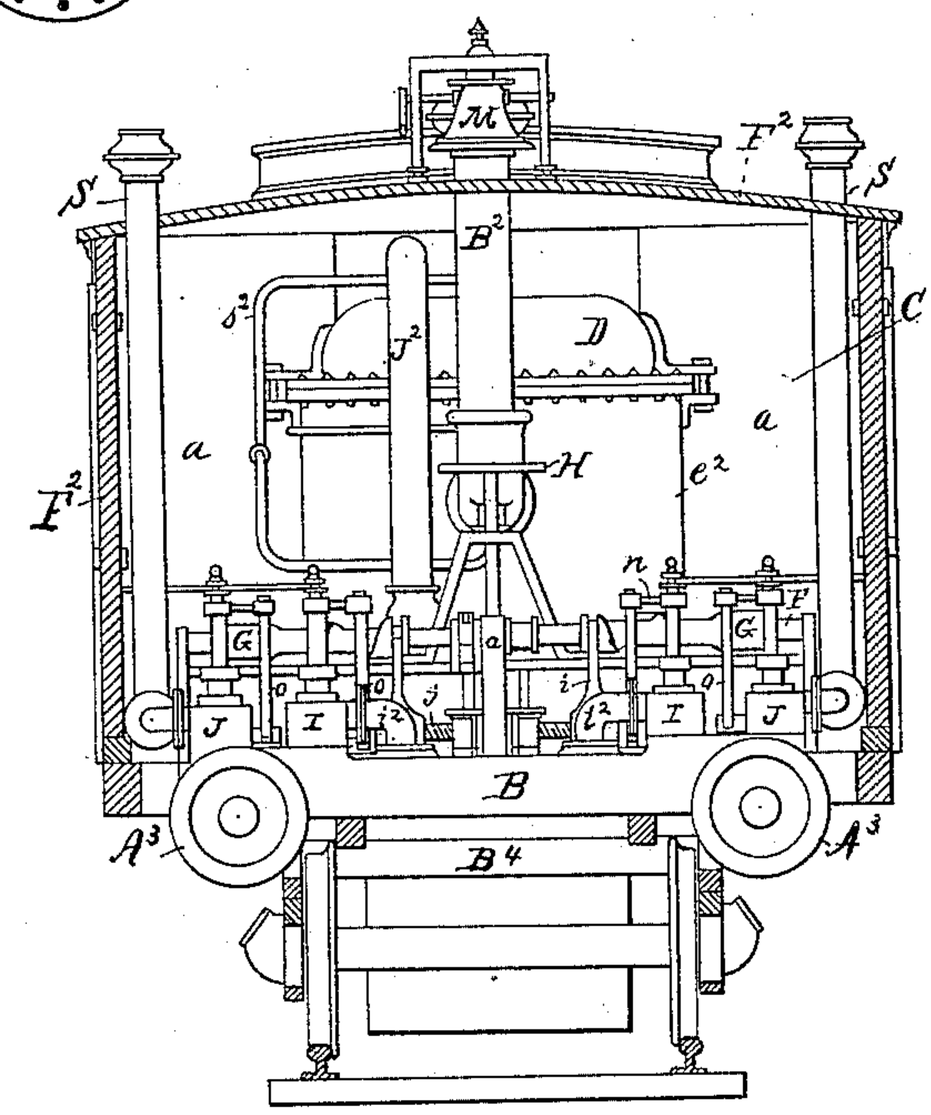


Fig: 12.



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UNITED STATES PATENT OFFICE.

FRANK M. STEVENS, OF CONCORD, N. H., ASSIGNOR OF ONE-HALF OF HIS RIGHT TO JOHN H. PEARSON; SAID PEARSON ASSIGNOR OF ONE-HALF OF HIS RIGHT TO CHAS. C. PEARSON, ALL OF SAME PLACE.

LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 232,776, dated September 28, 1880.

Application filed March 26, 1880. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. STEVENS, of Concord, in the county of Merrimack and State of New Hampshire, have invented certain Improvements in Locomotives or Locomotive-Engines, of which the following is a specification.

This invention relates to improvements in locomotive-engines, and has for its object, among other things, a novel construction and arrangement of the different parts that together united constitute a locomotive-engine, and also to economize fuel, and prevent sparks, cinders, and excessive smoke.

One part of my invention consists in a locomotive having a boiler or steam-generator arranged at the rear of the bogie-truck, above the driving-wheels, the said boiler having at its rear end an apartment for the fireman and at its front end an apartment or housing-cab for the engineer, the said engineer's apartment containing the valve-gear and valve-controlling mechanism, all as hereinafter set forth, whereby the engineer is placed at the front of the locomotive, where his view of the track and signals is entirely unobstructed, where he is removed from the presence of smoke, steam, and dust, and has all the mechanism for starting, stopping, and reversing the locomotive completely under his control. This construction affords additional security to the lives of passengers and safety of rapidly moving-trains.

I have discovered that the universal system of discharging exhaust-steam into the stack to increase the draft produces sharp intermittent blasts through the fire, tearing it to pieces and sending the products of combustion and small particles of coal therein through the tubes and stack so rapidly as to afford but little time for the products of combustion to surrender their heat to the tubes and water, and causing the emission of showers of sparks and cinders—a source of danger and annoyance—and the products of combustion and contained particles, traveling at such rapid rate, soon cut out the tubes and spark-arresting screens. To obviate this difficulty I have devised a method of accelerating the draft by a jet of live steam taken from the boiler, the said jet being introduced, preferably at the base of the stack, at a pressure less than that at which the exhaust-steam is commonly introduced; and at the same time I have connected with the exhaust-valves suitable outlets to convey the exhaust-steam into the atmosphere. To enable me to practically carry out this plan I have constructed the valve mechanism and its actuating-gear so as to work the steam in the cylinder to full advantage—that is, I have provided for a full, or nearly full, opening for the steam to its admission-ports at or near the beginning of the stroke, and have provided means to exhaust the steam at as near the end of the stroke of the piston as is practicable with the speed of the engine, and at the same time I have retained means to vary the point of cut-off or admission of steam into the valves, and have arranged the mechanism so as to obviate excessive lead or compression common in the present forms of locomotives.

To enable me in a practical way to abandon the use of exhaust-steam as a means for stimulating the draft, it became necessary for me to provide the locomotive with more rapid and efficient means for generating steam—means whereby I could better utilize the heat in the fuel and products of combustion. To do this I have applied to the locomotive a form or class of boiler not heretofore employed in locomotives, such boiler containing improvements invented by myself, whereby I am enabled to generate steam very rapidly and with the least possible expenditure of fuel and loss of heat. The boiler or steam-generator herein shown is not, however, made the subject of an independent claim, as it forms the subject-matter of another application for patent filed in the United States Patent Office March 23, 1880, to which reference may be had.

The metallic casing or shell forming the furnace or combustion-chamber of this locomotive-engine is lined with fire-brick or other refractory material, which greatly adds to the efficiency of the apparatus in the rapid generation of steam. I have extended the combustion-chamber nearly or quite the whole length of the boiler or steam-generator, so that more

time and space are allowed for the more perfect combustion of the gases produced by the consumption of the fuel than can be gained in the present forms of locomotive-boilers.

In this my locomotive I employ separate inlet and exhaust valves, as I desire the exhaust-valves to be held open, or nearly so, under certain conditions, while the inlet ports or valves are closed, or nearly so, and this while the engine is in motion on the track.

If it is desired to reverse the motion of and run backward a locomotive provided with separate inlet and exhaust valves for each end of each cylinder, as herein described, the engineer, under most circumstances, will first reverse the motion of the engine, partly in order that steam-power may be subsequently employed to arrest and reverse the motion of the locomotive; but by holding open the exhaust-ports and closing the inlet-ports it will be apparent that a sufficient quantity of steam to result in injury to the cylinder and piston cannot be entrapped in the cylinder, nor can a vacuum be formed in the said cylinder which would tend to stop the locomotive or train.

Operating the valves as herein described is especially desirable when running into a station or on a downgrade, as then, instead of shutting off the steam entirely by the throttle-valve, as is commonly done in ordinary locomotives, I place the valves in such position that the steam-admission ports of the moving locomotive shall be held closed and the exhaust-ports open, leaving the piston free to act without tendency to compression.

Prior to this my invention I am not aware that a locomotive has ever been constructed in which the valves may be made inoperative in such position that the exhaust-ports are held open and the admission-ports closed.

The valve mechanism herein described as having been invented by me to operate in the manner stated has been made the subject-matter of another application for United States patent filed the 26th day of March, 1880.

Figure 1 is a side elevation of a locomotive-engine containing my improvement; Fig. 2, a longitudinal and vertical section of the same; Fig. 3, a plan, the roof being removed to show the interior of the structure, in which is made the different apartments for the engineer and stoker, the steam-generator being located between the said apartments, connected by a passage-way at one side of the said generator; Fig. 4, an enlarged plan of the valves and their actuating mechanism, so as to more clearly and exactly show the cylinder and valve mechanism on a larger scale than in Figs. 1 and 2; Fig. 5, a front elevation of Fig. 4; Figs. 6 and 7, views of opposite sides of the cam-barrel, hereinafter described, drawn to a scale twice the size of Fig. 5. Fig. 8 represents cross-section of one of the said cam-barrels on the dotted lines, Fig. 6. Fig. 9 is detail of the valve mechanism; Fig. 10, an enlarged vertical sectional detail of one of the depending tubes connected with the upper and lower sheets of the boiler-shell; Fig. 11, an enlarged detail of the steam-jet ring; Fig. 12, a front view of the locomotive, Fig. 3, with the front of the engineer's apartment removed.

Let A represent the driving-wheels; A^2, the usual connecting-rods; B^4, the bogie-truck, placed at the front of the structure F^2, in which is placed the steam-generating apparatus or boiler, the said structure also furnishing at its front part, in advance of the boiler, an apartment, C, for the engineer, and at its rear an apartment, C^2, for the fireman. The engineer's apartment is above the bogie-truck. The main part of the framing for the boiler and engine is hung upon springs on the usual axle-boxes, and is extended forward over the bogie-truck and to the pilot D^2. These two apartments C C^2 are connected along the sides of the boiler or steam-generator by the narrow gangways *a a*. (See Fig. 3.)

In order to enable me to produce steam in the most rapid and uniform manner with the least possible expenditure of fuel, I have invented and applied to the locomotive a flattened boiler or shell, D, which I have supported upon the metallic furnace-casing e^2, lined with fire-brick or refractory material e^4, the said casing constituting the combustion-chamber e^3 and fire-box P of the locomotive, it having a grate and ash-pan of the usual construction. I have attached to this boiler a series of staggered compound water-circulating tubes, E, in which the water is made to circulate rapidly and freely. The outer part of each of these tubes is firmly connected with the lower part of the boiler-shell by means of a nut, F^3, and the inner tube, *i*, located within the outer tube, is also connected with the said nut F^3, suitable water-ways being made between them to permit the water to circulate in the direction of the arrows, Fig. 10.

The boiler and tubes are further stayed by the stay-bolts h^2, having heads j^2. These compound tubes, boiler-shell, and fire-chamber are all as in my other application, hereinbefore referred to, and to which reference may be had. The stack or smoke-pipe B^2, located at the front end of the boiler D, has placed within it a steam pipe or jet, *s*, perforated to discharge live steam into the stack, the said jet-pipe being connected by a suitable pipe, s^2, the said ring being connected (see Fig. 3) with a suitable portion of the boiler D, preferably at its rear end, so as to place the steam-jet under control of the fireman.

A^2 represents the engine-cylinders, connected by means of a suitable bed-plate, B; E^2, the axle, upon which are fixed the drivers A and the eccentrics *f* that operate the connecting-rods *c'*. Each engine is provided with like valves and operating-gear, so a detailed description of each will be unnecessary, it being understood that like letters are employed for like parts.

Let F represent the cam-shaft, mounted in bearings at *a*, and provided with two cranks, *b*, bent and arranged at right angles to each other. Connecting-rods *c c* take hold of these

cranks and extend back to and connect with upright levers or arms *d d*, pivoted on the frame-work at *e e*, as shown. To the lower extremities of these arms are attached other connecting-rods *c' c'*, which extend backward and are connected with eccentrics *f f* on the axle E^2. The levers *d d* are employed partly to enable me to arrange the connecting-rods in a horizontal position, and thus economize room, and partly to employ cranks which differ in throw from the eccentrics. If the connecting-rods were carried directly from the eccentrics *f f* to the cranks *b b* while the former are in a plane so much below the latter, the vertical play of the frame on the springs of the locomotive would be sufficient to derange the functions of the parts, if not to render them entirely inoperative, as the distance between the centers of the axle E^2 and the shaft F will be constantly varying to a considerable degree; but with the connecting-rods arranged in parallel planes at right angles to the substantially vertical play of the frame on the springs this injurious effect is practically neutralized.

On the shaft F is an elongated cam-barrel, G, which is arranged to slide longitudinally upon the shaft, being prevented from turning by means of a spline, *g*. Referring to Figs. 5, 6, and 7, where this cam-barrel is more fully illustrated, 1 represents a circumferential groove between the exhaust end of the cam (that to the right) and the inlet end. The inlet end consists of two spirally-constructed cut-off cams, 2 and 3, the former of which may be designated the "go-ahead" inlet-cam and the latter the "backing" inlet-cam. These cams are alike, but are arranged in inverse order. As a spirally-arranged cam is not of itself new, it will not be necessary to describe its construction more fully. The exhaust end consists of two exhaust-cams, 4 and 5, the former of which may be designated the "go-ahead" exhaust-cam and the latter the "backing" exhaust-cam. The elongated cam-barrel G may be considered as a cylinder, having a diameter equal to a section taken on the line *y y* in Figs. 5 and 6, and as shown at the left in Fig. 7, and the cams 2 3 4 5 may be considered as enlargements on said cylinder.

The exhaust-cams 4 and 5 are each extended half-way around the cylinders, and there is a zone between them where the enlargement extends all round the cylinder in the form of a belt, 6. Through this belt the section shown at the right in Fig. 7 is taken. Thus, at 6 I have an enlarged cylinder between the exhaust-cams, and a lesser zone consisting of the cam-barrel itself at 7, between the inlet-cams. The object of these will be explained farther on.

On the end of the barrel G is formed a clutch-groove, *h*, with which engages a fork, *i*. This fork has a nut or threaded bore on its lower end, which engages a horizontally-arranged screw, *j*, that has fixed bearings on the main frame. This screw bears a miter or bevel wheel, *k*, that engages a bevel-wheel, *b'*, on a shaft arranged at an angle to the screw-shaft *j*. On the other end of this shaft is another bevel-wheel, *l'*, which meshes with a larger wheel, *m*, on a vertical shaft, provided with a suitable hand-wheel, H, so that by rotating the hand-wheel the screw *j* may be rotated, the fork *i* caused to travel thereon, and the cam-barrel G be caused to move longitudinally on its shaft.

I I are the inlet-valves, and J J the exhaust-valves. These are preferably oscillating valves, which may be of any suitable character; or single-acting slide-valves may be used instead. The valves shown are similar to that illustrated in my patent of July 16, 1878, and numbered 205,982. To the stems of these valves are fixed arms *n n*, and these arms are arranged to connect with levers *o o*, (see Fig. 9,) pivoted or hinged at their bottom ends, as shown. Each valve has its arm *n* and lever *o*, and the valves are coupled together in pairs—the exhaust together and the inlet-valves together—by means of springs *p p*, arranged between the pairs of levers *o o* and adapted to keep them pressed inward or toward each other.

The exhaust-steam is discharged from the exhaust-valves into the pipes S, herein shown as extended up through the roof of the structure F^2.

The cam-barrel G, with its cams, is arranged to rotate between the levers *o o* in such a manner that the springs *p p* will cause the levers to grasp it, and they are provided with rounded protuberances p^2 p^2 to bear on the barrel and cams.

The go ahead cams 2 and 4 and the zones or belts 3 and 5 are the same distance apart, and are spaced to correspond with the distance apart of the valve-levers *o o*, so that when the levers of the exhaust-valves engage, say, the cam 4 those of the inlet-valves will engage the cam 2.

The operation is as follows: Suppose the locomotive to be going ahead, the driver-axle E^2 communicates rotary motion to the shaft F and through it to the cam-barrel G and its various cams. Each revolution of the axle imparts a corresponding revolution to the cams. The cam 2 in its revolution acts alternately upon the levers *o o*, pressing them outward, and they, in turn, act upon the arms *n n*, to oscillate the valves and admit the steam to the cylinders. At the same time the cam 4 acts in a like manner upon the exhaust-valve levers to permit the escape of the steam. If the engineer wishes to reverse the engines, he shifts the valve mechanism through the medium of the hand-wheel H. The rotation of the said wheel in the proper direction causes the cam-barrel G to move along its shaft, in a manner hereinbefore described, until the backing-cams 3 and 5 take the places before occupied by the cams 2 and 4.

It will be observed, however, that in making this change the belts or zones 6 and 7 must coincide, while the movement is being made, with

the levers connected, respectively, with the exhaust and inlet valves, and the result will be that the two inlet-valves will be closed and the two exhaust-valves thrown wide open, and all simultaneously. This clears both ends of the cylinders of steam before the change is or can be made from backing to go-ahead, or vice versa. While the cams are in this position the valves are stopped from moving, although the engine-pistons may yet be in motion; and in going down a grade while the cams are so set the pistons operate freely and can neither compress steam in the cylinders nor form a vacuum, and consequently the cylinder and piston cannot be injured or the motion of the train retarded.

One most important feature of this valve-gear is that by it the engineer is enabled to throw open both exhaust-valves and close both inlet-valves simultaneously.

Ordinarily with this gear the throttle-valve will not be employed, as the setting of the valves as just described effectually cuts off all the steam from the cylinders.

To enable the cams to be brought successively under the protuberances on the levers by a lateral movement as well as a rotary movement, I provide inclines or easements, as shown, avoiding all abrupt offsets.

The springs *p* serve to close the valves at the proper moment, and each lever *o* may have a separate spring.

As shown, the cams employed on one cylinder are arranged oppositely to those on the other, and the two sets of cams move outwardly and inwardly at the same time when shifted. They might, however, be differently arranged so as to move in the same direction simultaneously. I prefer to employ two distinct screws, *j*, one for each cylinder, as shown, provide each with a bevel-wheel, *k*, and drive them from a common bevel-wheel, *l*; but one screw for both would answer very well.

I do not care to confine myself to any particular arrangements of these gear-wheels for operating the screw or screws *j*, nor to the use of screws for effecting the longitudinal movement of the cam-barrels, as a rack-and-pinion or other movement might be employed for this purpose.

The ball-and-socket connection of the lever *o o* with the valve levers or arms gives perfect freedom to the movement without detracting from its positiveness, and the employment of the levers enables me to get a greater movement of the valve with a given throw of the cams than could be had by causing the latter to act directly upon the arms *n n*. In some cases the levers might be dispensed with, and the arms *n n* be arranged to bear directly upon the cams or barrels G.

As a matter of convenience I contemplate so constructing the gearing that less than one revolution of the hand-wheel H will be sufficient to shift the cams, and to so mark the wheel that the engineer may know at a glance in what position the valves stand.

In the case of engines that do not require to be reversed the reversing-cams may be omitted from the barrel, and the zones 6 and 7 can be employed without them.

J^2 is the steam-pipe from the boiler, which passes forward and taps a cavity or steam-passage of the bed-plate B, with which, by elbows or suitable couplings i^2, are connected the inlet-valve casings I.

At each side of the engineer's apartment is a door, n^2, which affords easy ingress and egress to and from it. The hand-wheel H, by which the valves are shifted, is directly under the hand of the engineer as he stands upon the foot-board d^2; and $e^\times$ is the throttle-valve in the steam-pipe.

The front of the structure F^2 is made V-shaped, substantially as shown in Fig. 3, to divide the opposing body of air in the manner of a vessel dividing the water, and thus lessen the power required to drive the locomotive.

L is the head-light, which is accessible from the interior of the engineer's cab by a door, l^2, and may be reached by the engineer or other employé from a latticed step or platform, g^2. A flag-socket may also be added, which can be provided with a flag from the inside of the structure F^2. The ropes from the bell M and the whistle N are within reach of the engineer's hand as he stands at the wheel H.

To suit the tractive force of the locomotive to the traffic or the work it has to perform, I provide it with removable weights, by which the pressure of the drivers on the track may be varied at pleasure or as circumstances may demand. These weights may be arranged on the locomotive at any point where they will serve to keep the drivers down to the rails; but I prefer to arrange them, as a matter of convenience, under the locomotive and between the fire-box P and the forward driver-axle, as indicated at R in Figs. 1 and 2. The weights may be simply cast-iron blocks placed on the engine-frame or on brackets or supports attached thereto, and may be held by bolts. When thus provided, if the traffic is light, as it is on some roads at certain seasons of the year, these weights, or portions of them, may be removed, so as to lighten up the engine. I am the better enabled to do this, as my boiler is much lighter than those in ordinary use and is better adapted to receive the weights.

It is well known that for heavy work all the weight of the locomotive should, as far as possible, be made to rest upon the driving-wheels. My construction makes it possible for me to place a greater percentage of the entire weight over the driving-wheels than in any other locomotive that I know of.

I desire to state that I am aware that depending water-circulating tubes have been employed in stationary furnaces, but not in locomotives. So, also, fire-brick has been employed in fire-boxes of boilers; but I am not aware that a metal casing to sustain at its top and be covered with or by a boiler, and constituting the furnace for the generator, has

ever been lined with refractory material. So, also, I am aware that the exhaust-steam has at times been discharged into the atmosphere, and that live steam has been used to stimulate the draft; but no single engine or locomotive has ever, to my knowledge, been provided with contrivances to stimulate the fire by live steam in regulated quantities and deliver the exhaust-steam into the atmosphere outside the stack.

I am also aware that locomotives or engines for roads and highways have been designed showing an apartment for the pilot or steersman in front of the boiler and for the fireman and engineer proper at the rear of the boiler, and also that the engineer's apartment has been placed at the top of the boiler, near its front part; but all these contrivances differ from my plan herein described, as the apartment at the front of the boiler does not, as in my plan, contain all the valves and mechanism for opening them, and the engineer is not therein, as in my plan, given an apartment and position in advance of the smoke-stack and smoke issuing therefrom, which in ordinary engines affects the clear view of the engineer.

Having thus described my invention, I claim—

1. A railroad-locomotive consisting of the steam-generator composed of the shell D, pendent circulating-tubes, and a metal casing lined with a refractory material, the structure F^2, mounted on a proper supporting-frame above the drivers and bogie-truck to receive the said generator, the said structure being divided to form in front of the generator an apartment for the engineer and at the rear of the generator a separate apartment for the fireman, two sets of inlet and two sets of exhaust valves and mechanism to open and close them at the proper times, the said valves and their operating mechanism being located in the said engineer's apartment in front of the said generator or boiler and in front of the smoke-stack, and suitable running-gear, all as shown and described.

2. In a locomotive-engine, the steam-generator and a chimney or stack and a pipe to conduct live steam from the generator to the chimney or stack, combined with the exhaust or outlet valves disconnected from the stack, and independent pipes to deliver the exhaust-steam from the exhaust-valves into the air outside of and independent of the chimney or stack, as and for the purpose set forth.

3. The combination, in a railroad-locomotive, of the following instrumentalities, viz: two sets of inlet-valves to receive steam from the steam-chamber, and two sets of exhaust-valves, substantially as described, having outlets to discharge the exhaust-steam into the atmosphere, the steam-generator, smoke-stack, and pipes adapted to conduct a regulated amount of live steam to and discharge it into the stack both while the engine is in motion and at rest, the combination being and operating substantially as and for the purposes set forth.

4. A locomotive provided with the structure F^2, mounted on a proper supporting-frame above the drivers and bogie-truck to receive the steam boiler or generator near its central part, and having an apartment in front of the said generator for the engineer and an apartment at the fire-box or rear end of the generator for the fireman, the bed-plate B, provided with steam-passages, the foot-board or platform d^2 above it for the engineer to stand upon, a set of independent inlet and outlet exhaust-valves and cam-barrels to move them, located in the said engineer's apartment, and with a hand-wheel located at the front of the said platform by which to control the admission into and escape of steam from the said valves, to thereby enable the engineer, when operating the locomotive, to stand at the rear of the hand-wheel with his face in the direction of forward motion of the locomotive.

5. The frame-work, the drivers and bogie-truck of a locomotive-engine, and a steam-generating apparatus mounted thereon, as described, consisting of an extended furnace-chamber, e^2, lined with fire-brick, the boiler-shell D, and depending water-circulating tubes projected into the said extended combustion-chamber of the furnace, as set forth, combined with two sets of inlet and exhaust valves and mechanism to control the admission into and escape of steam from the said valves, all located in the engineer's apartment in advance of the steam-generator, and with the described system of connecting rods and levers between the rotating axle E of the drivers, and the valve-operating shaft to operate the said inlet and exhaust valves, all substantially as described.

6. A locomotive provided with the structure F^2, having its front end made V-shaped, as shown, as and for the purpose described.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK M. STEVENS.

Witnesses:
HENRY CONNETT,
ARTHUR C. FRASER.