No. 616,086. Patented Dec. 20, 1898.

A. P. DODGE.

LOCOMOTIVE ENGINE.

(Application filed May 19, 1897.)

(No Model.) 5 Sheets—Sheet 1.

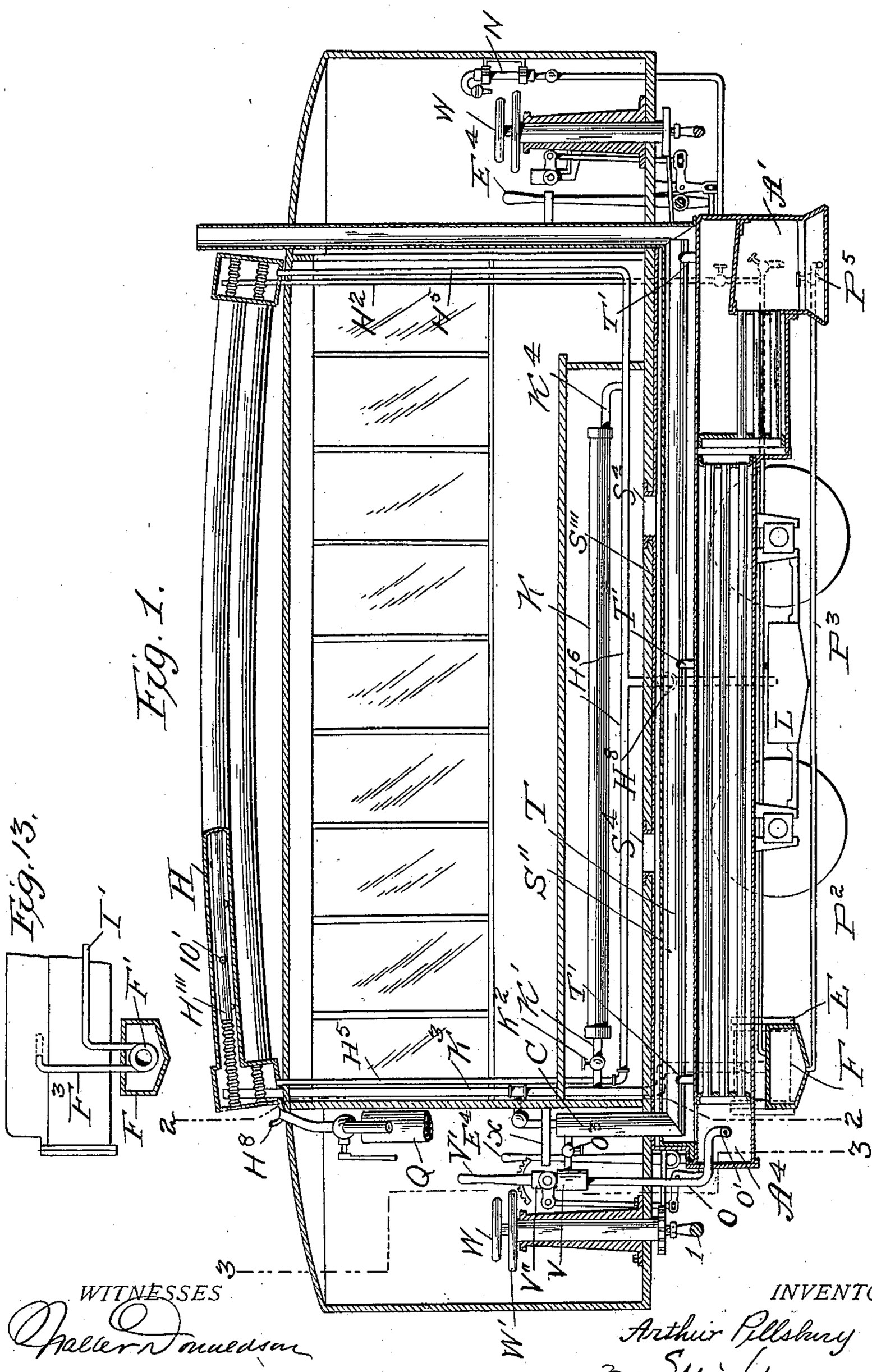

Fig. 1.

Fig. 13.

WITNESSES

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Fig. 2.

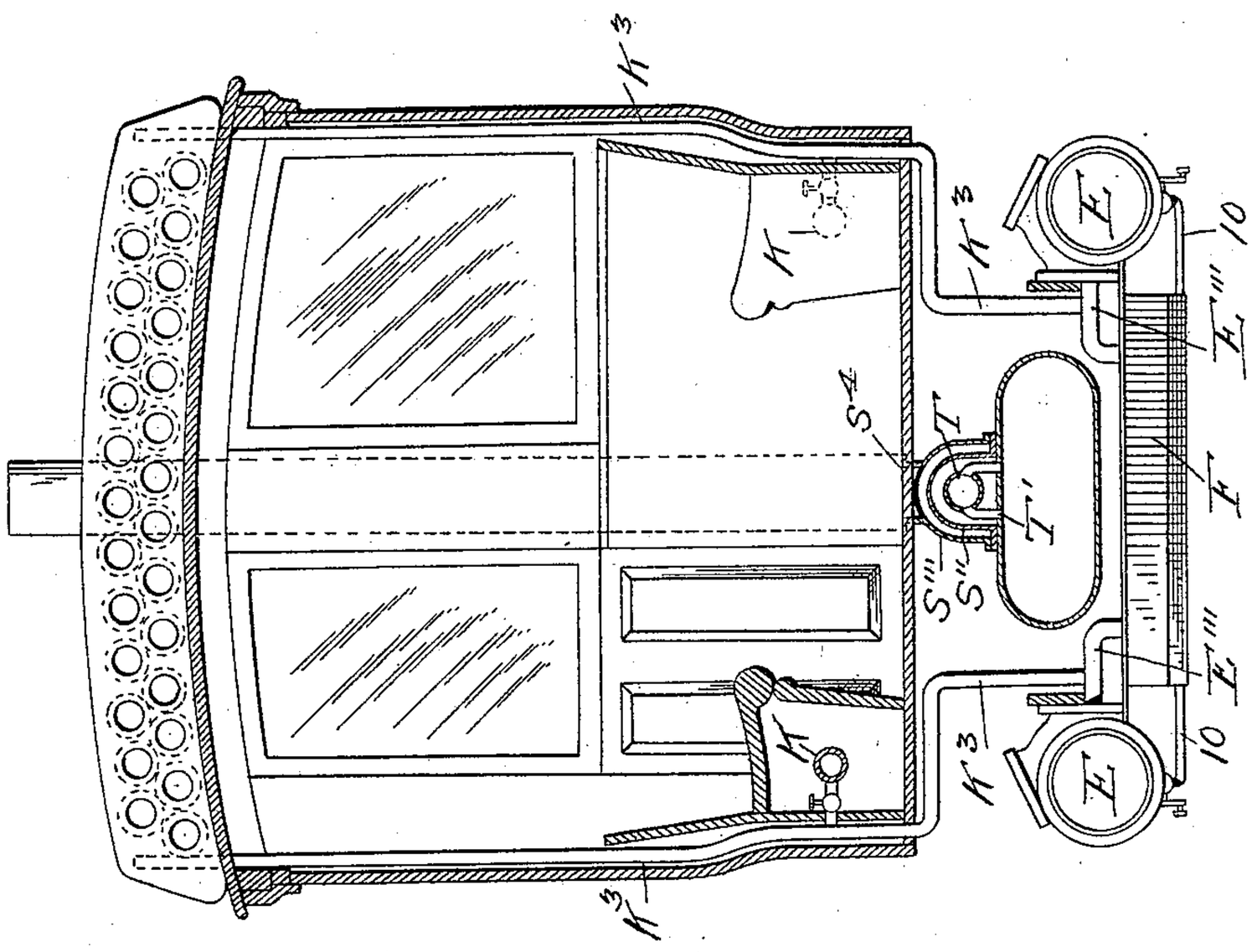
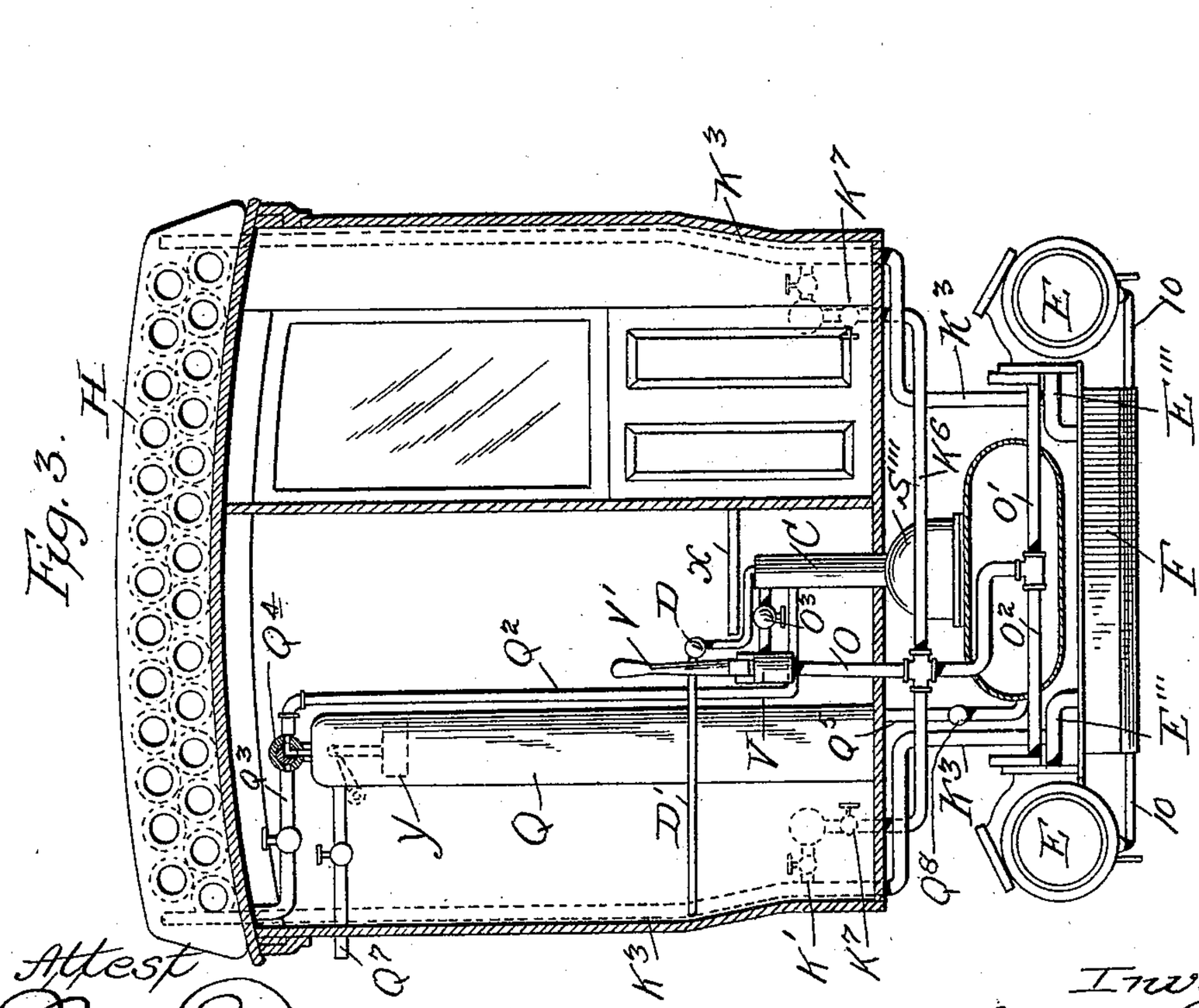


Fig. 3.



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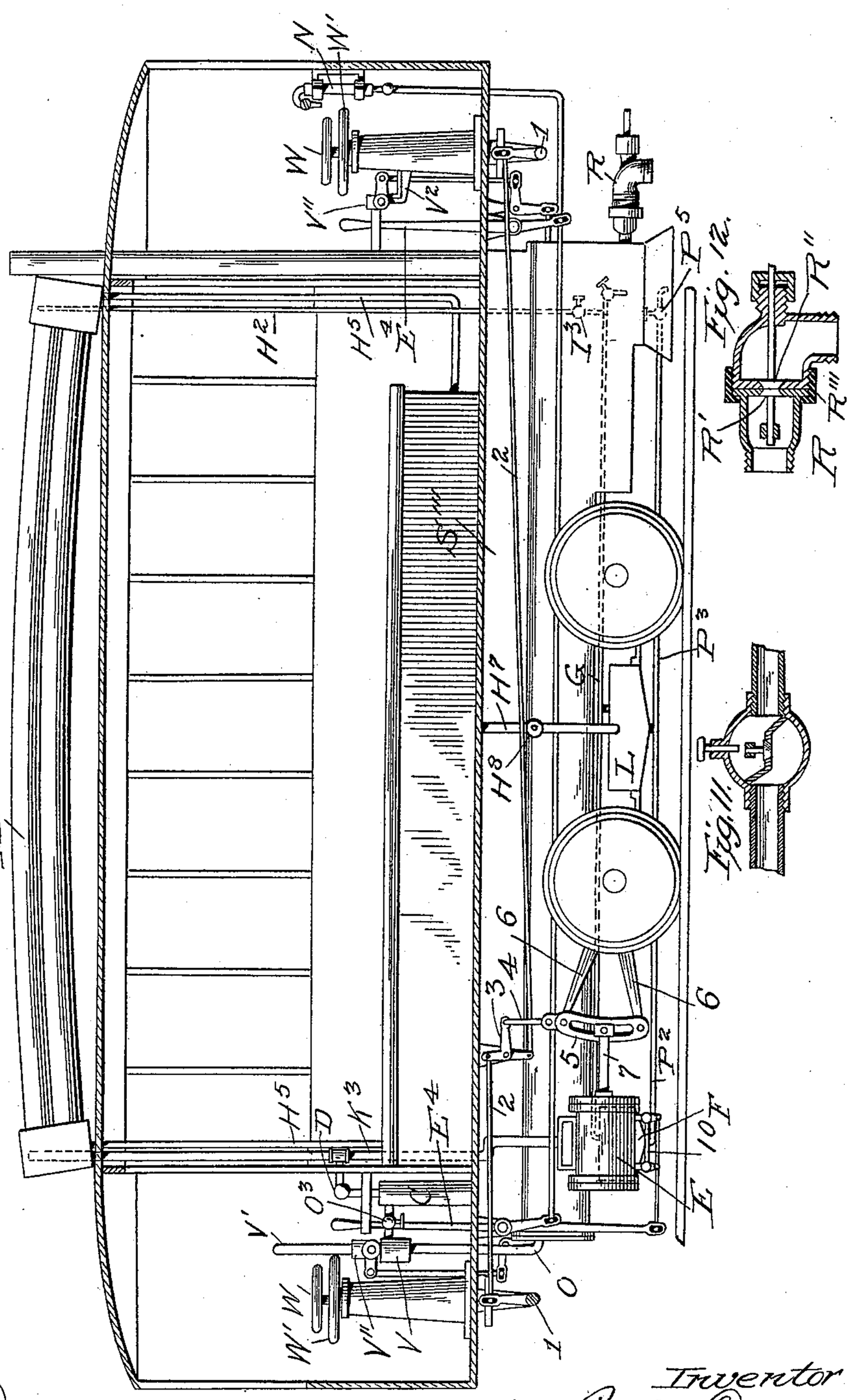

Fig. 4.

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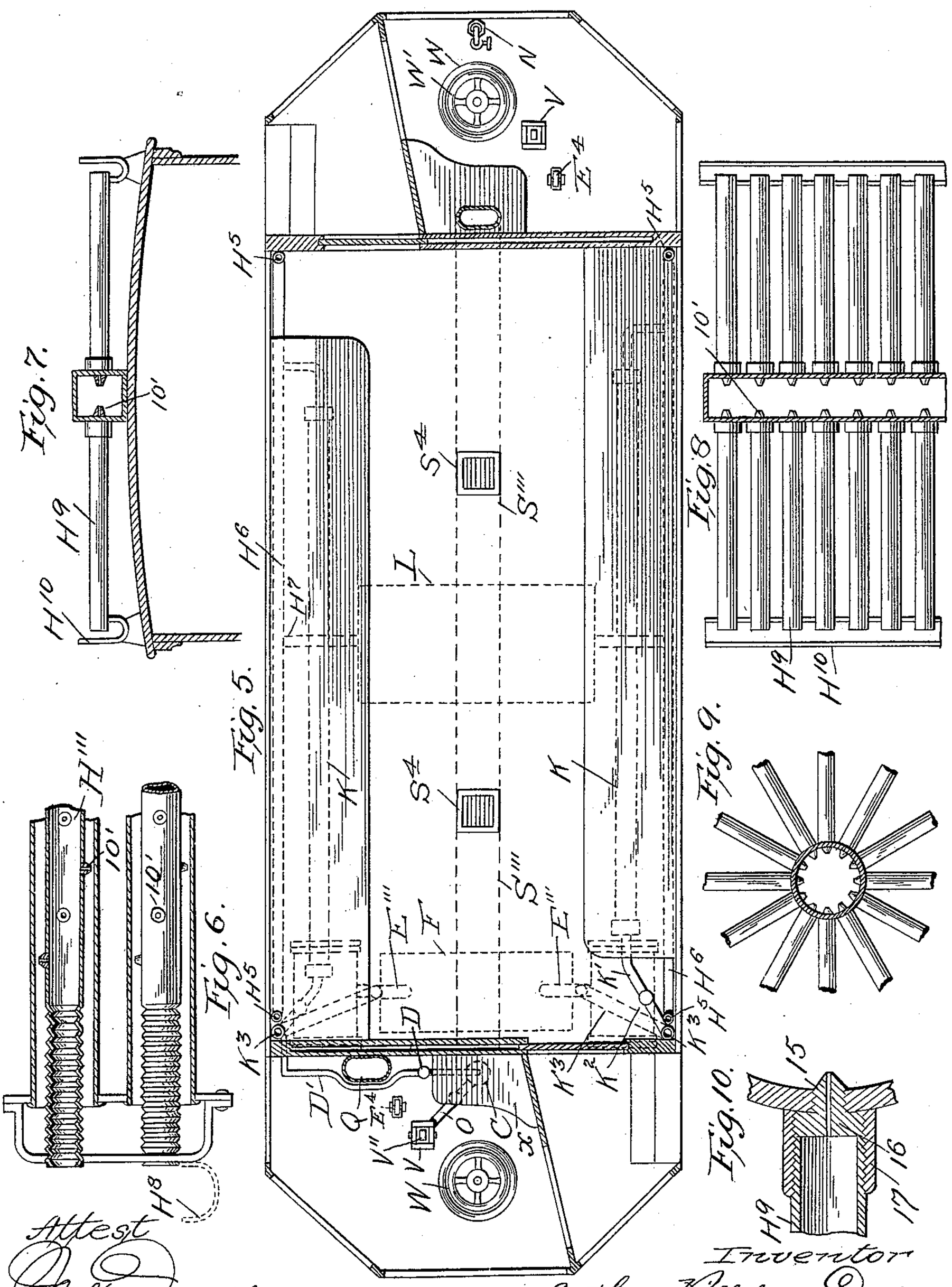
(No Model.) 5 Sheets—Sheet 4.



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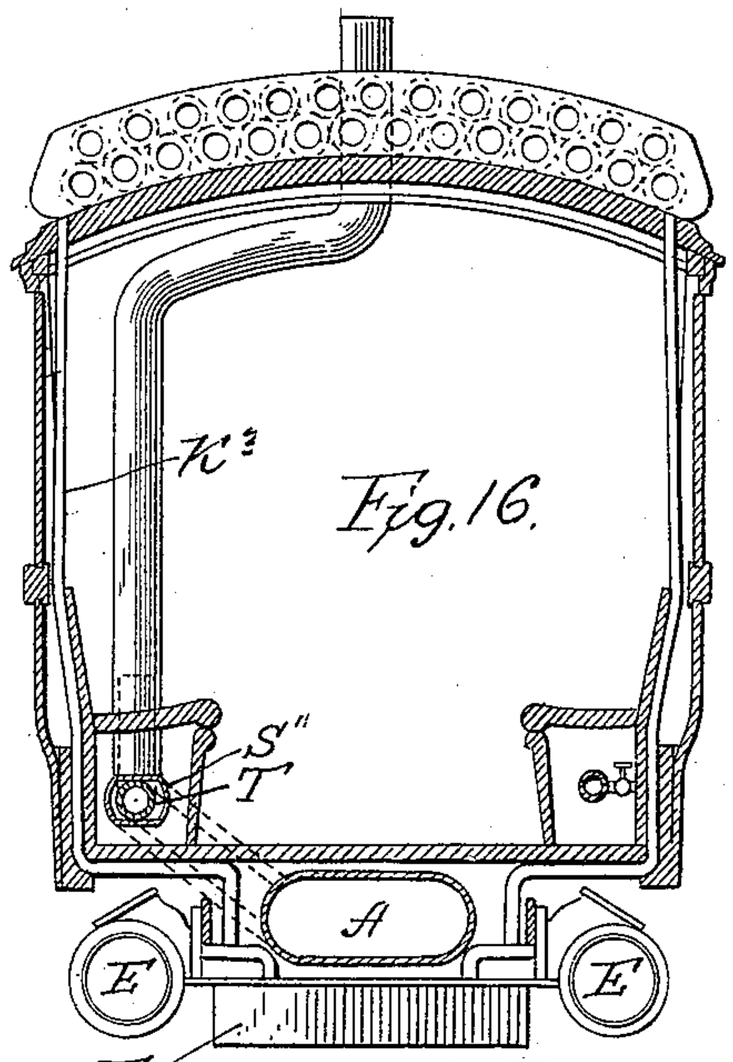


Fig. 16.

Fig. 6ª

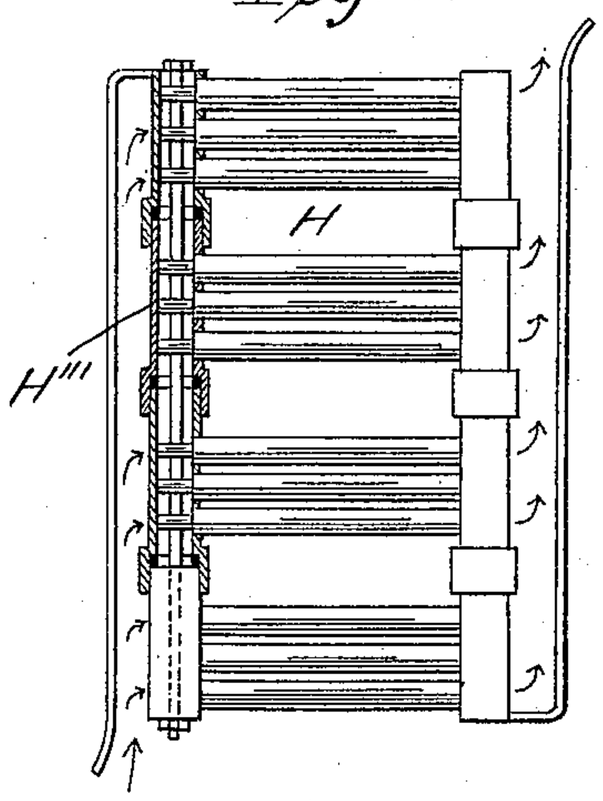
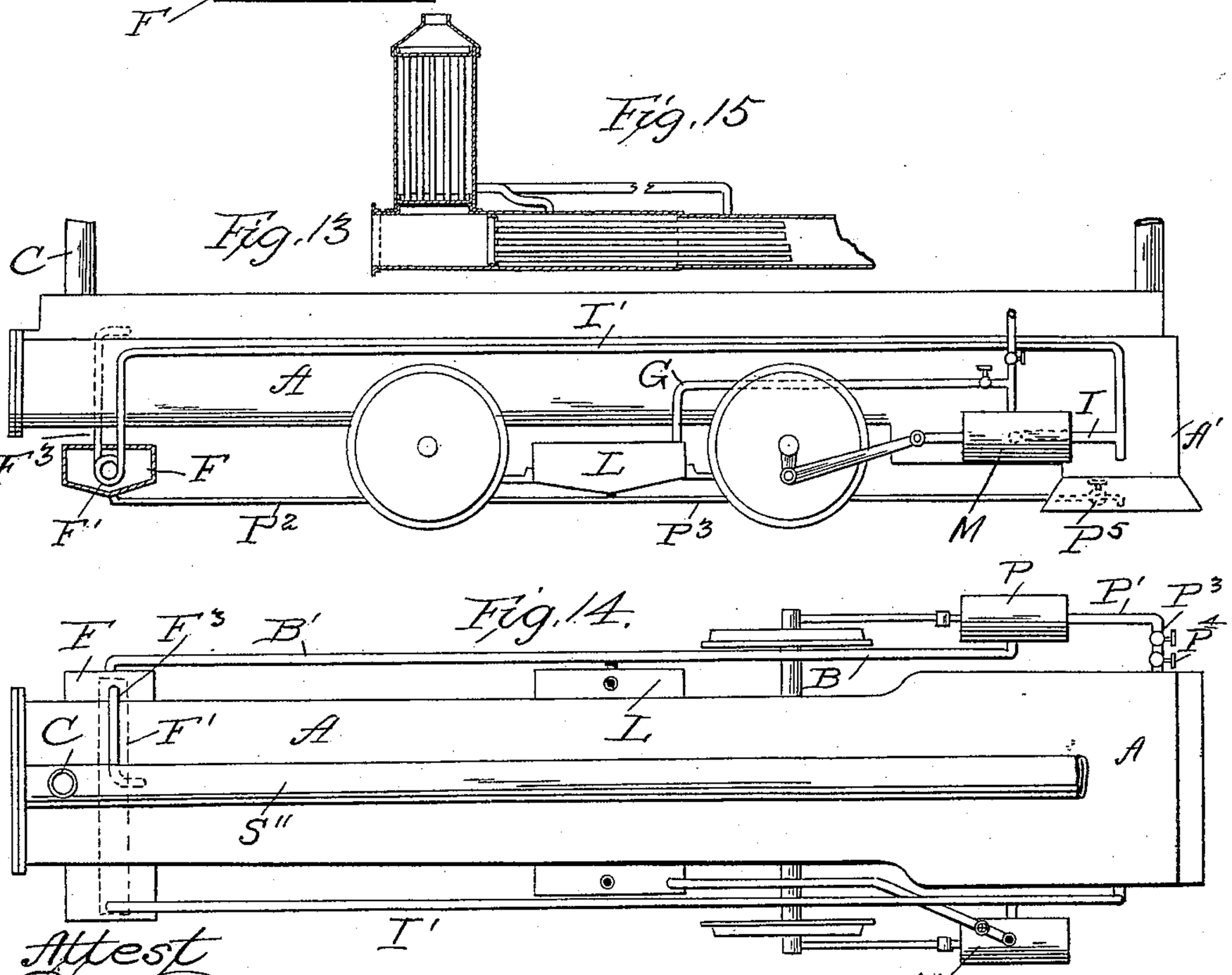


Fig. 15

Fig. 13

Fig. 14.



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UNITED STATES PATENT OFFICE.

ARTHUR PILLSBURY DODGE, OF CHICAGO, ILLINOIS.

LOCOMOTIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 616,086, dated December 20, 1898.

Application filed May 19, 1897. Serial No. 637,276. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR PILLSBURY DODGE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Locomotive-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to locomotive-engines, and is particularly adapted for street-car, suburban, or like service, where the demands of rapid transit must be met.

My present invention is an improvement on those described in applications for United States Patent filed by me August 14, 1896, Serial No. 602,806, and March 24, 1897, Serial No. 628,933.

In my present invention I have in view the main objects sought to be attained in the inventions mentioned—that is, I aim herein to provide a steam car or locomotive specially adapted for street-car use, it being free from all objectionable features, such as noise from escaping of exhaust-steam from the cylinder-cocks, as well as from the smoke-stack, and the nuisance of throwing out the cinders and smoke, which features alone render the ordinary type of locomotive unfit for street-car use.

In my present invention I employ the same form of boiler and dry-steam pipe disclosed in my former application, Serial No. 628,933. The condensation and heating systems are the same in their general features as those disclosed in the said applications, the improvements in the present case comprising a different arrangement of parts, whereby the invention is simplified. I have also improved herein the condenser proper, so that the exhaust-steam is brought into direct contact with the outer air and at the same time is allowed to condense against the walls of tubes, which will prevent all show of steam and will collect the water of condensation, so that it may be led to any desired point for regenerating the steam from it to save fuel or otherwise.

In my present invention I dispense with the ordinary throttle-valve commonly used in locomotive practice and use instead, as a means of controlling the motor, an adjustable reducing-valve between the boiler and the cylinders in conjunction with an adjustable link-motion, both being under the control of the motorman, the first-mentioned device controlling the steam-pressure at the cylinders, while by that last mentioned the motorman can vary the point of cut-off, and thus change the speed at will.

In the drawings, Figure 1 is a longitudinal section taken centrally of the car, the seat on the far side of the car being also shown in section. Fig. 2 is a transverse section on line 2 2 of Fig. 1. Fig. 3 is a transverse vertical section on line 3 3 of Fig. 1, showing the interior of the cab or vestibule. Fig. 4 is a view similar to Fig. 1, but showing the boiler and the operating connections in side elevation. Fig. 5 is a sectional plan view of the motor. Fig. 6 is a detail view of part of the overhead condenser. Fig. 7 shows another embodiment of the principle upon which my condenser is based. Fig. 8 is a plan view of the same, partly in section. Fig. 9 is a modified form of this condenser. Fig. 10 is a detail view relating thereto. Fig. 11 is a detail view of a type of combined stop and check valve. Fig. 12 is a detail of the charging-valve. Fig. 13 shows an arrangement of air-blast pipe.

As in my former application, the boiler extends under the car-floor from one platform to the other, having a steam-dome rising through the platform into the motorman's cab at one end, while the smoke-stack rises through the platform and cab at the opposite end. A small fire-box A′ is designed to carry a slow anthracite-coal fire or contain a liquid-fuel burner, said fire-box being situated at one end of the boiler. From this fire-box the hot gases pass through the tubes of the boiler into a small smoke-arch or combustion-chamber A^4 at the opposite end of the boiler, and thence by way of the smoke-pipe S″ to the smoke-stack, the said smoke-pipe extending the whole length of the car-floor centrally thereof and entirely below the same. The steam from the steam-space of the boiler passes into a dry-steam pipe T through a plurality of short pipes T′, connected with the boiler at different points throughout its length. This dry-steam pipe is arranged within the smoke-pipe, and is therefore heated by the passage of the hot gases from the

smoke-arch to the stack. The dry-steam pipe extends practically the whole length of the boiler, and at one end it has an extension C through the platform and into the motorman's cab, forming a steam-dome.

The steam-supply pipe O extends from the top of the dome through the motorman's cab and thence downwardly into the smoke-arch, where its branches O' O^2 lead off to the cylinders, as shown in Fig. 3. The steam in its passage through the dry-steam pipe T is superheated, and this effect is further increased by the action of the hot gases in the smoke-arch upon the steam in the supply-pipe, and by thus superheating the steam losses in the cylinders due to condensation will be greatly reduced.

The feed-pipe has a cut-off valve O^3 within convenient reach of the motorman, whose seat is shown at X, and it has also a pressure-reducing valve V under control of the motorman by means of a lever V', connected to the valve in any suitable manner to regulate the spring-pressure thereon.

In my motor I dispense with the ordinary throttle-valve employed in locomotive practice and use instead this reducing-valve in combination with mechanism for changing the point of cut-off at the cylinders, and by this combination the speed of the motor is regulated, the motorman simply adjusting the pressure-reducing valve to the initial pressure best suited for the grade or load and increasing the point of cut-off until the desired speed is obtained. This adjustable cut-off mechanism is controlled by a hand-wheel W, arranged in the cab in front of the motorman, the shaft of this wheel being connected with a rocker-shaft 1 below the car-platform, which shaft is connected through links 2, one on each side of the boiler, with bell-cranks 3, which are connected with the slotted links 5 by the rods 4. These links are oscillated through eccentric-rods 6 from eccentrics on the cax-axle, as usual, and the slot in the link receives a block on the end of the valve-rod 7, connected with the slide-valve of the cylinder. From this it will be seen that by turning the wheel the motorman can regulate the point of cut-off through the connections described. These operating connections, including the hand-wheel, are duplicated at the opposite end of the motor. The reducing-valve may be adjusted to the desired initial pressure from either cab, for which purpose the lever V' may be set in either of the pivoted sockets V'', that at the right of Figs. 1 and 4 being supported by any suitable bracket V^2, while that at the left is pivoted to the valve-frame.

I have thus far followed the course of the live steam from the boiler to the cylinders and have described the means whereby this steam-supply is controlled to run the motor at the will of the motorman. I will next follow the course of the exhaust-steam and describe the means by which the condenser system is rendered efficient by preventing the collection of air therein and also the means whereby all show of exhaust or escaping steam is prevented.

The exhaust from the cylinders E E passes by way of pipes E''' into a transverse condenser F, arranged below the front end of the boiler, and the steam here gives up its water of condensation, and it thence passes up through the exhaust-pipes K^3, which rise from the pipes E''', along the corners of the car to the overhead condenser H. From this overhead condenser the water of condensation is drained off through the pipes H^5, extending vertically at the corners of the car, into a lower condensation-chamber L, supported on the car-truck below the boiler. The pipes H^5 have horizontal extensions H^6 under the car-seat, and these are connected with condensation-chamber by vertical branches H^7, provided with valves H^8. Both the rising exhaust-pipes and the drip-tubes being in the corners of the car are out of the way, and in a great measure they are out of sight of the passengers.

In order to relieve the condenser system of air which might collect in the different parts thereof and impair its efficiency, I connect the top of the condensation-tank L and the top of the transverse condenser with a pipe G, which may lead to the furnace either above or below the grate, and by this means any water-vapor mingled with the air removed from the condenser system may be discharged invisibly into the furnace. A similar pipe connection H^2 may be made with the overhead condenser, and these pipes are preferably provided with stop and check valves opening toward the furnace.

An air-pump may be used in this system, as in my former application.

The cylinder-cocks are arranged to discharge steam and water into the transverse condenser F by a pipe 10, and these cocks are controlled by levers E^4, one at each end of the car, through the connections shown in Fig. 4.

The safety-valve D, connected with the steam-dome C, is arranged to discharge into the pipe D', which conducts the escaping steam into the condenser system by way of the rising exhaust-pipe K^3, so that there will be no noise of escaping steam nor will it be visible to the passengers or to the public.

The water of condensation may be returned to the boiler through suitable pipes by a pump, as in my former application, from the tank L and condenser F, and by means of pipes P^2 P^3 water may be led in limited quantities from these tanks to the ash-pit to cool the same, a stop and check valve P^5, opening toward the furnace, being provided in the pipe P^3.

I have improved the overhead condenser, which in its general features is like that described in my former application, so that the steam or a portion thereof may be brought into direct contact with the outside air. For

this purpose, as shown in Figs. 1 and 6, the inner air-tube H''' is provided with small openings, preferably formed through nipples 10', projecting into the steam-space, so that the steam issuing from this steam-space between the inner and outer tubes will be projected in jets across the air-tube and will be diffused through the tube to be condensed on the inner walls thereof. A double condensation thus takes place, part taking place in the space between the tubes and part within the air-tubes. The water of condensation from between the tubes is led off by the pipes H^5, while any water from the inner tube will be caught by a trough H^{18}, Fig. 1, to be conducted to any suitable place. Fig. 6 shows that the inner and outer tubes may be straight instead of curved, as in my former application. Figs. 7 and 8 show modifications of this condenser, in which the outer tubes are omitted and the open air-tubes H^9 are connected to the steam head-box extending longitudinally above the car-roof. The air-tubes extend transversely of the car-roof and their outer ends are arranged to discharge into troughs H^{10}. These air-tubes connect with the steam head-box by jet-nipples, through which the steam is conducted into the open tubes to condense against the walls thereof. It will be understood that the size of the openings in the nipples and the condensation-surface area of the tubes are relatively proportioned, so that all the steam passing through the nipple will be condensed before the open end of the tube is reached and there will be no show of steam at the ends of the tubes. There will be no noise of exhaust-steam escaping, as the condenser will act as a muffle. The troughs may connect with the vertical tank Q, presently to be described, or with any other point of discharge.

The condenser may assume the form shown in Fig. 9, in which a circular head-box is combined with a series of radiating air-tubes similar to those described, having the nipple connection between the head-box and the tube.

Fig. 10 shows the detail construction of the nipple-joint, 15 being the nipple proper screwed into the head-box and having a flange 16, fitting against the outer side of the head-box. The air-tube H^9 fits against this flange, and a coupling-sleeve 17 completes the joint by engaging the screw-threads of the nipple and the tube. I have shown a tank Q extending vertically of the cab to receive the water from the overhead condenser and to discharge it into the boiler after receiving a full supply. A pipe Q^3 connects the top of the tank with the condenser, while a second pipe Q^5 leads the water from the tank to the boiler. A pipe Q^2 connects the top of the tank with the steam-space of the boiler or with the steam-dome C, as shown in Fig. 3. These pipes Q^2 Q^3 are connected with the tank through a valve Q^4.

In one position of the valve the water is allowed to enter the tank from the condenser, the steam meanwhile being cut off, while in the other position of the valve the condenser is cut off from communication with the tank and the steam-pipe is opened to the tank, so that the steam-pressure acting at both ends of the tank will be equalized and the water will flow from the tank into the boiler. The pipe Q^3 is provided with a stop and check valve, while the pipe Q^5 has a similar valve Q^6, opening toward the boiler. A type of this combined stop and check valve is shown in Fig. 11. There may be one of these tanks at each end of the car, though I have shown but one, this being sufficient to illustrate this part of my invention.

I have shown the valve Q^4 as adapted for manual operation; but it will be understood that a suitable float and trip mechanism, as generally indicated in dotted lines at Y, may be used to operate the valve automatically when the tank has been filled to a certain point. Such mechanism has not been illustrated, as it may be similar to that described in my former application.

Having now described the condensation system, I will now describe the means for heating the car.

In the present invention I have, as before set forth, located the horizontal dry-steam pipe and smoke-pipe below the car-floor, and by placing a non-conducting jacket S''' over the smoke-pipe, with an air-space between, the heat radiated from the smoke-pipe may be delivered into the car through the registers S^4 in the floor thereof, said registers being arranged centrally of the width of the car. Heater-pipes K are arranged under the seats, and these are connected at one end to the rising exhaust-pipes K^3 by the branches K', and at their other ends the heater-pipes connect with the return drip-tubes H^5 H^6 by the pipes K^4, suitable valves K^2 being provided to control the admission of exhaust-steam into these pipes. The water of condensation from these pipes passes through the branch pipe K^4 into the horizontal drip-pipes H^6, and thence into the condensation-chamber L. I provide also pipes K^6, connecting with the live-steam pipe O, for heating these pipes K by live steam, if desired, valves K^7 being used to control this live-steam supply. A gage-glass N is arranged in the motorman's cab to indicate the height of the water in the boiler, this device being similar in all respects to that described in my former application. The charging-valve R, Fig. 12, is the same as that described in my former application, comprising two parts, one of which carries a check-valve R' and is permanently carried on the motor-boiler, while the other part, which carries the stop-valve R'', is permanently carried by the charging-boiler at the charging-station, where the motor derives its charge of hot water and steam for the trip or trips. The coupling-nut R''' joins the two parts of the charging-valve. Instead of charging the boiler through the valve R on the

boiler it may be charged through the tank Q, and said tank for this purpose has an inlet-pipe Q^7 extending therefrom.

W′ represents a brake-wheel connected with any suitable brake mechanism.

An air-blast pipe I′ may be employed connecting with an air-heater pipe F′ in the transverse condenser F, the continuation F^3 of this pipe leading into the smoke-pipe S″. This air-blast pipe may be connected with the air-pump, if one is used, or with the air-relief pipes of the condensers, a suitable check-valve being employed in this pipe to prevent the entrance of air to the condenser system.

In the operation of the motor the first movement is to connect the charging-valve R to a stationary boiler below the water-line of said boiler preparatory to filling the motor-boiler with water. I prefer that the pressure on the stationary boiler should not be less than two hundred pounds to the square inch. Having made this connection properly, with the valve R″ closed, water from the charging-boiler is admitted to the said valve freely and then that valve is opened gradually, when the water will pass through it and the check-valve R′ to the motor-boiler. When the boiler is filled to the proper height, which is ascertained by trying the water-gages N, the valve R″ is closed and the coupling-nut R‴ disconnected, the check-valve preventing the water in the motor-boiler from escaping, and as the seats of valves R′ and R″ are contiguous there is no space there for water to be held to escape when the connection between the two sections is broken. Having placed a good hard-coal fire in the fire-box A′, the motor is ready to start.

In each vestibule of the car are five operating devices—an adjustable pressure-regulator V, an adjustable cut-off and reversing-wheel W, a brake connection W′, a furnace-damper regulator, (not shown,) and a cylinder-cock-operating lever E^4—and these are so arranged that the motorman can set the maximum pressure he wishes for the work and then adjust the speed of his motor by the point at which the steam is cut off. Having opened the valve O^3 to let the steam to the operating parts and having the pressure-reducing valve set at zero and the reversing mechanism set centrally, the motorman adjusts the pressure-reducing valve to the pressure best suited for the grade and load and increases the point of cut-off until the desired speed is obtained and thereafter regulates this speed by the same method, except where great variation requires that the initial pressure supplied by the pressure-reducing valve should be varied, when that valve is adjusted to meet it. The steam from the boiler A passes through the dry-pipe S′, the dome C, the valve O^3, the pressure-regulating valve V, where the pressure is reduced as desired, to the steam-chests of the cylinders E E via the forward smoke-box and branch pipes. The steam-valves admit it to the cylinders, from whence, after having performed its work, it passes by pipes to tank F, where it drops any condensation that may have taken place and passes through the pipe to the condenser H. Here it is condensed and drains back to tank L, from which it is either pumped to the boiler or allowed to collect. The air which collects from the steam is either passed to the fire-box, the air-blast in the stack, or allowed to escape freely into the ash-pan, check-valves in all these pipes preventing air passing backward in case a vacuum is formed in the condenser.

The check-valves may be weighted to insure a perfect closure before a vacuum is formed.

I claim—

1. In the passenger motor-car the combination of an exhaust-steam-condensing system, which consists of a condenser-tank between and connected with the exhaust-ports and cylinder-cocks of the motor, cylinders under the car-bottom, and a secondary condenser overhead of the car-body and a hot-water tank under the car-body, and pipe connections from said first-mentioned condenser-tank to said condenser overhead, and pipes to connect the delivery of the overhead condenser to the hot-water tank, for condensing the exhaust from the ports as well as that from the cylinder-cocks, substantially as herein set forth.

2. In combination in a motor, the car-body having the cab, the boiler below the body, the dome in the cab, the cylinders below the body, and the steam-feed pipe leading from the dome in the cab down below the body to the cylinders, said feed-pipe extending through the smoke-arch of the boiler and having branches leading to the cylinders, substantially as described.

3. In combination, the car-body, the boiler under the car and extending from end to end, the overhead condenser, the cylinders having connection with the said condenser, the condensation-tank L under the car, and the transverse condenser F under the car and between the cylinders in the condensation system, and an air-relief pipe leading from the top of the said condensers, and from the tank, substantially as described.

4. In combination, the car-body, the boiler below the floor thereof extending from end to end, the overhead condenser, the cylinders having their exhausts connected therewith, the condensation-tank below the car-floor and boiler and centrally of the car-body, the transverse condenser-tank in the condensation system and between the cylinders, and a pipe for conveying water from one or both of said tanks to the ash-pit, substantially as described.

5. In combination in a motor, of the boiler, the cylinders, and the condenser for receiving the exhaust-steam, said condenser comprising air-tubes open at both their ends to

the outside air having steam-inlet openings through which the steam is discharged into the tubes to be condensed against the inner walls thereof and in contact with the air, substantially as described.

6. In combination in a motor, the boiler, the cylinders and the condenser for receiving the exhaust from the cylinders said condenser comprising a series of air-tubes open at their ends to the outer air and head-boxes to which the tubes are secured, said tubes having jet-openings for receiving the steam, substantially as described.

7. In combination with the boiler, and cylinders with their exhausts, the condenser having the inner air-tube open at both ends to draw the air in freely at one end and discharge it with the exhaust at the other, and the outer steam-conveying tube surrounding the inner tube, the head-boxes to which the tubes are connected said inner tube having a steam-inlet opening or openings, to admit steam into the air-space of the inner tube, substantially as described.

8. In combination in a motor-car with the boiler, and cylinders, the condenser connected with the cylinder-exhaust, and comprising a head-box with open-ended tubes extending therefrom said tubes having jet-openings at their ends which connect with the head-boxes so that the steam will be projected longitudinally of the tubes, substantially as described.

9. In combination in a motor-car, the car-body, the boiler below the car-floor, the cylinders, the exhaust-pipe leading therefrom, the overhead condenser connected with the exhaust-pipe, and means for returning the water of condensation from the condenser to the boiler consisting of the tank Q or receiver between the condenser and boiler and in a higher plane than the boiler, the connections from said tank to said condenser and boiler, and means for controlling the flow of water into and from said tank, substantially as described.

10. In combination in a motor, the car-body, the boiler, the cylinders, the overhead condenser, the connection from the cylinder-exhaust to the overhead condenser the tank between the boiler and condenser connected with both the double valve controlling the flow of water and steam to the tank, and the pipe connecting said valve with the steam-space, substantially as described.

11. In combination, the car-body, the boiler, the cylinders, the overhead condenser connected with the cylinder-exhaust, the tank between the condenser and boiler, connections from the tank to the boiler and to the overhead condenser, the steam connection leading to the top of the tank the double valve with automatic means for controlling the same, and the check-valve in the discharge-pipe of the tank opening toward the boiler, substantially as described.

12. In combination, the car-body, an elongated boiler extending below the floor thereof, the cylinders with their pistons and driving connections, the dry-steam pipe extending over the boiler longitudinally of the car between the boiler and car and substantially coextensive with the boiler, and the smoke-pipe surrounding the dry-steam pipe and substantially coextensive with the boiler, said pipes being arranged centrally below the car-floor, substantially as described.

13. In combination, the boiler, the cylinders, the exhaust-pipes leading therefrom, the condenser system connected with the said exhaust-pipes, and including a condenser-chamber, the smoke-passage extending under the car-floor and an air-blast pipe leading thereto, said pipe extending through the condensing-chamber and thence into the smoke-passage, substantially as described.

14. In combination in a steam-motor car, the car-frame, the horizontal boiler, the engine-cylinders, the dry-steam pipe extending over the boiler and having a steam-drum at one end, a smoke-pipe jacketing the dry-steam pipe, and an insulating-jacket for the smoke-pipe, substantially as described.

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

ARTHUR PILLSBURY DODGE.

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HORACE F. HODGES.