No. 657,366. Patented Sept. 4, 1900.

R. H. SMITH.

STEAM CONDENSER AND FEED WATER HEATER.

(Application filed Apr. 13, 1900.)

(No Model.) 4 Sheets—Sheet 1.

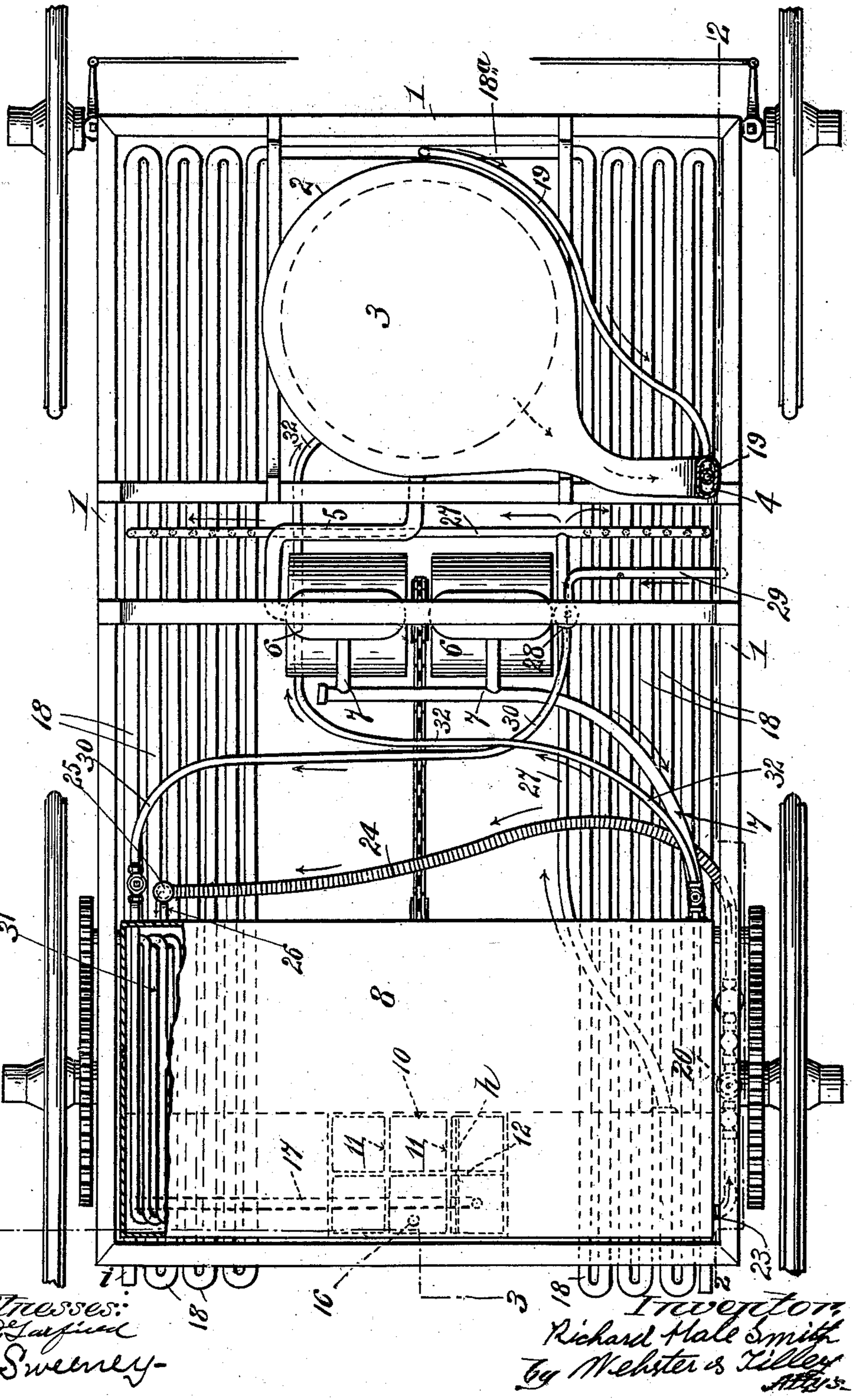

Fig. 1.

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(No Model.) 4 Sheets—Sheet 2.

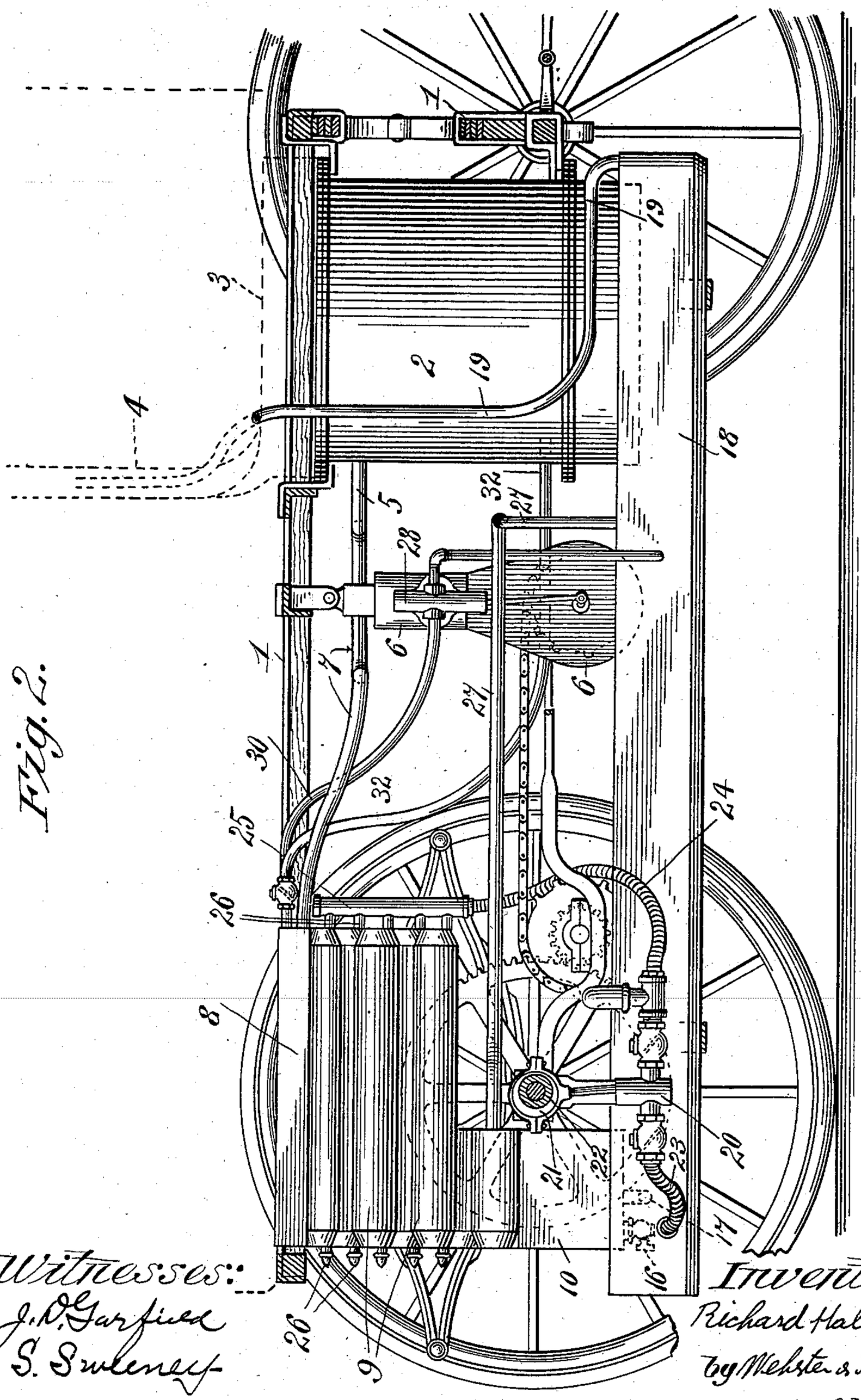

Fig. 2.

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(No Model.) 4 Sheets—Sheet 3.

Fig. 4.

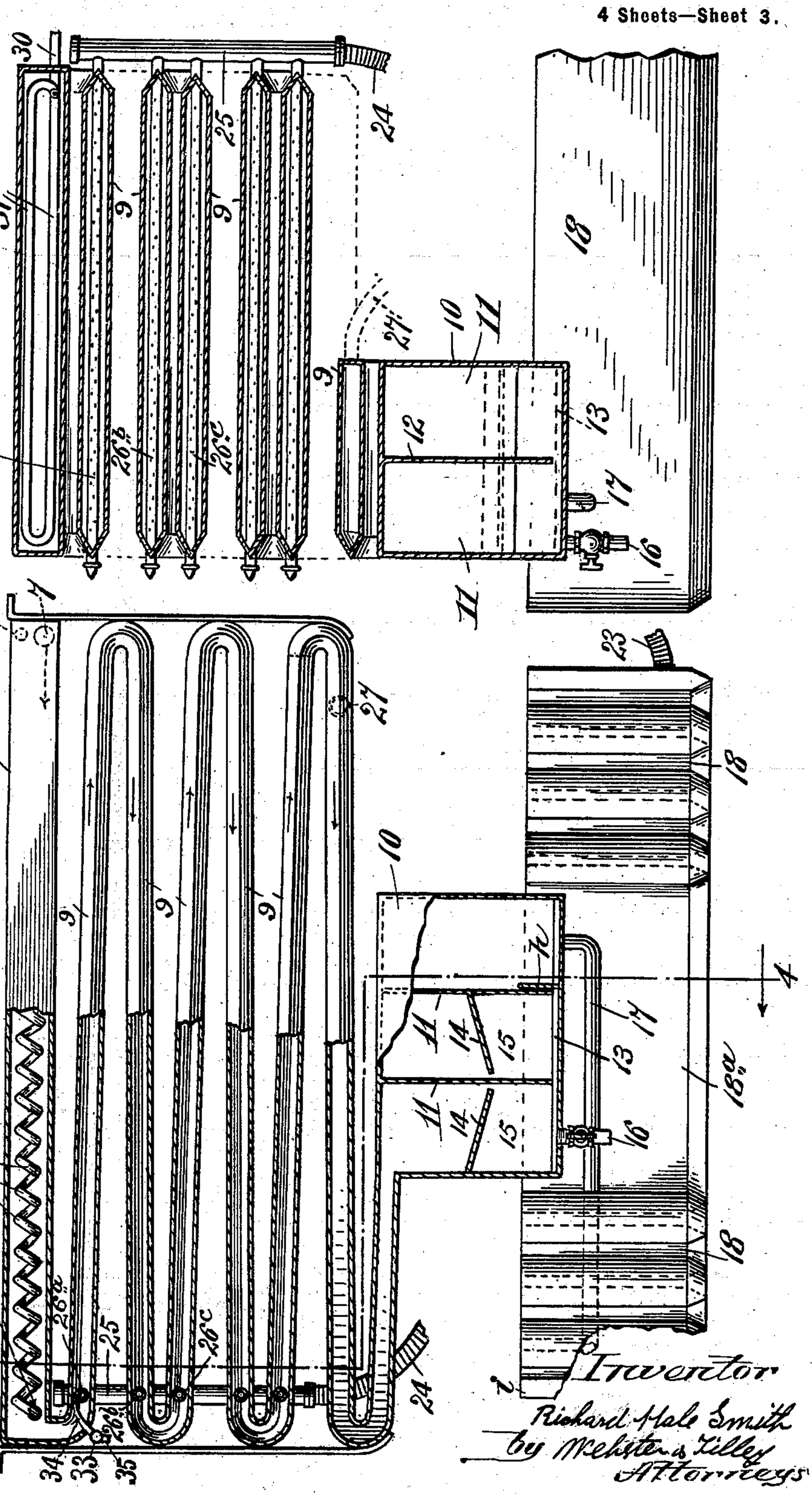

Fig. 3.

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(No Model.) 4 Sheets—Sheet 4.

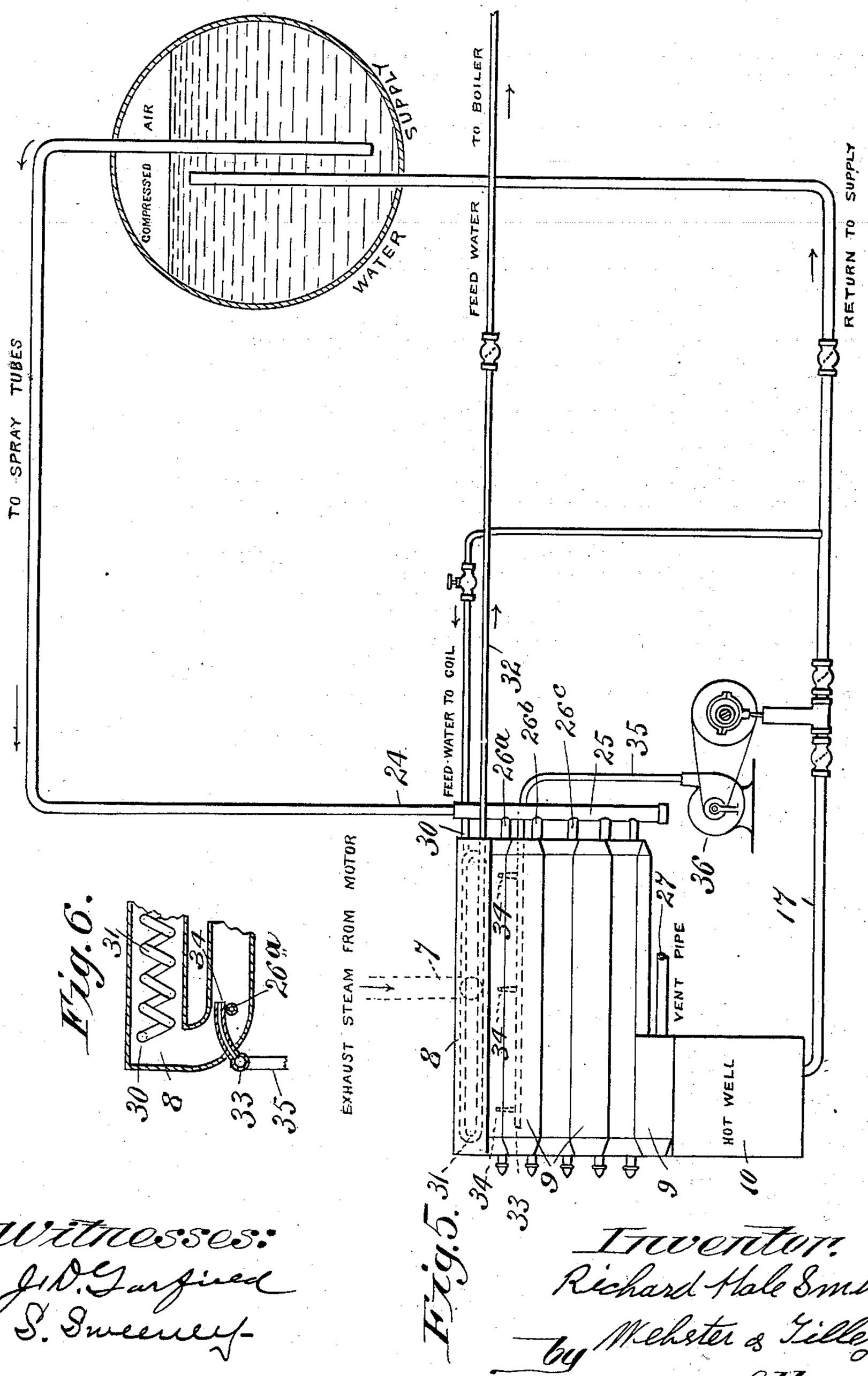

Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE.

RICHARD HALE SMITH, OF SPRINGFIELD, MASSACHUSETTS.

STEAM-CONDENSER AND FEED-WATER HEATER.

SPECIFICATION forming part of Letters Patent No. 657,366, dated September 4, 1900.

Application filed April 13, 1900. Serial No. 12,712. (No model.)

To all whom it may concern:

Be it known that I, RICHARD HALE SMITH, a citizen of the United States of America, residing in Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Steam-Condensers and Feed-Water Heaters Especially Adapted to be Used on Steam-Motor Vehicles, of which the following is a specification, reference being had to the accompanying drawings and the characters of reference marked thereon.

My invention relates to devices adapted for the ready condensation of steam and for feed-water-heating appliances.

The object of my invention is especially to provide a construction which may be employed upon a steam-motor, whereby loss of water may be avoided and the objectionable escape of steam be overcome.

The object of my invention is, further, to provide an improved construction wherein steam may be rapidly condensed by the employment of sprays or jets of air and by the exposure to the air of a large condensing-surface or by either or all in combination.

My object is, further, to provide an improved construction wherein the feed-water for a boiler may be raised to near the boiling temperature, so that no loss will result by reason of water of too low a temperature being fed to the boiler.

My object is, further, to provide a device which shall be compact, of light weight, comparatively inexpensive, efficient, simple, and automatic in its operation.

I accomplish the objects of my invention by the construction herein shown.

In the accompanying drawings, in which like characters of reference indicate like parts, Figure 1 is a plan view of a motor-wagon frame, showing my device mounted thereon. Fig. 2 is a side elevation of the same. Fig. 3 is an elevation, partly in section, upon line 3 3, Fig. 1, of the condenser as seen from the rear of the wagon, showing the hot-well in section and showing the end of the water-supply tank in full lines. Fig. 4 is a view showing the condensing-passages and spray-tubes, taken on dotted line 4 4 of Fig. 3. Fig. 5 is a side elevation of a modification wherein the supply-tank is elevated, and Fig. 6 is an enlarged view in section of one end of the condenser. Figs. 3 and 4 are on a scale slightly greater than Figs. 1, 2, and 5.

Generally, 1 indicates the framework of a vehicle; 2, a boiler; 3, a sheet-metal hood; 4, a smoke-stack; 5, a main steam-pipe; 6 6, engines; 7, an exhaust-pipe; 8, an upper condensing-chamber containing feed-water-heating coil; 9, condensing-compartments containing spray-tubes; 10, a hot-well for receiving the condensation and spray water; 11, partitions extending from front to rear of hot-well; 12, a partition extending across the hot-well at right angles to 11; 13, a narrow space between the bottom of partitions and bottom of hot-well; 14 14, slightly-inclined horizontally-arranged partitions; 15 15, spaces, as shown; 16, a blow-off or emptying-outlet; 17, a pipe connecting hot-well with the water-supply tank; 18, a water-supply tank; 19, an outlet from water-tank to smoke-stack; 20, a spraying-pump; 21, an eccentric; 22, a hub of driving-gear; 23, a flexible pipe connecting with spray stand-pipe; 25, a spray stand-pipe; 26, perforated spray-pipes; 27, a vent-pipe connecting the lower portion of condensing-passage 9 with the water-supply tank 18; 28, a feed-water pump; 29, a suction-pipe; 30, a feed-water pipe or coil; 31, a coil of pipe for heating feed-water arranged in upper section of condensing-chamber 8; 32, a pipe connection between coil 31 and the boiler 3; 33, an air-conduit leading from the conduit 35 to the conduit entering the condenser; 34, an air-conduit for projecting air into the condenser; 35, a conduit leading from air blower or pump to conduit 33, and 36 an air-blower.

In Figs. 1, 2, 3, and 4 I have shown the construction and operation of my device as applied to a motor-wagon or automobile. It will readily be seen, however, that the devices are adapted to very many uses and purposes other than upon a motor-vehicle, and I do not limit myself to such employment. Generally speaking, the steam from the motor passes first into the condenser, from which it emerges in the form of water and passes to a hot-well, where the oil and sediment is extracted from it, and from the hot-well the water passes to the water-supply tank to be used again. From the tank a portion of the

water is conducted through a suitable feed-water-heating coil, which coil is located in the condenser, and from the coil it is carried and fed to the boiler. Water is also taken from the tank and carried to spraying-tubes, from which it is projected in the form of spray to aid in the rapid condensation of the steam in the condenser.

A description of the construction and operation of the condenser, the hot-well, the tank, and the feed-water heater are each hereinafter set forth in detail under their respective designations.

As illustrated herein, I have shown a motor-vehicle frame (indicated by Fig. 1) provided with suitable wheels, gears, steering appliances, and supporting-framework for the various parts, together also with a boiler, motors, driving-chain, &c., and in detail I have shown a condenser which may be described generally as comprising an upper compartment and a series of broad flat conduits connecting one with the other and arranged at a slight incline to facilitate the flow of water therethrough and provided with a series of spray-pipes by which jets or sheets of spray may be projected against and mingled with the steam and also provided with air-tubes arranged to project air into the condenser when found desirable and provided also with a feed-water-heating coil. I have also shown a hot-well comprising a suitable receptacle provided with projections to prevent swashing and turbulence of the water and to separate the oil and sediment from the water in its passage through the hot-well. I show also a water-tank which, as illustrated, comprises a series of two or more narrow compartments separated from each other, except when the water flows from one to the other, and so constructed as to provide a large cooling or radiating surface, the particular details of which devices are as follows:

Condenser.—The condenser comprises an upper chamber 8 and a series of broad but thin flat conduits 9, arranged with their flat surfaces approximately horizontal or dipping downwardly slightly, as shown in Fig. 3. At one end I arrange a stand-pipe having branches projecting into the conduits 9, in which branches (on the parts inside the conduits) are innumerable minute openings, thus forming spray-tubes, and in the upper chamber or compartment 8 I arrange a feed-water-heating coil, which coil is hereinafter described in detail. I also in some cases provide air-inlet tubes 34, adapted to project air into the condenser, preferably at a point adjacent to the first or upper spray-tube 26ª. The stand-pipe is designed to carry the water from a suitable conduit connected with a pump to the spraying-tubes. The exhaust-steam enters the condenser in the upper chamber and there coming in contact with the feed-water coil is partially condensed, because of the fact that the feed-water passing through the feed-water coil maintains the coil at a temperature below the temperature of the exhaust-steam. The steam and products of condensation flow from the chamber 8 through a suitable connection or conduit to the upper one of the thin flat conduits 9, and upon entering the end of the first conduit 9 the steam is met by the spray projected from the first spraying tube or tubes, (the spray being at this point preferably projected in the direction of the flow of steam,) by reason of which spray the steam is rapidly condensed. Thence passing into the second section of the conduit 9 it moves toward the second spraying tube or tubes and is met by showers of spray projected against the flow of the steam, thus further rapidly lowering the temperature and condensing the steam. From this it passes on to the next conduit, where sheets of spray projected in the direction of the flow of the steam and water commingle in the conduit, and so on successively until when it reaches the outlet of the condenser the steam is all condensed and the water flows through a suitable conduit into the hot-well. I find in some cases it is advantageous to force air under a very light pressure into the condenser and prefer that it enter through a suitable conduit at a point adjacent to the upper spray-tube, and I may use the air in conjunction with the water, or either may be used without the other, depending on circumstances, temperature of the outside air, condensation required, &c.

It will be observed that while the condenser, as shown, comprises broad flat tubes arranged at inclines and suitably connected as before described, leaving free air-spaces between the respective adjacent surfaces, so that rapid condensation results by reason of the contact of the outside air with these surfaces, it will be seen that as a modification of the construction of said broad flat condensing-surfaces I may employ a multiplicity of tubes suitably arranged side by side and connected at each end with a suitable conduit, in which latter conduit I may arrange spraying-tubes projecting into said tubes, and thus produce the same result by such modified constructions. It will also be seen that if for any cause it becomes necessary to in part or in whole obstruct the free passage of natural air-currents through the air-passages between the condenser-sections this may be overcome by the employment of deflecting-plates or by induced currents of air being directed through said air-passages.

Hot-well.—The hot-well comprises a suitable tank or receptacle preferably divided into six compartments, as shown in the drawings, by two vertical partitions extending from front to rear and one partition 12 extending through the center at right angles to the partitions 11, thus dividing the well into six compartments. The partitions have contact with the top and sides of the hot-well walls, but do not reach quite to the bottom, leaving a small opening for the water to pass under-

neath. A slight distance from the second partition 11 I arrange a low partition extending from the bottom inwardly and leaving a small space between it and the lower portion of said partition 11. This acts as an oil-trap to prevent the passage of any oil from the motor that may be floating upon the surface of the water of condensation from passing through into the third chamber. A portion of the hot-well is provided with lateral partitions arranged approximately horizontal, preference being given to their being arranged at an incline, as shown in Fig. 3. These partitions operate to prevent turbulence of the water, and thereby facilitate the settling of any sediment therein contained. The inclination of the partitions is to prevent lodgment of sediment upon them. The number of partitions will depend upon the uses in which the apparatus may be employed. The water after passing these several compartments reaches the third compartment, from whence the then-purified water passes in a conduit 17 and enters the cooling and supply tank at a point indicated by the letter *i*, this point being the most remote from the point where the water is taken by the spray and the feed pumps.

Water-tank.—The water-supply tank, as shown, comprises a series of long narrow chambers 18, each having a large amount of radiating-surface with which the air comes in contact, each being connected with the adjacent ones, preferably as shown in Fig. 1. It will of course be readily seen that this tank may be made in one or more continuous coils or convolutions consisting of thin wide walls set very near to each other, forming a narrow continuous tank, with suitable air-passages between the narrow adjacent sections, so that there will be a large area of radiating-surface exposed to the air, and while the natural air-currents are in practice found sufficient to accomplish the desired results deflectors may be employed to direct the air between the tank-sections and induced currents of air may be employed, and the tank may be made in the form of a flat spiral coil or other convenient shape, provided it has the requisite large area of radiating-surface exposed to the air. These water-chambers are of a capacity to collectively hold a sufficient quantity of water for the purposes required—that is to say, as the water is returned to it from the hot-well at a high temperature and must be taken from it at a lower temperature the water-supply reservoir being shaped and adapted to operate as a cooler should be of sufficient capacity to present the required cooling area, and to hold a sufficient quantity of water, so that the whole volume will not pass in too short a period through the spray and feed pumps. It will therefore be readily seen that the exact size or number of chambers required will be dependent to a large extent upon the varying conditions existing with reference to different styles and types of motor and different uses in which the device may be employed. It will be seen that in any event the water entering one of these chambers will pass slowly along and enter the next chamber, and so on continuously until reaching the outlet-orifice, and that during its passage it is subjected to the cooling and condensing influence of a large area exposed to the atmosphere, so that, for illustration, if this condensing device be employed upon a motor-vehicle and the vehicle be moving slowly upon a smooth road without load the trifling amount of steam to be condensed would produce a correspondingly trifling amount of water and the small amount of water requiring to be cooled would be easily cooled, because of the large area of surface of the walls of the chambers of the water-tank exposed to the atmosphere, and that if the vehicle be in rapid motion and as a result a large amount of steam is employed, and hence is required to be condensed and a correspondingly large amount of water to be cooled, then the rapid passage of the air between the walls of the condensing-passages and of the tank tubes or sections would produce a more rapid condensation of the steam and cooling of the contents of the tank.

Inasmuch as there is no pressure in the water-tank it will be seen that I am enabled to employ very thin material in its construction, as a strength only is required necessary to safely carry the quantity of water which may be stored in the tank, so that very much more rapid cooling effect will be produced than if the material were required to be of a thickness sufficient to sustain steam-pressure. I find in practice that sheet-copper of No. 24 gage is sufficiently strong to construct the water-tank in the form described, and as copper is a good conductor of heat I prefer to employ it in the construction of the tank, and to obtain an increase of the radiating surface or area and at the same time obtain more rigid walls I prefer to employ a corrugated or crimped sheet metal, as this gives more rigid walls of light weight of ample strength and largely-increased radiating or cooling area.

As it is found that while a vehicle is in motion an upward current is induced, I utilize this current for the purpose of aiding in the cooling of the water by the arrangement before described, and to facilitate the passage of the air between said sections the sections are so formed in their lower edge as to deflect the air-current between the several sections, thus utilizing the whole current of air for the beneficial results referred to.

Feed-water heater.—The feed-water heater consists of a flat coil, the coil being of a size to rest within the chamber 8 of the condenser. In shape I prefer that the feed-water coil be substantially of the shape of a coil-spring, with the convolutions lying closely adjacent to each other and with the whole flattened, as shown most clearly at 31 in Fig. 4. The feed-water coil, as illustrated at 31 in Figs.

3 and 4, is arranged to allow a large volume of steam to pass through the opening formed between the convolutions and also so arranged in the chamber or upper compartment 8 to permit the steam to flow both above the upper and below the lower series of pipes in said coil, thus bringing the whole area of surface in contact with the steam passing through and around the coil, rapidly bringing the contents of the coil nearer to the temperature of the steam in said upper compartment and at the same time condensing the steam to some extent. The heating-coil extends substantially from end to end of the upper compartment 8, and as the temperature of this compartment is highest at the end portion where the exhaust-steam enters it and as a high temperature of the water just before being fed to the boiler is desirable I feed the water into the coil at the coolest end of the compartment 8 and take it from the coil at the hottest end of the compartment, so that the feed-water leaves the coil at the end of the tank where the exhaust-steam enters it. From this point the water passes through suitable conduits and is fed to the boiler in any convenient manner.

To avoid possibility of steam-pressure in the condenser, which might occur under adverse conditions, and to provide ready relief for it and for the escape of the air, if any, in the condenser, I arrange a vent-conduit 27, extending, preferably, from the upper portion of the lower section of the condensing-passage 9 and reaching thence to a conduit suitably connecting with one or more sections of the water-tank, this arrangement being shown at 27 in Figs. 1 and 2, and by reason of this arrangement if any steam passes through these conduits it is brought in contact with the surface of the water in the tank-sections, where it is rapidly condensed. A conduit 19 extends from the connecting-section 18^a of the water-tank and opens into the smoke-stack 4.

It will be observed that the shape of the several parts of the condensing and cooling mechanism is such as to bring about the free circulation of air throughout substantially their whole extent of surface.

The cooled water employed for the purposes of spraying is taken from the part of the water-tank most remote from the point where the water enters the tank and is forced by a pump (shown in the drawings at 20) through a suitable conduit to a stand-pipe 25, from which stand-pipe it enters the spraying-tubes 26, as before described. These spraying-tubes are arranged laterally in the condenser and the pump being properly proportioned will force a lesser amount of water through the spraying-tubes when but little is required and will force a greater amount through said tubes when a greater amount is required, because of the fact, as will readily be seen, that the pump works faster when the vehicle is in rapid motion and a large amount of steam is being used.

In Fig. 5 I show a modification of the details of one part of my invention whereby the water-supply may be elevated above the steam-condenser and located in any convenient position without effecting any change in the arrangement or action of the condenser, in which the spray-water and the condensed-steam water mingle together and flow into the hot-well, from which it is returned to and mingled with the supply-water, as before, except that instead of flowing into the receptacle by gravity it is raised by a pump, and when arranged as shown in Fig. 5 it is forced into the water-tank against a volume of air, compressing the air to any desired degree and the compressed air employed to force the water from the tank through the spray-tubes.

It will readily be seen that instead of compressing the air in the tank for means to feed the spray-tubes the tubes may be fed either by pumping the water from the tank, or if the elevation be sufficient for the purpose then gravity may be relied upon to give the requisite pressure, and thus to perform the work without the employment of a pump to force the water through the spraying-tubes.

Having therefore described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination of a source of steam-supply, a source of water-supply, and a condenser comprising a series of condensing-tubes, having a large aggregate of radiating-surface arranged to have free and unobstructed access to the surrounding moving currents of air suitably connected with each other, spraying-tubes arranged to project spray into the condensing-tubes, and means to return the comingled spray-water and water of condensation to the source of water-supply, and suitable conduits connecting the steam-supply with the condenser, and the water-supply with the spraying-tubes, substantially as shown.

2. The combination of a steam-condenser comprising a chamber as 8, and a series of wide thin flat condensing-tubes arranged with air-passages therebetween, and a feed-water-heating coil as 31 located in said chamber and suitable conduits connecting said coil with the water-supply and boiler, and said chamber with the exhaust of a steam-motor.

3. A steam-condenser comprising a series of broad flat condensing-tubes adjacent to, but separated from, each other for passage of air therebetween, suitable conduits to conduct the steam into and water away from the condenser, and means to force air into the condenser.

4. The combination of suitable conduits, a steam-condenser comprising broad flat condensing-tubes, with air-passages therebetween, conduits for projecting spray and

water into the condenser-tubes, and means to force water and air into said conduits respectively substantially as shown.

5. The combination of a suitable frame, wheels suitably mounted thereon, a water-supply tank comprising a multiplicity of narrow sections, suitably connected and arranged near each other but with air-spaces between their broad flat sides, the same being suitably supported on said frame, a steam-boiler, a motor, suitable connection between the motor and traction wheels, a steam-condenser comprising an upper chamber to receive the exhaust-steam and a series of thin flat steam-conduits alternating with a series of open air-passages arranged below said chamber, the upper conduit being connected with said chamber, and the others connected with each other to conduct the steam and water in a tortuous course to a hot-well located below the level of the condenser, means to convey the water from the hot-well to the water-tank and means to force water from the tank into the boiler and from the tank through the spray-tubes into the condenser substantially as shown.

6. The combination of a source of steam-supply, a water-supply tank, a steam-condenser, and a feed-water heater, the condenser consisting of a series of broad thin condensing-tubes alternating with a series of open air-passages, a chamber as 8, a feed-water coil arranged in the chamber 8, a series of spraying-tubes arranged to project the spray into the condenser-tubes, means to force water from the water-tank through the spraying-tubes, and means to force water from the water-tank through the heating-coil to the boiler, substantially as shown.

7. The combination of a source of steam-supply, a source of water-supply, and a condenser comprising a series of condensing-tubes, having a large aggregate of radiating-surface arranged to have free and unobstructed access to the surrounding moving currents of air, suitably connected with each other, spraying-tubes arranged to project spray into the condensing-tubes, and arranged to project the spray in the direction of the flow of steam while passing through a portion of the condenser and to project spray against the flow of the steam during its passage through another portion of the condenser, means to return the comingled spray-water and water of condensation to the source of water-supply, and suitable conduits connecting the steam-supply with the condenser, and the water-supply with the spraying-tubes, substantially as shown.

8. The combination of a steam boiler or motor, a conduit for exhaust-steam, a storage water-supply, and a steam-condenser comprising one or more flattened tubes or conduits of large area located adjacent to but having the convolutions separated from each other by open passages for air and provided with suitable conduits connecting the adjacent tubes with each other, whereby the steam and products of condensation flow in a tortuous course and are exposed to a large area of radiating-surface and means to return the water of condensation to the water-supply and to the steam-boiler, substantially as shown.

9. The combination of a source of steam-supply, suitable conduits, a source of water-supply, a condenser comprising one or more flattened condensing tubes or conduits of large area located adjacent to but with their convolutions separated from each other by open air-passages and provided with suitable conduits connecting the adjacent tubes with each other, whereby the steam and products of condensation flow in a tortuous course exposed to a large area of radiating-surface, spraying-tubes arranged in the condensing-tubes and means to return the comingled spray-water and the products of condensation to the water-supply, substantially as shown.

10. The combination of a steam-boiler, a steam-motor, a steam-condenser, suitable connections, and a water-supply tank consisting of two or more long narrow receptacles located adjacent to and substantially parallel with each other and with a space between them for the circulation of air for the purpose of cooling the water, substantially as shown.

11. In combination with a condenser a water-supply tank, comprising two or more narrow receptacles arranged substantially parallel and adjacent to each other, and having their lower edges V-shaped, substantially as shown.

12. The combination of a water cooling and supply tank consisting of two or more long narrow flat tubes connected in series and having their flat sides exposed to air-currents, a steam-generating apparatus and suitable conduits connected with the opposite ends of the said series of tubes, whereby the water is exposed to a large radiating-surface between its entry and discharge from the cooling and supply tank, substantially as described.

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