(No Model.) 5 Sheets—Sheet 1.

J. A. BARHYDT.

STEAM MOTOR FOR CARS.

No. 528,067. Patented Oct. 23, 1894.

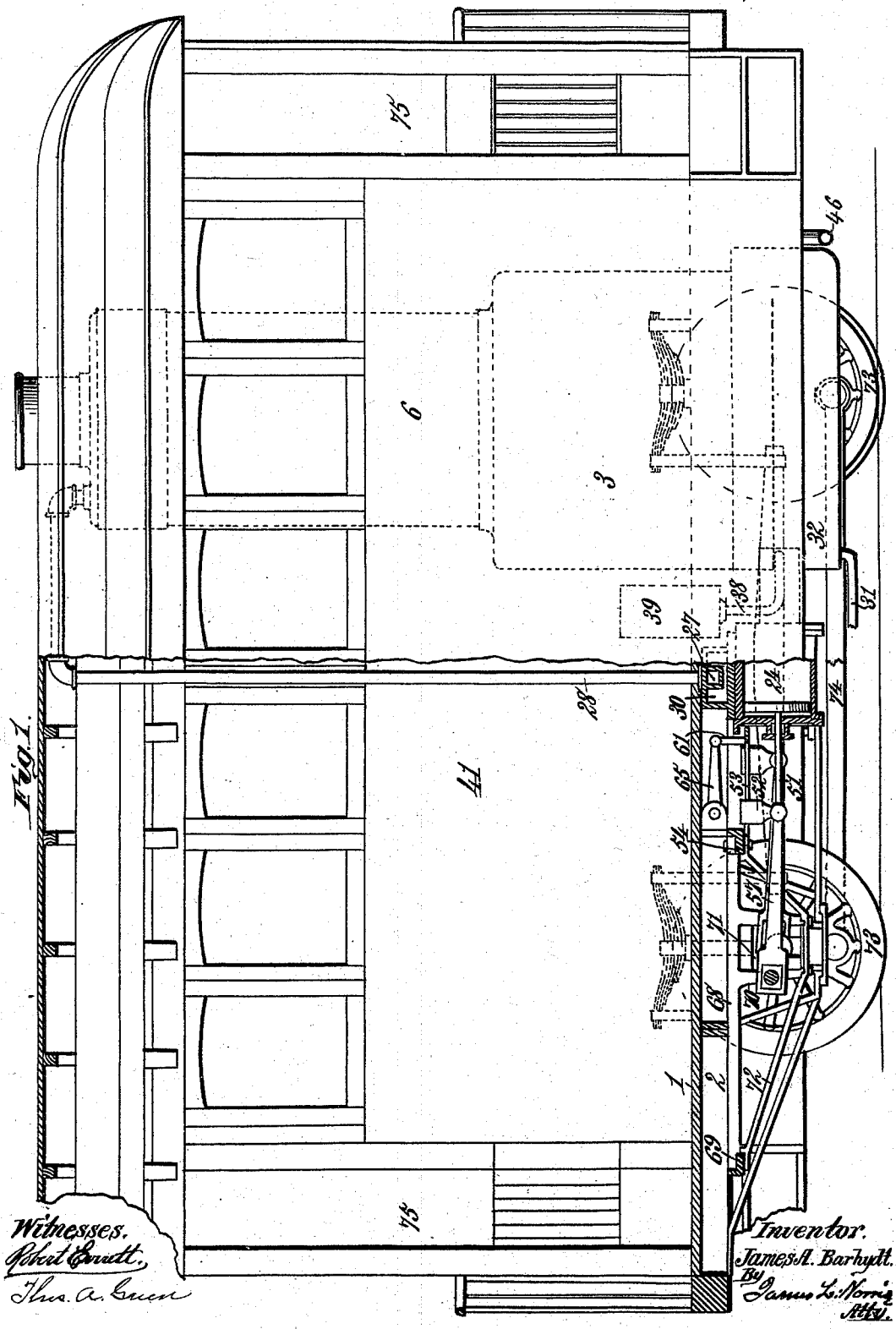


Fig. 1.

Witnesses.
Robert Burtt.
Thos. A. Green

Inventor.
James A. Barhydt.
By James L. Norris
Atty.

(No Model.)

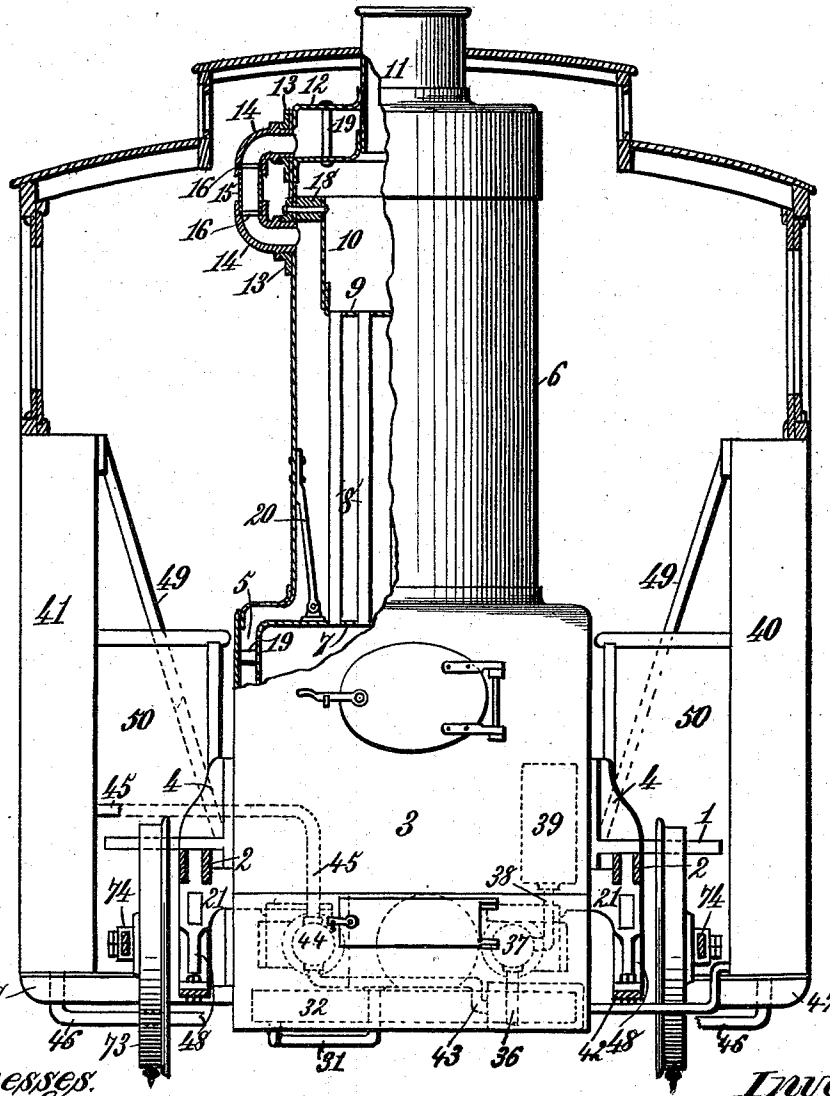
5 Sheets—Sheet 2.

J. A. BARHYDT.

STEAM MOTOR FOR CARS.

No. 528,067. Patented Oct. 23, 1894.

Fig. 2.



Witnesses.
Albert Gwett.
Thos. A. Green

Inventor.
James A. Barhydt.
By James L. Norris.
Atty.

(No Model.) 5 Sheets—Sheet 3.

J. A. BARHYDT.

STEAM MOTOR FOR CARS.

No. 528,067. Patented Oct. 23, 1894.

Fig. 3.

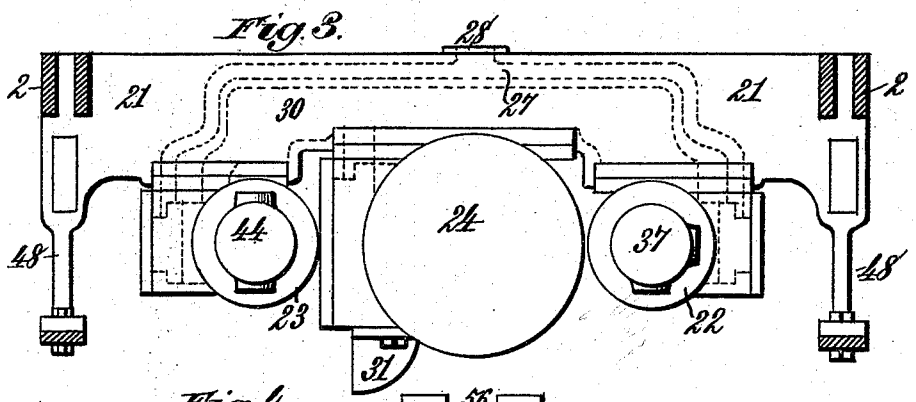
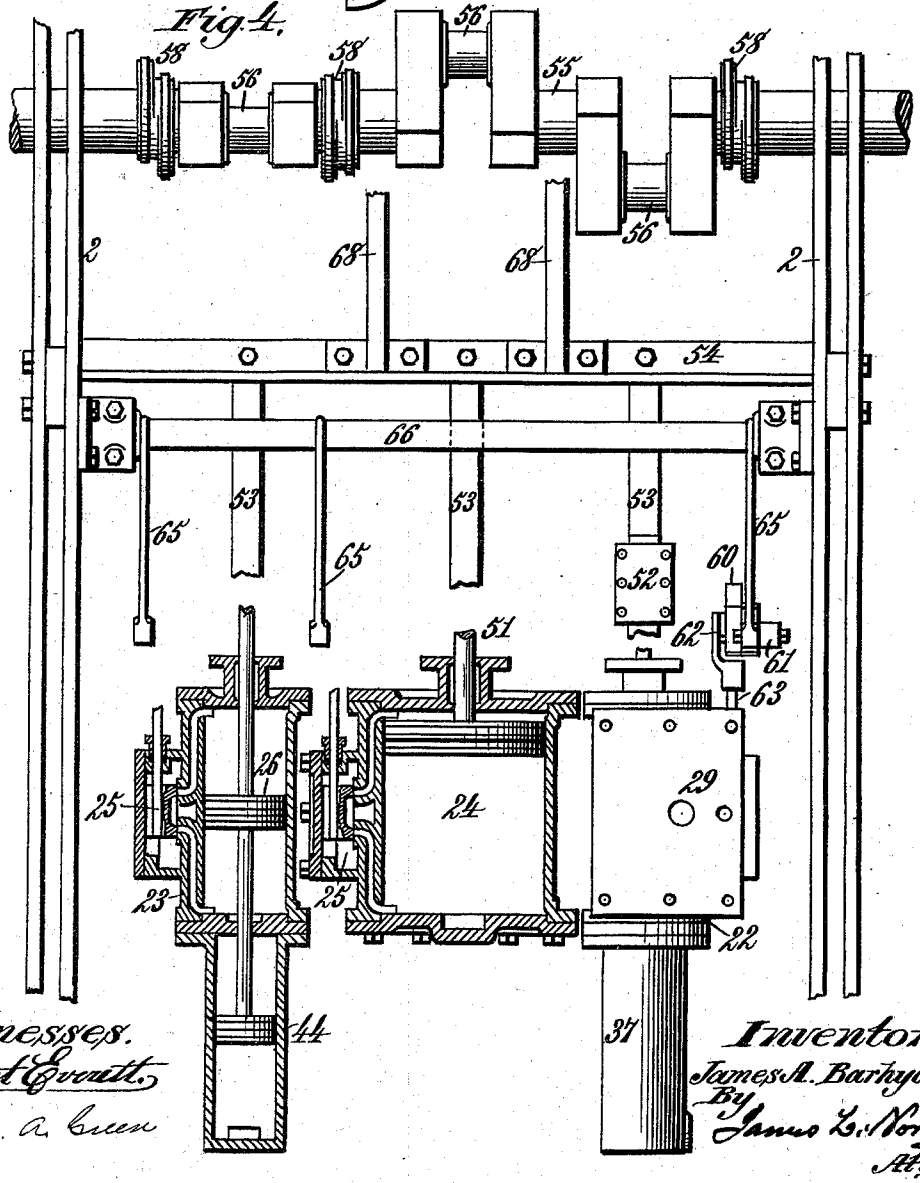


Fig. 4.



Witnesses.
Robert Everett.
Thos. A. Green

Inventor.
James A. Barhydt.
By James L. Norris.
Atty.

(No Model.) 5 Sheets—Sheet 4.

J. A. BARHYDT.

STEAM MOTOR FOR CARS.

No. 528,067. Patented Oct. 23, 1894.

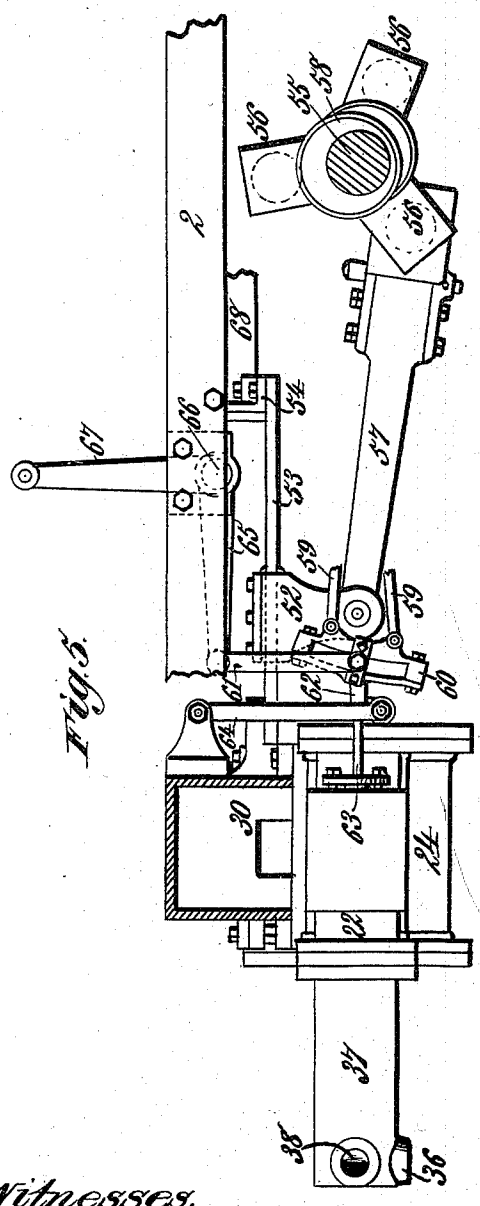


Fig. 5.

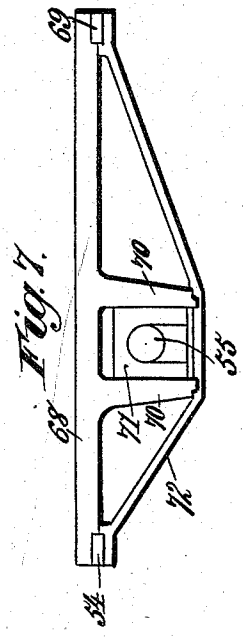


Fig. 7.

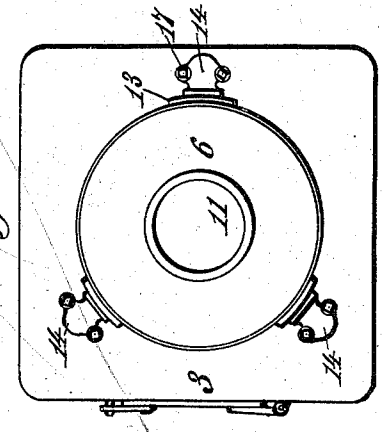


Fig. 6.

Witnesses.
Robt. Ewalt.
Thos. A. Brown

Inventor
James A. Barhydt.
By James L. Norris.
Atty.

(No Model.) 5 Sheets—Sheet 5.

J. A. BARHYDT.

STEAM MOTOR FOR CARS.

No. 528,067. Patented Oct. 23, 1894.

Fig. 8.

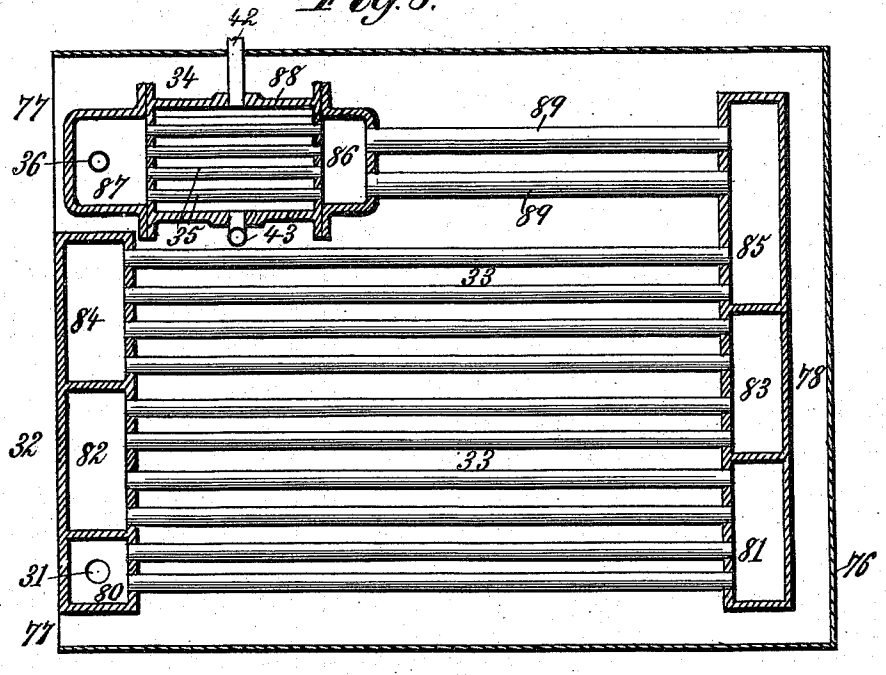


Fig. 9.

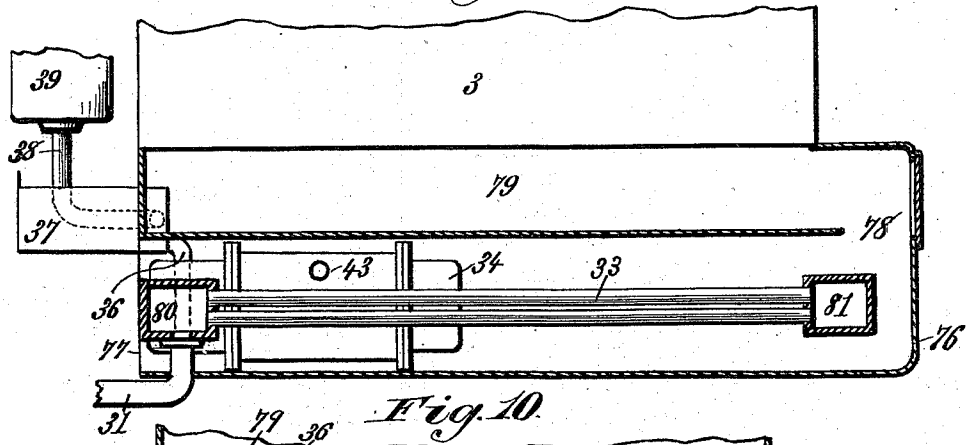
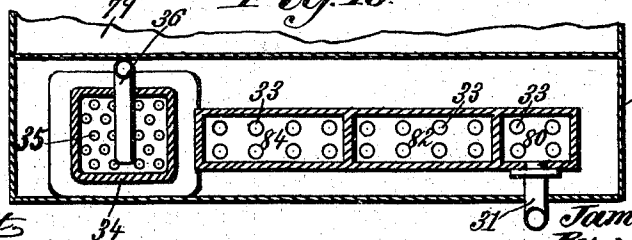


Fig. 10.



Witnesses.
Robert Everett
Thos. A. Green

Inventor.
James A. Barhydt.
By James L. Norris
Atty.

UNITED STATES PATENT OFFICE.

JAMES A. BARHYDT, OF LIMA, OHIO, ASSIGNOR TO GEORGE W. DISMAN, OF SAME PLACE.

STEAM-MOTOR FOR CARS.

SPECIFICATION forming part of Letters Patent No. 528,067, dated October 23, 1894.

Application filed July 10, 1894. Serial No 517,147. (No model.)

To all whom it may concern:

Be it known that I, JAMES A. BARHYDT, a citizen of the United States, residing at Lima, in the county of Allen and State of Ohio, have invented new and useful Improvements in Steam-Motors for Cars, of which the following is a specification.

This invention relates to an improved steam car motor, or locomotive for cars or traction dummies to be used on either elevated or surface railways, and has for its objects to provide a practically smokeless and noiseless steam motor, the exhaust steam being wholly condensed and utilized in the boiler feed, without opportunity of escaping to the atmosphere; to provide a compact arrangement of the engine, the boiler and the feed-water and condensing apparatus, and generally to improve the arrangement of parts in a compound engine comprising two double acting high pressure cylinders and a double acting low pressure cylinder connected with a triple crank-shaft or axle and provided with suitable valve gear and reversing mechanism.

To these ends and for other purposes hereinafter set forth my invention consists in the features of construction and novel combination of parts in a steam car motor as hereinafter more fully described and claimed.

In the annexed drawings illustrating the invention—Figure 1 is a part sectional side elevation of a street car provided with my improved motor. Fig. 2 is a sectional end elevation of the same. Fig. 3 is a part sectional end elevation of the compound engine and its steam passages. Fig. 4 is a part sectional plan of the engine, the cranked shaft or axle and their connections. Fig. 5 is a side elevation of the same, showing the link motion and reversing mechanism. Fig. 6 is a plan of the upright cylindrical boiler with its rectangular base and fire box. Fig. 7 is a detail view illustrating means for bracing the cranked shaft or axle against the thrust of the engine. Fig. 8 is an enlarged horizontal section of a duplex condensing apparatus. Fig. 9 shows on an enlarged scale parts of the fire-box of the boiler, the hot well and the air-pump in elevation and the condensing apparatus in vertical longitudinal section. Fig. 10 is an enlarged vertical transverse section of the duplex condenser.

Referring to Figs. 1 and 2, the numeral 1 designates the car platform or floor supported on sills or frame pieces 2 carried by the car-axle trucks which may be of any suitable or well known construction.

In one end of the car, as shown in Fig. 1, is placed an upright steam boiler having a square fire box 3, Fig. 6, partly extended below the car floor and rigidly supported by brackets 4, Fig. 2, carried on the frame pieces 2 of the car floor or platform. The form and capacity of the square fire box 3 are such as to afford a large grate area and an extensive heating surface for the boiler which comprises a rectangular base or water jacket 5 surrounding the square fire box and a cylindrical boiler shell 6 riveted or otherwise securely fastened to the top of the water jacket 5 and communicating therewith.

In the fire box 3 is a large water grate, not shown, that may be of any suitable construction. The top of the fire box is formed by a substantially square crown sheet 7 perforated at close intervals for connection with the lower ends of numerous vertically arranged flues 8 the upper ends of which are similarly connected with the bottom or tube sheet 9 of a combustion chamber 10 that is suspended in the upper part of the upright boiler cylinder. The top of the cylindrical boiler shell 6 is provided with a stack 11 located centrally above and communicating with the open top of the elevated combustion chamber. Surrounding the stack 11 is a superheating steam dome 12 that is separate from the body of the cylindrical boiler shell but securely connected to its top. At suitable intervals are placed steel plates or flanges 13 riveted to the side of the dome 12 and to the body of the boiler. Through these plates 13 and through the sides of the steam dome 12 and upper portion of the cylindrical boiler shell is formed a number of perforations into which are threaded the inner ends of reversibly arranged cast iron elbows 14 having their outer ends turned toward each other and at a slight distance apart. The outer ends of each pair of elbows 14 are counter bored to receive a short loosely fitting wrought iron pipe 15 with copper rings 16 placed between the ends of said pipe and the shoulders in the elbows. On the opposite sides of the elbows 14 are

perforated lugs to receive vertical screw bolts 17 provided with nuts by which the elbows and their connecting pipes are securely clamped together, thus forming a series of steam passages from the body of the boiler to the superheating steam dome.

The water line or level in the cylindrical boiler shell 6 is above the upper ends of the flues 8 and bottom of the elevated combustion chamber 10 into which all the hot gases from the fire-box are received. The location of this open top combustion chamber 10 at a point but slightly below the superheating steam dome 12 and the arrangement of the stack 11 so that it will pierce or be surrounded by said dome, will at all times keep the steam hot and dry. The manner of connecting the steam dome to the boiler cylinder, by clamping bolts on the elbows, provides perfect steam tight joints between the dome and boiler and renders the dome easily detachable to afford ready access to the boiler for repairing its flues. By first removing the steam dome and boiler top the combustion chamber 10 may also be removed, if desired. Between the top of the combustion chamber and upper portion of the boiler cylinder is an annular ledge or partition 18 to which the combustion chamber is joined, and which serves as a means for suspending the combustion chamber and separating its open top from the body of the boiler. Any required number of stay bolts 19 may be arranged in the steam dome 12 and between the water jacket shell 5 and fire box 3, or elsewhere, to strengthen and steady the boiler. To further brace the boiler it may be advisable to arrange in its interior a number of stays 20 to connect the shell 6 with the crown sheet 7 of the fire box.

Beneath the floor of the car and adjacent to the lower end of the boiler is a transversely arranged cast iron bracket 21 having its ends connected with and braced by the frame pieces 2, as shown in Figs. 2 and 3. This bracket 21 is connected with and forms part of the support for an engine comprising three horizontally arranged cylinders 22, 23, and 24 that are located between the side bars or frame pieces 2 of the car frame. The two outer cylinders 22 and 23 are for high pressure and the central cylinder 24 is for low pressure. Each of these cylinders is provided on one side with the usual slide valve 25 and connecting passages for alternately supplying steam to the opposite sides of a double acting piston 26 placed in the cylinder. In the bracket 21 is a steam-way 27 that receives live steam through a pipe 28, Figs. 1 and 3, from the superheating steam dome of the boiler. The opposite ends of this steam-way 27 communicate, as at 29, Fig. 4, with the valves of the two high pressure cylinders. The exhaust steam from the high pressure cylinders 22 and 23 enters a receiver 30, Fig. 3, formed in the bracket 21 through which it is conducted to the valve of the low pressure cylinder. An exhaust pipe 31, Figs. 1 and 2, leads from the valve-box of the low pressure cylinder 24 to one end of a manifold or air-surface condenser 32 arranged to supply superheated air to the fire-box of the boiler and forming part of a condensing apparatus through which the condensed water of the exhaust steam is utilized for the boiler feed; thus obviating the noise and unsightliness resulting from the escape of visible vapor into the atmosphere.

The incasing chamber of the air-surface condenser 32, Figs. 1, 2, 8, 9, and 10, is arranged transversely below the car floor, adjacent to the engine, and is traversed by a body of steam pipes 33 open at one end to the exhaust cavity of the low pressure cylinder 24, and discharging into the main condenser 34, as hereinafter more fully explained. In passing around the pipes 33 the air is raised to a high temperature by proximity to the exhaust steam and thus provides the fire-box with a superheated natural draft that results in a large saving of fuel. At the same time the cold air passing around these pipes reduces the temperature of the exhaust steam before it enters the main condenser 34 with which one end of the manifold air superheater, or air-surface condenser 32, communicates.

The main condenser 34 may be of any suitable construction that will permit the circulation of water around a series of steam pipes 35 receiving exhaust steam from the air surface condenser or air superheater; the said pipes 35 being arranged to communicate on one hand with the manifold 32 and on the other hand with the suction pipe 36 of an air pump 37 that discharges through a pipe 38 into a hot well 39 from which the heated condense-water may be taken by a feed pump, not shown, or other device, and utilized in the boiler feed.

Water tanks 40 and 41 are carried on opposite sides of the car, as shown in Fig. 2. The tank 40 communicates directly with the condenser 34 through a pipe 42 for supplying water to surround the exhaust steam pipes 35; a pipe 43 being arranged to lead from the condenser to a circulating pump 44 that communicates through a pipe 45 with the tank 41 on the opposite side of the car. The tanks 40 and 41 also communicate with each other through a pipe 46 at any convenient point, and thus by means of the pump 44 a constant circulation of water is maintained through the main condenser 34 and from one tank to the other.

The pumps 37 and 44 may each be coupled to one of the high pressure engine cylinders with the same piston-rod running through an engine cylinder and a pump cylinder.

The opposite water tanks 40 and 41 may be supported by cross beams 47 forming part of the supports for the engine and condensing apparatus and carried by hangers 48 depending from the bracket 21 or other support.

Suitable stays 49 may be provided to brace and steady the tanks. The water tanks 40 and 41 are of flat rectangular form, set upright, and may be extended throughout nearly the entire length of the car, thus furnishing an ample supply of water for the boiler feed and for use in the condenser. Fuel bunkers 50 may be placed along the lower inner sides of the tanks and can be extended beneath the car seats.

The piston rods 51 of the engine cylinders are connected with cross-heads or slide blocks 52, Figs. 1, 4, and 5, suspended from a series of parallel longitudinally arranged guides 53 that may be supported at one end by the bracket 21 and at the other end by a yoke or cross-bar 54 of the car frame.

One of the car axles is in the form of a triple crank-shaft 55 having its cranks set at thirds, and each crank-pin 56 affords a bearing for one end of a connecting rod 57 the other end of which is pivotally attached to one of the cross-head slide blocks 52, as shown in Figs. 1 and 5.

The cranked shaft or axle 55 is provided with three pairs or sets of eccentrics 58 each of which connects by a pair of eccentric rods 59, Fig. 5, with a link 60 suspended from a hanger 61 and carrying a valve-stem cross-head 62 with which one of the valve stems 63 is connected. The valve stem cross heads 62 are suspended from hangers 64 pivoted to and depending from the cylinder bracket or frame. The several hangers 61 of the link motion are pivotally suspended from arms 65 rigidly attached to a tumbling shaft 66 having an operating arm or lever 67 forming part of the reversing gear. By means of suitable rods or levers extended from the arm 67 in opposite directions the motorman can control the engine from a vestibule or platform at either end of the car and reverse its direction of movement as required.

For the purpose of bracing the cranked shaft or axle 55 so as to avoid any tendency to its springing under the thrust of the moving parts of the engine, two center sections or bars 68 of the car frame are extended across the said shaft or axle on each side of its center crank arms. These bars 68 are supported at their ends by cross bars 54 and 69 of the car frame. The under side of each longitudinally arranged bar 68 is provided with jaws or brackets 70 that straddle the cranked shaft or axle and support a bearing box 71 through which the shaft or axle 55 is passed. A bar or strap 72 is extended between the cross bars 54 and 69 and under the brackets 70 of each bar 68 and is securely bolted to the said cross bars and brackets. The box 71 carries no weight of the motor car from the fact of its having a free movement up and down between the jaws or brackets 70, and yet it will at all times withstand the front and back thrust of the engine at the crank shaft center.

The wheels 73 of the forward and rear axles may be connected by the side rods 74 as usual.

By reference to Figs. 1 and 2 it will be observed that the water tanks 40, 41, and outer sides of the car body are extended down a considerable distance below the car floor, on each side, thus concealing the engine from view. The car trucks are preferably provided with the usual springs and with an equalizing connection to obviate shocks and strains from any unevenness of the track or from contact with stones or like obstructions. The usual safety valves and blow-off cocks are provided wherever needed, in connection with the boiler, engine, condensers, &c.

It is preferable to provide at each end of the car, a vestibule or compartment 75 for the motor-man, from which he can have an unobstructed view of the track and street when proceeding in either direction. The exhaust steam being wholly condensed and conducted to the boiler feed it is obvious that the annoyance resulting from escape of steam into the street will be entirely obviated, thus rendering the motor practically noiseless. The escape of smoke may be avoided by employing a smokeless fuel or by conducting the smoke into a condenser or to a smoke consumer.

In Figs. 8, 9, and 10, I have illustrated a preferred form of condensing apparatus in which the air surface condenser 32 and the main condenser 34 are inclosed in the casing 76, one end of which is open at 77 to the atmosphere while the other end communicates through a passage 78 with the ash pan 79 of the boiler fire box. This casing 76 is arranged beneath and, preferably, extends at one end beyond the ash pan or compartment 79, as shown in Fig. 9. The air surface condenser 32 consists of a number of exhaust steam pipes 33 arranged horizontally and parallel with each other in several separate but communicating groups, connected at their opposite ends with headers 80, 81, 82, 83, 84, and 85, Fig. 8, so arranged that the exhaust steam entering the header 80 through the pipe 31 (leading from the exhaust cavity of the low pressure cylinder 24), will traverse the several pipes and headers alternately in opposite directions. The condenser 34 comprises two end chambers 86 and 87, Fig. 8, connected by a body of pipes 35 surrounded by a water jacket 88 which communicates on one hand, through the pipe 42, with the water tank 40 Fig. 2, and on the other hand, through the pipe 43, with the pump 44 which in turn communicates, through pipe 45, with the water tank 41 on the other side of the car; and said tanks being also connected with each other through a pipe 46, Fig. 2, it is obvious that when the motor is in operation there will be a circulation of water through the condenser water jacket 88 and around the steam pipes 35 from one water tank to the other. The header 85 of the air surface condenser 32 connects by pipes 89 with the end chamber 86 of the condenser 34 and the end chamber 87 of said condenser 34 receives the suction pipe

36 of the air pump 37 which communicates with the hot well 39, as before described. The condenser casing 76 being open to the atmosphere at the end 77 will receive cold air that will circulate around the several exhaust steam pipes and header of the air surface condenser. Thus, while the exhaust steam in the pipes and headers condenses and flows on to the condenser 34, the air in contact with and circulating around said pipes and headers becomes heated and passes upward through the opening 78 to the ash pan 79 of the furnace fire-box and thence to the grate, thereby supplying a superheated natural draft for the furnace. In the pipes 35 of the condenser 34 the condensation of the exhaust steam is completed by the circulation of cold water around said pipes. From the chamber 87 the heated water from the condenser pipes 35 is drawn by the pump 37 and discharged into the hot well 39 to supply the boiler feed.

The duplex condensers 32, 34, in which the air supply for the boiler fire-box is made to assist in the condensation of the exhaust steam from the engine, require less water than would be otherwise necessary and at the same time effect a thorough and complete disposition of the exhaust steam without permitting any of it to escape into the atmosphere.

This motor is not only adapted for street railway traffic and elevated roads, but may be used for dummy, traction and portable engines.

What I claim as my invention is—

1. In a steam motor, the combination with the engine and boiler, of a condensing apparatus located beneath the fire box of the boiler and comprising a casing having one end open to the atmosphere and its other end communicating with the fire box, and an inclosed body of pipes and headers for conducting exhaust steam alternately in opposite directions and around which the air in said casing circulates and passes to the fire box to supply a superheated natural draft and assist in the condensation of the exhaust steam, substantially as described.

2. In a steam motor, the combination with the engine and a vertical boiler having an enlarged square fire box extended below the car floor, of a condensing apparatus arranged beneath the fire box of the boiler and comprising a body of exhaust steam pipes and headers and an inclosing casing open at one end to the atmosphere and communicating with the fire box to permit the passage of air around the condensing passages and supply a superheated natural draft, substantially as described.

3. In a steam motor, the combination of the compound engine comprising the two double acting high pressure cylinders and the double acting low pressure cylinder, the bracket 21 supporting said cylinders and provided with the passage 27 for conducting live steam to the high pressure cylinders and the receiver or passage 30 for conducting exhaust steam from the high pressure cylinders to the low pressure cylinder, the vertical boiler having a superheating steam dome connected with the steam passage 27, and a condenser communicating with the exhaust pipe 31 of the low pressure cylinder, substantially as described.

4. In a steam motor, the combination of the boiler, the compound engine comprising two high pressure cylinders and the low pressure cylinder, the manifold or air surface condenser communicating with the exhaust pipe of the low pressure cylinder and having exhaust pipes leading from the low pressure cylinder to a main condenser, two water tanks having a connecting pipe, a main condenser connected with the manifold or air surface condenser and with one of the water tanks, a circulating pump intermediate the main condenser and the other tank and communicating therewith, and an air pump intermediate the main condenser and hot well, substantially as described.

5. In a steam motor, the combination with a low pressure cylinder and two high pressure cylinders, of a manifold or air surface condenser communicating with the exhaust pipe of the low pressure cylinder, a main condenser communicating with the air surface condenser and having separate passages for water and exhaust steam, two oppositely arranged water tanks having a connecting pipe, one of said tanks being in direct communication with the main condenser, a circulating pump connected with and operated from one of the high pressure cylinders, said circulating pump being connected with the other tank and with the main condenser, and an air pump intermediate the main condenser and hot well and connected with and operated from the other high pressure cylinder, substantially as described.

6. In a steam motor, the combination of the vertical boiler having its fire box extended below the car floor, the superheating steam dome at the top of the boiler and surrounding the boiler stack, the two high pressure cylinders and the low pressure cylinder, the steam bracket supporting said cylinders and provided with the steam ways 27 and 30, the pipe connecting the steam dome with the live steam passage 27 in said bracket, a duplex condenser comprising a main condenser having passages for water and exhaust steam and an air surface condenser having passages for air and exhaust steam, whereby the air is superheated and supplied to the boiler fire box, water tanks, a circulating pump intermediate one of said tanks and the main condenser, and an air pump intermediate the other tank and the main condenser, substantially as described.

7. In a steam motor, the combination of the triple cranked shaft or axle, the compound engine supported horizontally below the car floor and comprising the two double acting

high pressure cylinders and the double acting low pressure cylinder, a car frame comprising a steam bracket supporting the engine cylinders and provided with steam passages, parallel guides for the slide block cross heads of the cylinder pistons and connecting rods, and the link motion valve gear and reversing mechanism, substantially as described.

In testimony whereof I have hereunto set my hand and affixed my seal in presence of two subscribing witnesses.

JAMES A. BARHYDT. [L. S.]

Witnesses:
PAUL H. AGERTER,
HENRY BERGLUND.