(No Model.) 3 Sheets—Sheet 1.

G. E. WHITNEY.

ENGINE.

No. 601,218. Patented Mar. 22, 1898.

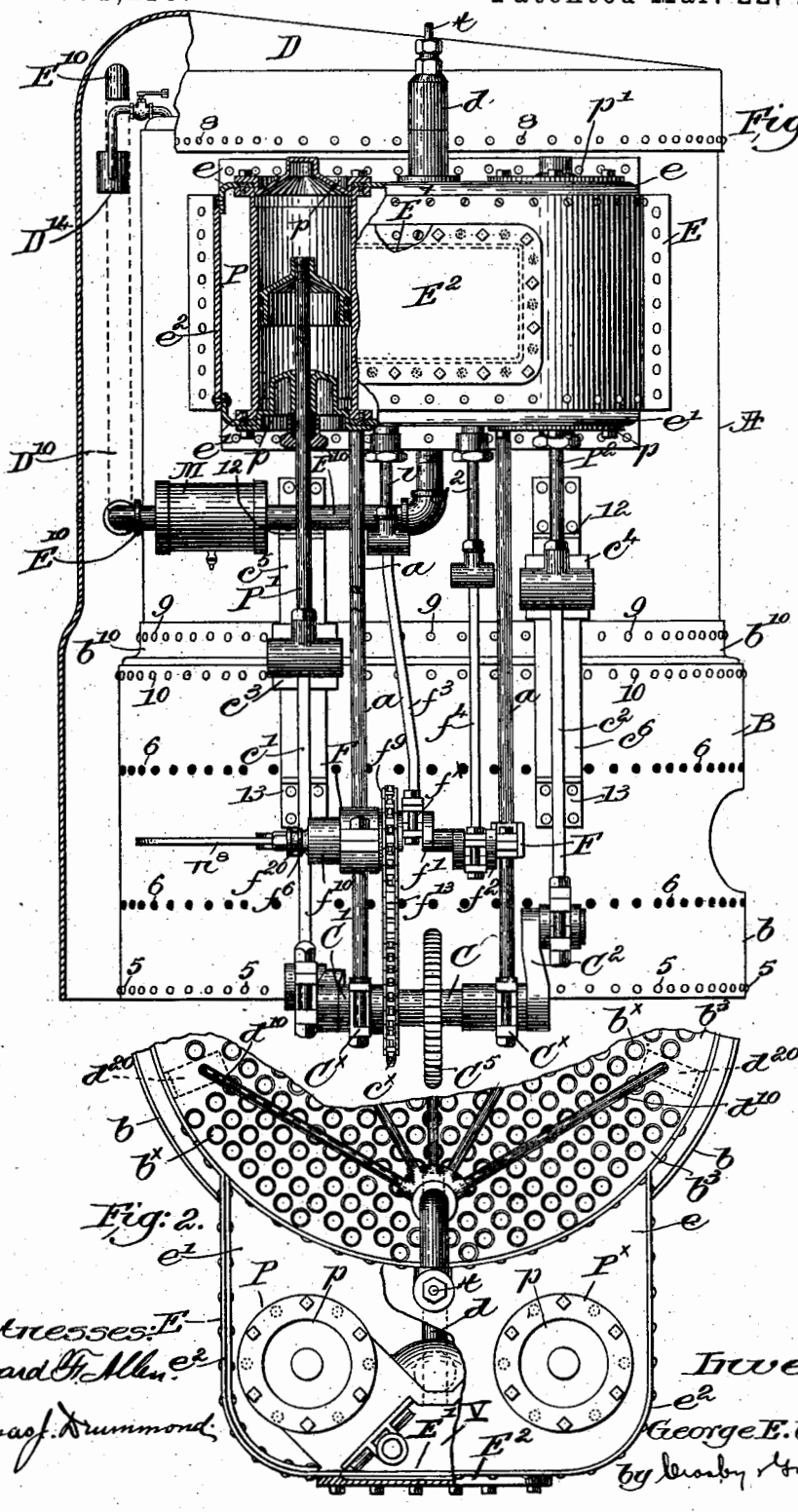

Fig. 1.

Fig. 2.

Witnesses:
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Inventor.
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by Crosby Gregory Allis.

(No Model.) 3 Sheets—Sheet 2.

G. E. WHITNEY.

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Fig: 3.

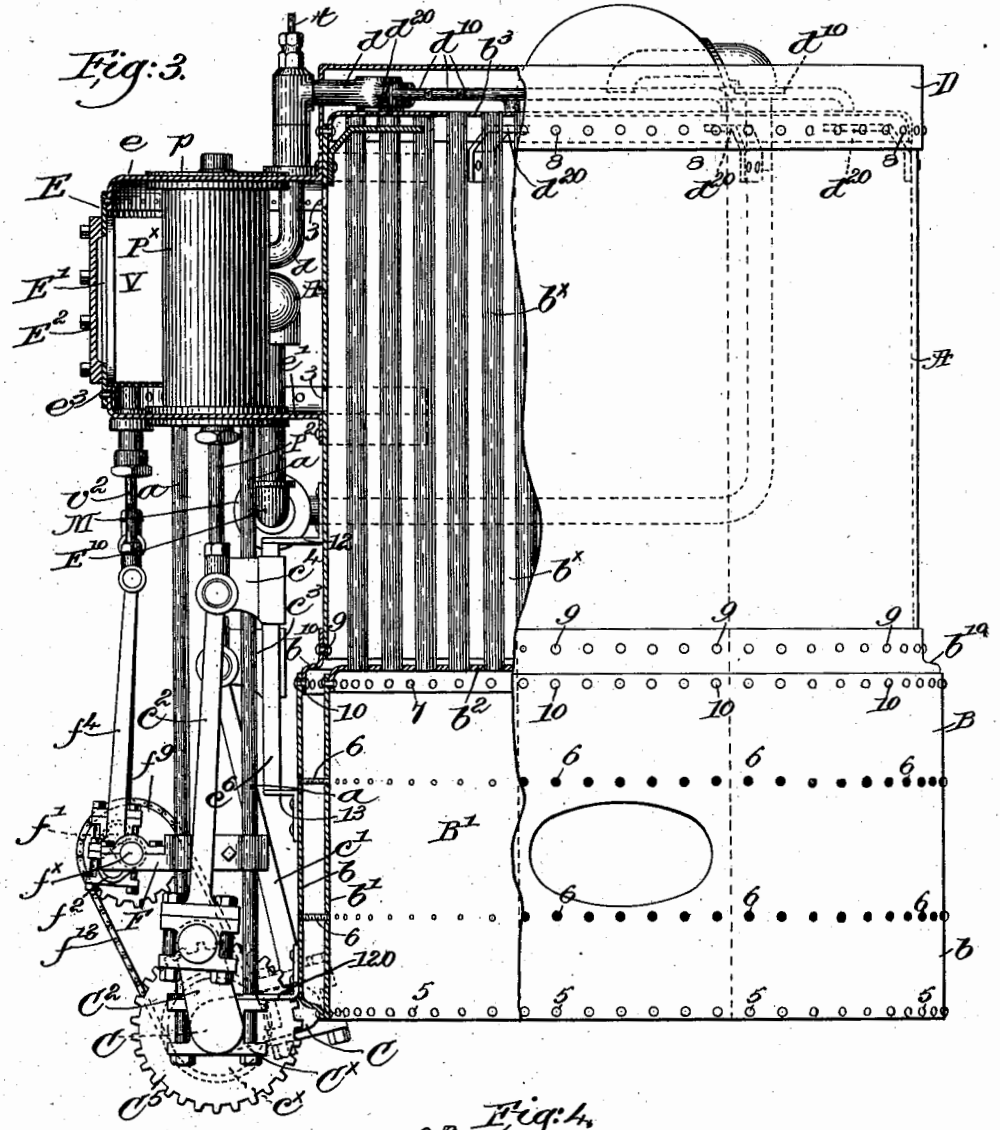
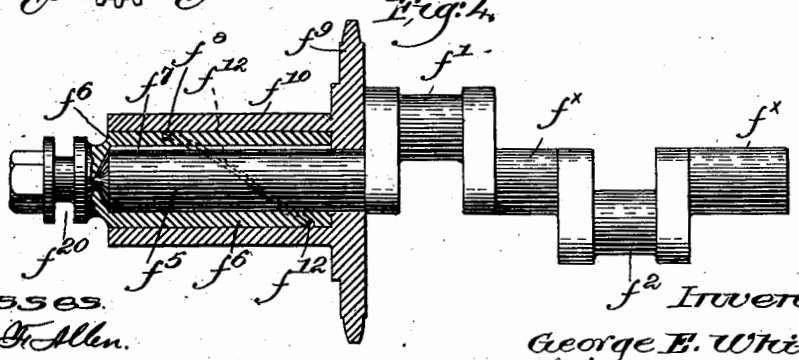


Fig: 4.



Witnesses.
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(No Model.) 3 Sheets—Sheet3

G. E. WHITNEY.

ENGINE.

No. 601,218. Patented Mar. 22, 1898.

Fig. 5.

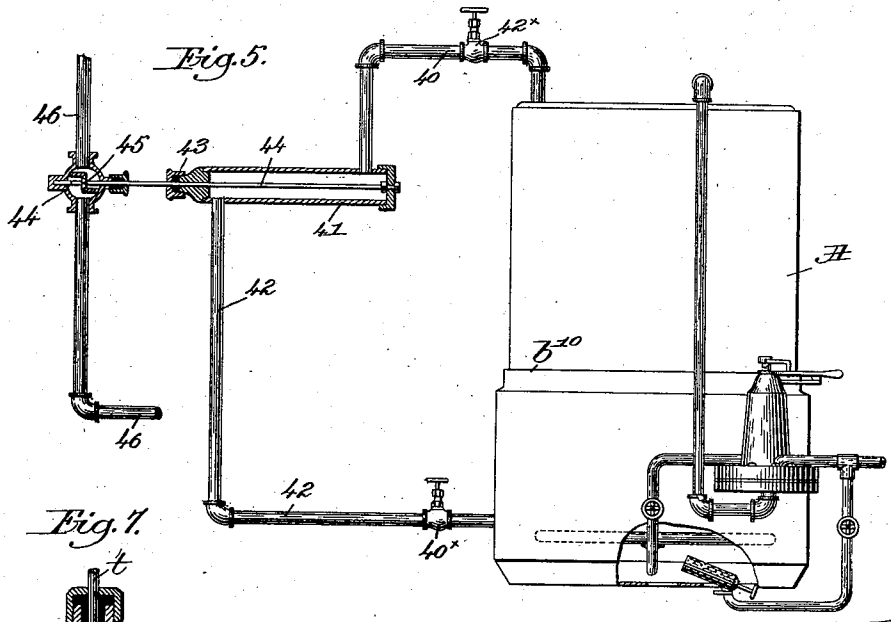


Fig. 7.

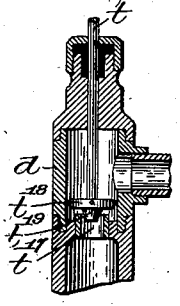


Fig. 6.

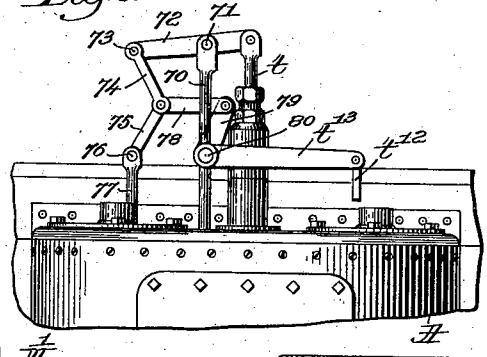


Fig. 8.

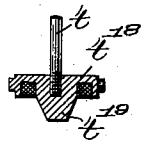


Fig. 9.

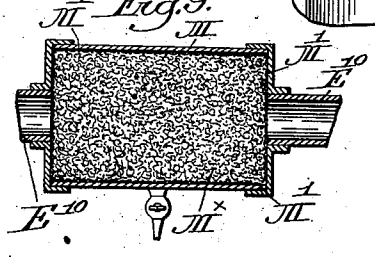
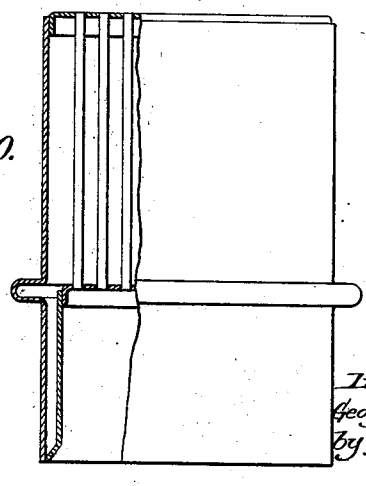


Fig. 10.



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UNITED STATES PATENT OFFICE.

GEORGE E. WHITNEY, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE WHITNEY MOTOR WAGON COMPANY, OF KITTERY, MAINE.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 601,218, dated March 22, 1898.

Application filed March 18, 1897. Serial No. 628,169. (No model.)

To all whom it may concern:

Be it known that I, GEORGE E. WHITNEY, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention has for its object the production of a novel engine of great power, economy, strength, and simplicity, compact and of light weight, and particularly adapted for use as a motor for vehicles.

I have herein shown my invention as provided with means whereby the speed may be varied, the engine reversed, the supply of water regulated automatically, the sound of the exhaust deadened, and the exhaust-steam dried, so as to become invisible before it is discharged into the atmosphere.

It is essential in the production of a practical horseless vehicle propelled by steam, which for many reasons I consider the most economical and easily controllable motive power, that the motive mechanism should possess the greatest possible economy of fuel and water, which has to be carried in the vehicle, and the greatest possible lightness and compactness consistent with strength and durability. In this connection I deem of great importance the arrangement of one or more cylinders and valve-chests within a jacket connected with the boiler-shell at one side, for thereby it becomes possible, by connecting the jacket with the interior of the boiler, to cause the hot water and steam when at boiler temperature to surround the cylinder and valve-chest, thus acting to prevent condensation and to dry the steam in the cylinder, so that the exhaust-steam contains less moisture and thereby decreases the waste of water as well as aids in rendering the exhaust-steam invisible when further treated, as hereinafter described.

The use of an upright boiler is considered by me essential in steam-propelled road-vehicles, as thereby considerable variation of water-level caused by passing over inequalities in the road is of no consequence, and the arrangement of the engine on the side of the boiler affords at once lightness, strength, durability, and compactness.

Figure 1 is a front elevation, partly in section, of an engine embodying my invention. Fig. 2 is a partial top or plan view thereof broken out and with the bonnet removed. Fig. 3, in side elevation and partial vertical section, represents the engine shown in Fig. 1. Fig. 4 is an enlarged detail view, partly in section, of the reversing mechanism. Fig. 5, in elevation and partially in section, represents the boiler with the feed-water-controlling device. Fig. 6, in side elevation, represents a throttle-actuating device whereby a very slight movement of the throttle is effected. Fig. 7 shows the throttle in vertical section enlarged. Fig. 8 is a section of the valve enlarged and detached. Fig. 9 is an enlarged sectional view of the muffler for the exhaust-steam shown in elevation in Fig. 1. Fig. 10 is a modified form of construction of the expansion member of the boiler, to be referred to.

I have herein shown the boiler of my engine as of the upright tubular type and comprising a preferably cylindrical steel shell A and water-leg B, surrounding the fire box or chamber B′, the water-leg forming the sides of the fire-chamber.

The water-leg is composed of concentric steel shells $b\,b'$, riveted together at their lower ends, as at 5, and strengthened and stiffened in usual manner by stay-bolts 6, a lower tube-head b^2 being riveted at 7 to the upper end of the inner shell b' and forming the top of the fire-chamber. A series of very thin long copper fire-tubes $b^\times$ are secured at their lower ends in the head b^2 and at their upper ends in the upper or top head b^3, (see Fig. 3,) the latter being riveted, as at 8, to the boiler-shell A, a bonnet D surmounting and closing the top of the boiler and connected with the down-turned flue D^{10} for the escape of the products of combustion.

It is well known that the copper has a much greater rate of expansion than steel, and great trouble has been experienced in using copper tubes of any length in firmly and rigidly securing them to the heads. In fact it is impossible to maintain copper tubes tight in

boilers as now constructed, and consequently steel tubing is used, which is not only much more expensive than copper, but owing to the liability of steel to corrode if made very thin the steel tubes must be made much thicker than is necessary with copper. The increased thickness of steel tubes decreases the heating effect of each tube and the boiler makes steam much more slowly. The thinner copper tubes possess not only the non-corrosive and quicker-heating qualities, but the further manifest advantage that a greater number of such tubes of a stated interior diameter can be inserted in a given boiler, thereby greatly increasing the heating-surface.

I have devised novel means whereby the copper tubes may be used without leakage, and owing to the thinness of the copper a boiler made in accordance with my invention will steam very quickly and economically.

Between the lower end of the shell A and the upper end of the outer shell b of the water-leg I have herein shown a thin resilient ring b^{10}, preferably of steel, riveted to the two parts at 9 10, respectively, said resilient expansion-ring being substantially λ-shaped in cross-section, or two parallel flanges connected by a reverse-curved web, as clearly shown in Fig. 3.

The walls b b' of the water-leg B are not connected at their upper ends, and as the tube-head b^2 forms a rigid part of the water-leg, while the upper head b^3 forms a rigid part of the boiler-shell A, the latter being supported by the expansion-ring b^{10}, the latter permits the longitudinal expansion of the tubes $b^\times$ and takes up the contraction, completely preventing disruption or any leakage at the points where the tubes are secured to the heads.

It is obvious that the longitudinal expansion of the tubes may be provided for by making an integral portion of the boiler-shell serve as the expansion member—as, for instance, by making an annular bend in the shell between the portions to which the tube-heads are secured, one form of such modification being shown in Fig. 10.

A main crank-shaft C is supported in suitable bearings $C^\times$, secured by brackets 120 to the water-leg, the preferably quartering-cranks C′ and C^2 being connected with the piston-rods P′ P^2 by connecting-rods c' c^2, cross-heads c^3 c^4, rigidly secured to the piston-rods, sliding on vertical guides c^5 c^6, secured by brackets 12 and 13 to the shell A and water-leg, respectively.

Inasmuch as the expansion member of the boiler is located between the crank-shaft bearings $C^\times$, to which the lower ends of the brace-rods a are attached, and the rigid points of attachment of their upper ends, the variation in the distance between these points of attachment due to action of the expansion member is provided for by the brackets 120, which while rigid laterally are sufficiently flexible in a vertical direction. The brackets 12 and 13, which support the guide-rods c^5 and c^6, in like manner yield sufficiently to prevent any distortion of the said guide-rods.

The two cylinders P $P^\times$ are mounted in and supported by a jacket E, preferably comprising flanged top and bottom members e e', riveted to the boiler-shell, as herein shown, and a vertical side wall e^2, riveted at top and bottom to said members and at its ends to the shell A, making a rigid and strong yet light support.

Referring to Fig. 1, it will be seen that the flanged ends of the cylinders are screwed to the members e and e', which have openings therein to receive the flanged cylinder-heads p p', bolted in place. The vertical brace-rods a a, passing through the jacket-bottom e' and secured to the cylinders and to the crank-shaft bearings $C^\times$, hold the crank-shaft in position.

Referring to Fig. 3, openings 3 are shown in the shell A, which communicate with the interior of the jacket E, so that the hot water and steam from the boiler will surround the cylinders and their valve-chests, of ordinary construction, thus preventing cooling by radiation and condensation and maintaining the cylinders at high temperature and greatly increasing the economy of the apparatus by drying the steam in the cylinders.

The brace-rods a are arranged in pairs, and each pair has rigidly secured thereto outwardly-extended stands F, which provide bearings for the valve-actuating shaft $f^\times$. (Shown separately in Fig. 4.) This shaft has cranks f' f^2 for the connecting-rods f^3 f^4, jointed in turn to the valve-stems v' v', working in the valve-chests V. The shaft $f^\times$ is elongated at one end, as at f^5, Fig. 4, to receive a sleeve f^6 longitudinally movable thereon and connected to and to rotate with the shaft by a key f^7, said sleeve having, as herein shown, a cam-groove f^8 in its outer surface. A sprocket-wheel f^9 has an elongated hub f^{10}, which receives the sleeve f^6, a lug or projection f^{12} on the hub entering the cam-groove f^8, said sprocket being connected by a suitable sprocket-chain f^{13} with a sprocket-wheel $c^\times$ on the crank-shaft C. Rotation is thus transmitted from the latter to the valve-actuating shaft $f^\times$, which operates the valves, and by moving the sleeve f^6 by any suitable means in or out on the valve-shaft the latter, through the projection f^{12} and cam-groove f^8, acts to reverse the direction of rotation of the shaft and thereby change the valves to reverse the engine.

In motor-vehicles particularly, passing as they must over various kinds and varieties of road-beds, it is evident that the boiler will be subjected to more or less vibration or jarring, which has a tendency to cause foaming, and should priming take place the water passing over into the cylinder will usually terminate in an accident to the mechanism. Instead, therefore, of taking the boiler-steam from a single point, I connect the steam-pipe d, Figs.

2 and 3, with a plurality of tubular branches d^{10}, which enter the steam-space at different points, and I thus almost entirely prevent the outflow of the steam from taking water over into the engine-cylinder, even should foaming take place, under ordinary circumstances. To still further guard against the entrance of water to the steam-pipe, I place a suitable baffle-plate d^{20} below the inner end of each of the various branches d^{10}, and by the distribution of the steam-outlets over different portions of the steam-space of the boiler, assisted by the baffle-plates, I am enabled to operate the engine and boiler with entire safety and without fear of priming even should considerable foaming occur.

The steam-pipe d is provided with a throttle-valve having a stem t, said pipe leading from the top of the steam-space of the boiler to the valve-chests, as described, and making an independent steam connection between the boiler and valve-chests.

The jacket E is provided with a manhole E′ and cover-plate E^2, by which access may be had to the interior of the jacket when necessary.

By referring to Figs. 1 and 2 it will be seen that when the cover-plate E^2 is removed direct access may then be had to the valve-chests to examine the same or to adjust the valves even while steam is up and full pressure on in the boiler, for the steam in the jacket is not admitted to the space between the valve-chests thus left open by the removal of the cover. So, too, if for any reason it is necessary to have access to the cylinders while the steam is up, the cylinder-heads may be removed, as there is no direct communication between the jacket and the cylinders, the steam admitted to the valve-chests and cylinders being controlled by the throttle.

The power is transmitted from the crank-shaft C in any suitable manner, and as herein shown by a sprocket-wheel C^5, if it is desired to apply the engine to a vehicle to drive the same.

An upright 70 (see Fig. 6) is erected on the upper end of the cylinder-jacket, on which is fulcrumed at 71 a lever 72, jointed at one end to the throttle valve-stem t, the other end of said lever being jointed at 73 to one arm 74 of a toggle, the other arm 75 being fulcrumed at 76 to a fixed upright 77. By straightening or breaking the toggle the lever 72 will be rocked to move the throttle, and when the toggle is nearly straight very slight movement will be imparted to the throttle-valve, so that it may be regulated with great nicety, while its movement is greater when the toggle is bent more. A link 78 connects the joint of the toggle with an arm 79 on a rock-shaft 80, having a bearing in the upright 70, and said rock-shaft has attached to it an arm t^{13}, operated by a link t^{12}, whereby the rock-shaft is turned by a suitable connection with a controlling device. (Not herein shown.)

Figs. 7 and 8 show details of the throttle. It consists, essentially, of an outer case, (marked d,) in which is mounted a valve-seat t^{17}. The valve-stem t within this case has on its end a valve composed of a flat-faced disk t^{18}, having on its side or edge guiding projections to bear against the interior of the case. The valve is closed tight by the contact of the flat seat and face and opened by separating them. In order to be able to separate the flat seat and face without a powerful rush of steam entering through the throttle into the cylinder and thus making the vehicle start with a jump when the engine is applied to a vehicle to provide the motive power therefor, I place on the center of the face of the valve a conical projection t^{19}, which when the valve is closed stands in and substantially fills the upper part of the opening in the valve-seat. By the addition to the valve of the said projection it is possible when opening the valve by separating the flat face and seat to leave a much smaller passage for the steam than would otherwise be left, thus to insure the very gradual and slow passing of the steam through the seat to the cylinder, or, in other words, the said cone so fills the seat that the steam can issue but slowly until after the flat part of the valve has been moved for a considerable distance from the said seat. By the mechanism shown in said Fig. 6 the throttle is under complete control; but to attain greater refinement of movement of the said throttle, which is necessary in order to start a motor-vehicle slowly or to move very slowly, as may be necessary with such a vehicle, in crowded streets, I also make use of the mechanism shown in Figs. 7 and 8.

In Fig. 1 the exhaust-pipe E^{10} leads from the valve-chests to the flue D^{10} on the exterior of the boiler-shell.

Referring to Fig. 5, I have shown a pipe 40 opening into the top of the boiler, said pipe at its other end opening into one end of a chest or chamber 41, arranged horizontally and at the normal water-level. The other end of the chest is connected by a return-pipe 42 with the lower portion of the water-leg B, so that the water may freely find the same level in the pipe 42, the chamber 41, and the lower part of the pipe 40 that is maintained in the boiler, and while freely finding such level (the water in these pipes and in the chamber 41 does not circulate otherwise than very slowly) it remains practically dead and therefore at a much lower temperature than the water and steam in the boiler. The chest is provided with a gland or stuffing-box 43, through which passes an expansion-rod 44, secured at its inner end, and at its free end attached to a valve 45 in the feed-water-supply pipe 46, which connects the water-tank with the boiler at a suitable point. A supply-pump constantly in operation is attached to the feed-water pipe 46 at a suitable point between the valve 45 and the boiler. Now when the water is at the proper level and therefore standing in the chest 41 the expansion-rod will maintain the

valve 45 closed; but when the water-level falls steam passes from the boiler into the chest and by its greater temperature causes rod 44 to expand and open the valve, admitting an additional supply of feed-water to the supply-pump and boiler, the valve being automatically shut when the water is raised high enough to fill the chamber 41.

The expansion-rod may be made of aluminium, which I find will give highly satisfactory results, or it may be made of other metal having the requisite degree of expansion.

By means of valves at $40^{\times}$ and $42^{\times}$ the automatic controller for the feed-water may be shut off from the boiler.

It is obvious that the feed-water regulator herein described may be applied to any type of steam-boiler wherein it is desired to automatically maintain a substantially constant water-level.

I prefer to heat the boiler by naphtha, kerosene, or other suitable liquid fuel supplied to the combustion chamber or furnace within the water-leg B and provided with suitable burners, (not shown,) and I have herein shown a feed-regulator for the fuel, (see Fig. 5,) the same not being herein described in detail, as it forms no part of this invention.

I prefer to mount the engine and boiler on a road-vehicle in such a manner that the same will be partly within and partly below the body thereof.

For the purposes of obtaining greater comfort to the occupants, compactness, improving the looks of the vehicle to which my present invention may be applied and making it less unlike ordinary vehicles, I construct the flue D^{10}, as in Fig. 1, with its discharge-opening at the lower end of the boiler, so that the slight gaseous products of combustion may pass off beneath the vehicle out of the sight and smell of the occupants. In order to induce a downward draft, I insert a downwardly-pointed steam-jet D^{11}, connected with the boiler in the flue D^{10} at about the point shown in Fig. 1. Now in using a steam-motor for such vehicles it must be borne in mind that a cloud of escaping steam from the exhaust, especially if accompanied with the puffing noise usual in the exhaust of high-pressure engines, would be very objectionable, mainly on the ground that it would be unsightly and would frighten passing horses. By the prevention of priming in the manner described and by exhausting the steam in a substantially dry state from the cylinder, due to the jacket described, there is very little moisture to be condensed, and the exhaust is further dried by its entry into the flue D^{10}, preferably at a point as near the top as possible, where it is acted upon by the hot gaseous products of combustion, so that there is practically under ordinary circumstances no visible exhaust issuing from the flue. The puffing noise, however, must be obviated by other means, and for this purpose I have devised a muffler and pressure-equalizer interposed in the exhaust-pipe E^{10} between the valve-chest and the flue D^{10}, the muffler serving to completely deaden any sound from the exhaust.

The muffler is shown in section in Fig. 9 as a metal cylinder M, into the ends of which the exhaust-pipe E^{10} is tapped, and the cylinder is filled with fibrous material $M^{\times}$, preferably curled hair. An envelop M', of wire-gauze, preferably surrounds the fibrous material, maintaining it in place in the cylinder and preventing its passage into the exhaust-pipe E^{10}. In actual practice the exhaust-steam passes in successive puffs from the cylinder to the muffler, and the fibrous material $M^{\times}$ seems to so break up or disintegrate the same that it issues therefrom into the flue D^{10} in a steady continuous stream without the least noise. The passage of the steam from the exhaust into the flue is thus continuous, and thereby the hot gases of combustion coming down the flue have time to dry and evaporate the exhaust steam or particles of water condensed therefrom, rendering it invisible. This the hot gases would not have so good an opportunity of doing if the steam or particles of water condensed therefrom were forced into the flue in successive intermittent puffs.

My invention is not restricted to the precise construction and arrangement of the various parts hereinbefore set forth, as obviously changes in the construction and rearrangement of parts may be made without departing from the spirit and scope of my invention.

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

1. A steam-boiler comprising a fire-chamber, water-leg, and shell, the water-leg having inner and outer walls joined at their lower ends and forming the sides of the fire-chamber, the outer wall being a continuation of said shell, a lower tube-head attached to the inner wall of the water-leg and forming the top of the fire-chamber, an upper tube-head attached to the upper portion of said shell, fire-tubes constituting a rigid connection between said heads within the boiler-shell, and communicating with the fire-chamber, the tubes being composed of a material having a different rate of expansion from that of the material of the shell, and an expansion member interposed between the parts of the boiler which support the tube-heads, whereby the difference of expansion between the parts joining the peripheries of the said heads and the tubes joining the interior portions of the heads is permitted without injury.

2. In an apparatus of the class described, an upright boiler, an engine mounted on the shell thereof, a jacket surrounding the engine-cylinder and secured to the boiler-shell, said jacket communicating with the interior of the boiler, and an independent steam-supply connection between the cylinder and the boiler.

3. A steam-boiler shell, an external chamber or jacket secured thereto, the boiler-shell forming the rear wall of the jacket and having openings thereinto, respectively above and below the normal water-level, and a cylinder within the jacket and detachably secured to the ends thereof, and an independent steam-supply connection between the cylinder and the boiler.

4. A boiler-shell, an exterior jacket, a cylinder and valve-chest supported by and inclosed in said jacket, a steam-supply connection between said chest and boiler, and an independent connection between the interiors of the shell and jacket, whereby the hot water and steam may circulate around the cylinder and valve-chest.

5. In an apparatus of the class described, a boiler, an engine mounted thereon wholly exterior thereto, a jacket secured to the boiler-shell and communicating with the interior thereof, the engine-cylinder being attached to the jacket ends, and cylinder-heads externally removable and adapted to be secured to the cylinder ends.

6. The boiler-shell having attached jacket ends *e* and *e'*, and the cylinder having its flanged heads and ends bolted to said jacket ends, a side wall interposed between the jacket ends and connected therewith and with the boiler-shell, steam-tight, thus forming a jacket inclosing said cylinder, the interior of the jacket communicating with the boiler above and below the normal water-level, whereby hot water and steam therefrom circulate about and surround the cylinder, and an independent steam-supply connection between the cylinder and boiler.

7. A tubular boiler comprising a shell, and tube-heads secured to the upper and lower portions thereof, tubes rigidly attached to the heads, and having a different rate of expansion from the shell, an expansion member for the shell, between the tube-heads, an engine mounted exteriorly on the shell, and connections between said engine and shell, laterally rigid and adapted to yield vertically to permit the operation of the expansion member of the boiler.

8. Propelling mechanism for road-vehicles, comprising an upright boiler, an engine mounted externally on said boiler, its cylinder and main shaft, a jacket surrounding and supporting the cylinder and secured to the boiler, bearings for the main shaft a support for said bearings laterally rigid and adapted to yield vertically, and secured to the boiler-shell, and upright brace-rods rigidly connecting said bearings and cylinder.

9. In an upright, tubular steam-boiler, the throttle, and a plurality of tubular branches in the upper part of the boiler leading to a single inlet to the throttle from different points of the upper tube-head and communicating with the steam-space, whereby passage of water to the throttle is prevented.

10. In an upright, tubular steam-boiler, the throttle, a plurality of tubular branches leading to a single inlet thereto from different points of the steam-space, the inner ends of said branches being held in the upper tube-head, and baffle-plates located below the tube-head and the inner ends of the branches, to thereby prevent passage of water with the steam to the throttle.

11. In a steam-engine, its throttle, a lever connected therewith and having a fixed fulcrum, a toggle one arm of which is jointed to said lever, the other arm having a fixed fulcrum, and means connected with the joint of the toggle, to straighten or break the latter and thereby rock the throttle-actuating lever.

12. A steam boiler and engine having a steam-drying apparatus consisting of a cylinder and a valve-chest inclosed in a steam-jacket mounted upon and connecting with the interior of the boiler, whereby the steam in the cylinder and valve-chest is kept hot and dry, a flue for the escape of the products of combustion, a steam-exhaust pipe leading from the cylinder and opening into said flue, and a muffler and pressure-equalizer in said pipe between the cylinder and the flue, whereby the exhaust of the steam into the flue is made continuous instead of intermittent, and the steam, or particles of water condensed therefrom is dried and made invisible.

13. An upright boiler, an external jacket or chamber secured thereto, a cylinder within the jacket, a throttle to control the steam-supply for the cylinder, means to draw steam from a plurality of points in the boiler steam-space for the throttle-supply, and to prevent passage of water thereto, and a connection between the jacket and boiler.

14. An upright boiler, an external jacket or chamber secured thereto, a cylinder within the jacket, a throttle to control the steam-supply for the cylinder, means to draw steam from a plurality of points in the boiler steam-space for the throttle-supply and to prevent passage of water thereto, and connections between the jacket and boiler, respectively above and below the water-level, whereby hot water and steam may surround the cylinder and valve-chest.

15. An upright boiler, an engine mounted exteriorly thereon, an external chamber or jacket inclosing and supporting the cylinder and valve-chest of the engine and located near the upper end of the boiler-shell, a crank-shaft supported on the lower portion of said boiler, a throttle for the cylinder, means to draw steam from a plurality of points in the boiler steam-space for the throttle-supply and to prevent passage of water thereto, and a connection between the interior of the boiler and the jacket.

16. A boiler-shell, an exterior jacket, a cylinder and valve-chest supported upon and inclosed in said jacket, a connection between the interior of the shell and the jacket, a throttle to control the supply of steam to the valve-chest and cylinder, and means whereby

access may be had to the valve-chest through the side wall of the jacket.

17. A boiler, an engine mounted thereon wholly exterior thereto, a jacket secured to the boiler-shell and communicating with the interior thereof, the engine-cylinder being attached to the jacket ends, cylinder-heads externally removable and adapted to be secured to the jacket ends and cylinder, a valve-chest within the jacket, a removable cover for an opening in the jacket adjacent the valve-chest, and a throttle to control the entrance of steam to the valve-chest and cylinder whereby access may be had to either the valve-chest or cylinder while the steam in the boiler and in the jacket surrounding the cylinder and valve-chest is under pressure.

18. A boiler-shell having an external jacket or chamber attached to the side thereof and comprising jacket ends flanged at their front, side and rear edges, the rear flanges being attached to the boiler-shell, and an interposed wall between said jacket ends and connected with the front and side flanges thereof, the ends of said walls being flanged and attached thereat to the boiler-shell, the whole forming a steam-tight jacket, a cylinder supported and inclosed within said jacket, and a communication between the interiors of the boiler and jacket.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GEORGE E. WHITNEY.

Witnesses:
GEO. W. GREGORY,
ADDIE F. DANIELS.