T. A. KILLMAN.

COMBINED GAS AND STEAM SYSTEM FOR ENGINES.

APPLICATION FILED SEPT. 11, 1917. RENEWED JAN. 6, 1921.

1,373,509. **Patented Apr. 5, 1921.**

4 SHEETS—SHEET 1.

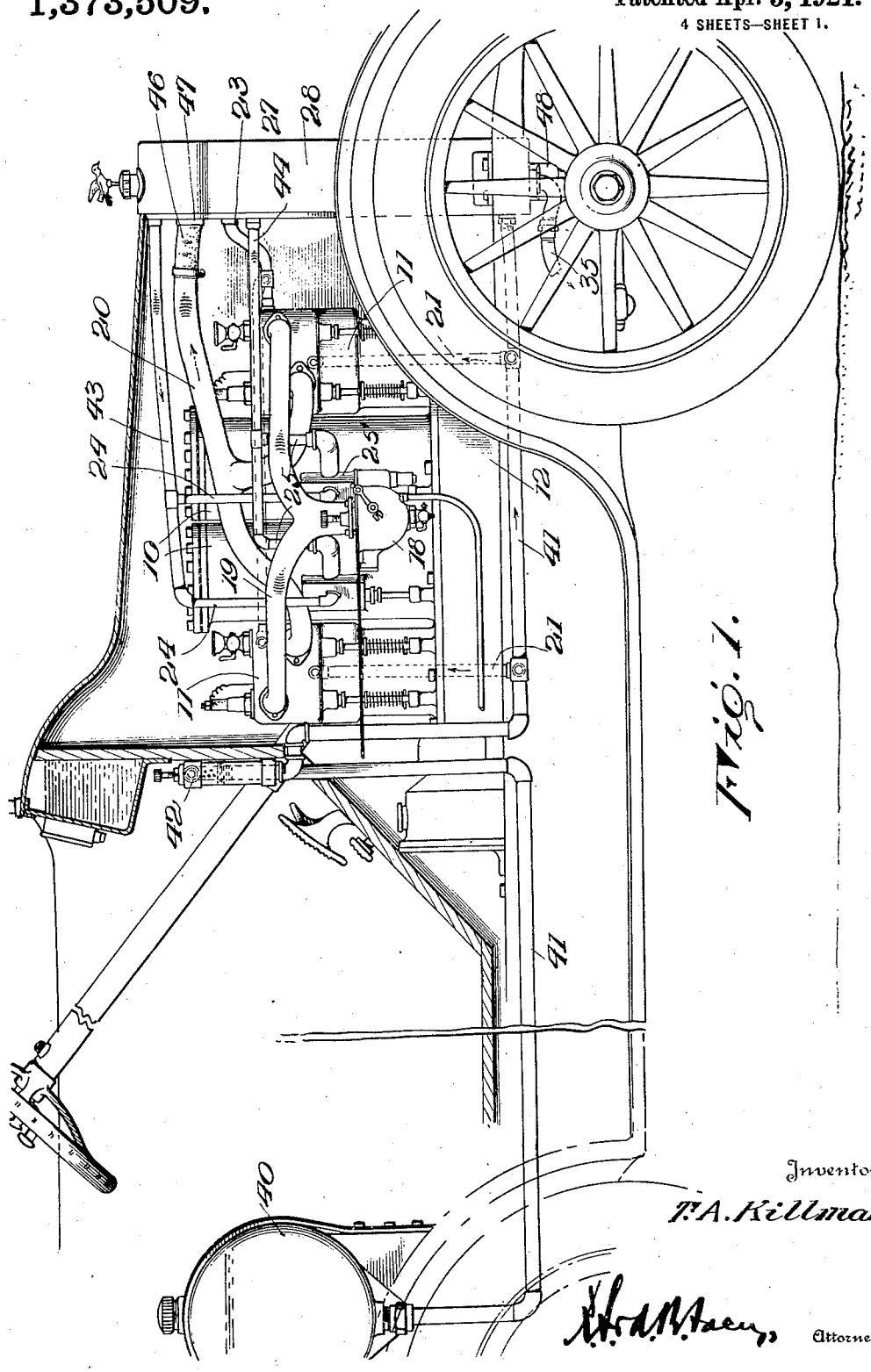


Fig. 1.

Inventor

T. A. Killman

Attorneys

T. A. KILLMAN.

COMBINED GAS AND STEAM SYSTEM FOR ENGINES.

APPLICATION FILED SEPT. 11, 1917. RENEWED JAN. 6, 1921.

1,373,509. **Patented Apr. 5, 1921.**

4 SHEETS—SHEET 2.

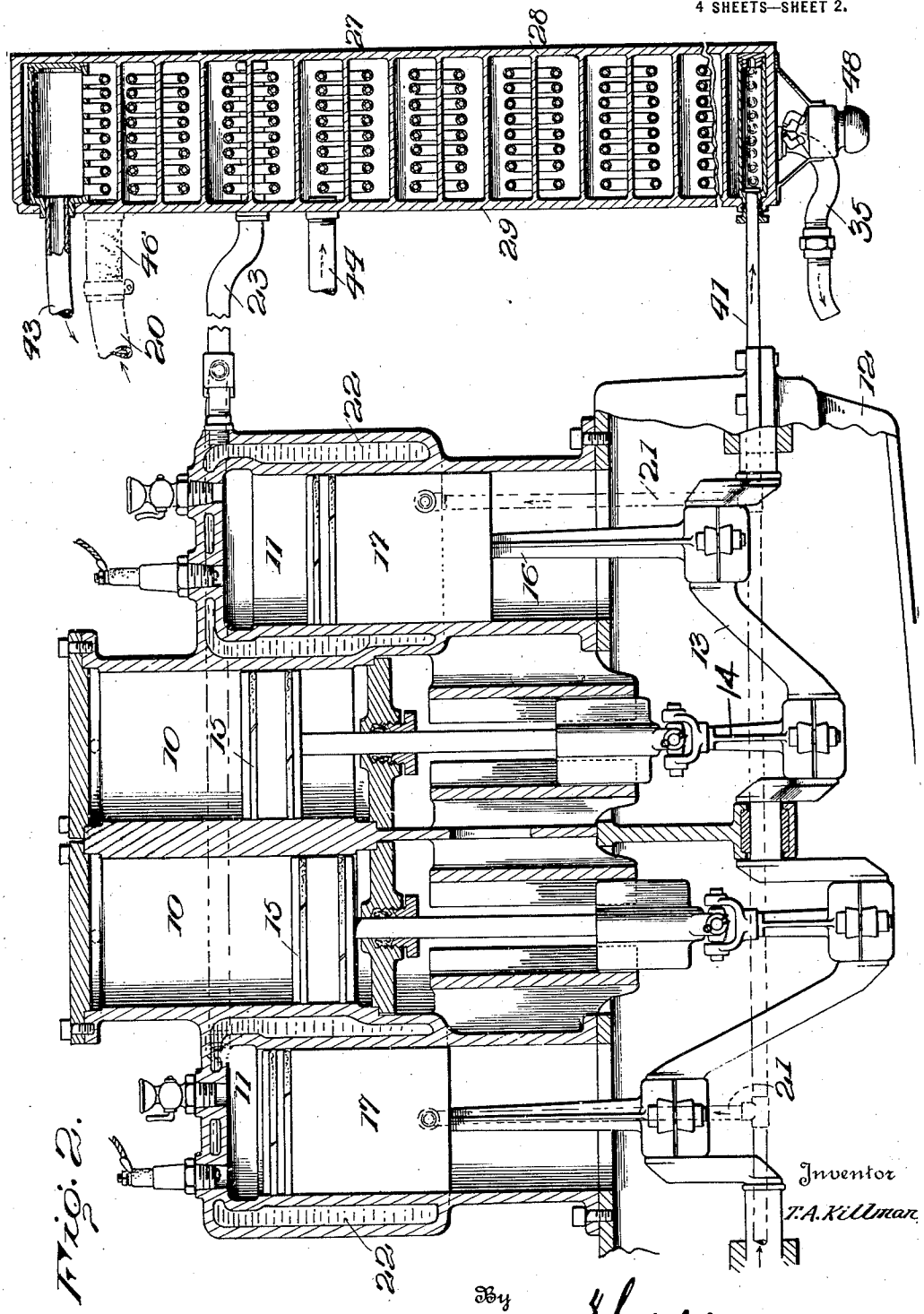


FIG. 2.

Inventor
T. A. Killman

By

Attorneys.

T. A. KILLMAN.

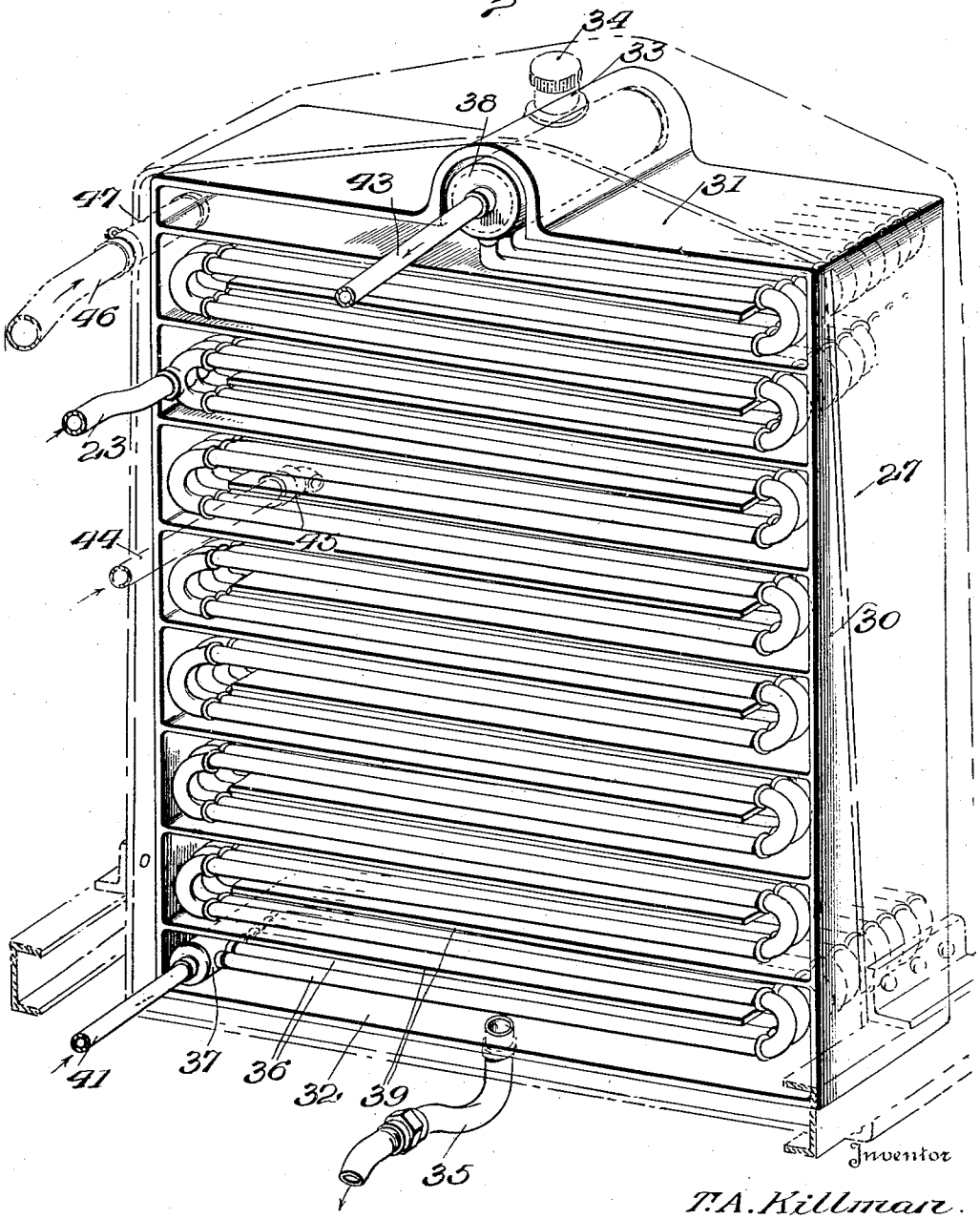
COMBINED GAS AND STEAM SYSTEM FOR ENGINES.

APPLICATION FILED SEPT. 11, 1917. RENEWED JAN. 6, 1921.

1,373,509. **Patented Apr. 5, 1921.**

4 SHEETS—SHEET 3.

Fig. 3.



Inventor

T. A. Killman.

By Attorneys.

T. A. KILLMAN.

COMBINED GAS AND STEAM SYSTEM FOR ENGINES.

APPLICATION FILED SEPT. 11, 1917. RENEWED JAN. 6, 1921.

1,373,509. Patented Apr. 5, 1921.

4 SHEETS—SHEET 4.

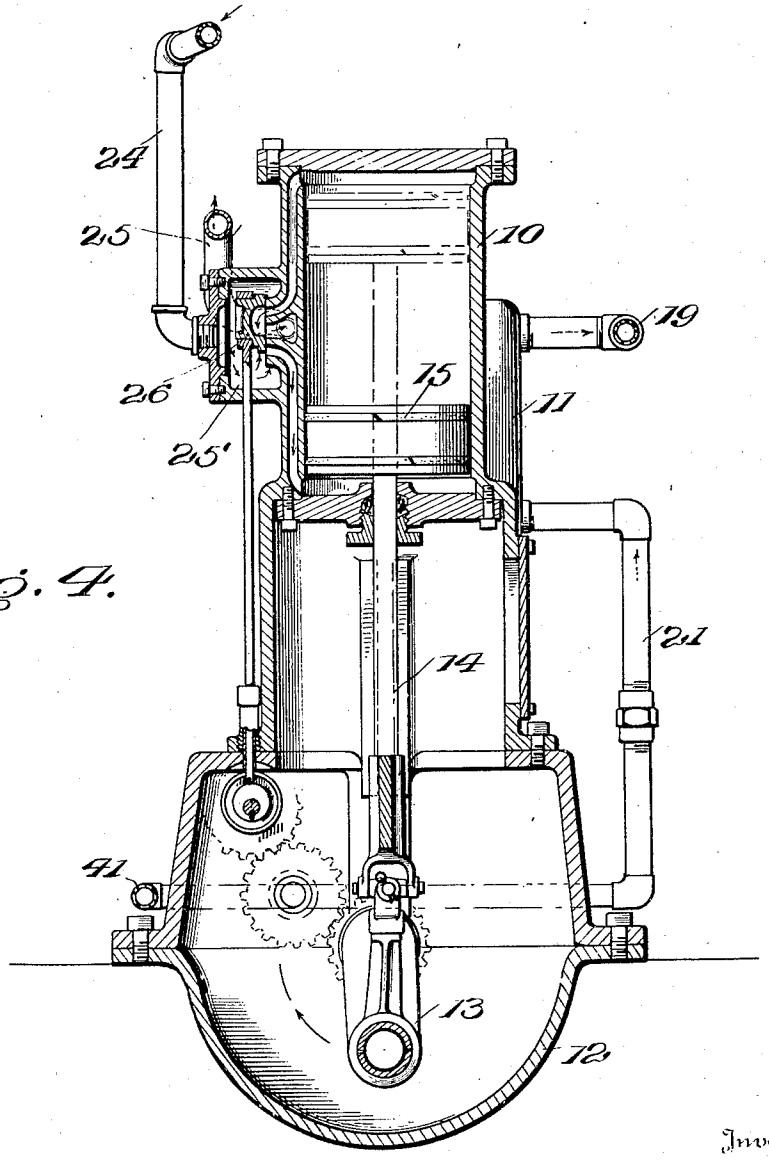


Fig. 4.

Inventor
T. A. Killman.

By Attorneys.

UNITED STATES PATENT OFFICE.

THOMAS A. KILLMAN, OF NASHVILLE, TENNESSEE, ASSIGNOR TO KILLMAN DEVELOPMENT CO., OF NASHVILLE, TENNESSEE, A CORPORATION.

COMBINED GAS AND STEAM SYSTEM FOR ENGINES.

1,373,509. Specification of Letters Patent. Patented Apr. 5, 1921.

Application filed September 11, 1917, Serial No. 190,844. Renewed January 6, 1921. Serial No. 435,534.

To all whom it may concern:

Be it known that I, THOMAS A. KILLMAN, a citizen of the United States, residing at Nashville, in the county of Davidson and State of Tennessee, have invented certain new and useful Improvements in Combined Gas and Steam Systems for Engines, of which the following is a specification.

My invention relates to new and useful improvements in prime movers and more particularly in engines, the primary object of my invention being the provision of an engine and correlated system by means of which a maximum degree of efficiency is obtained due to unusual conservation of the power or energy generated.

It is a well known fact that in fluid motors, such as steam engines or internal combustion engines there is a large waste of energy due to the fact that the expanding fluid, whether it be the burning gases of the internal combustion engine or the steam of the steam engine, loses its effectiveness long before its energy has been transformed into available power, that is long before such fluid has become cool. The primary object of my invention is to construct an engine which will, to a great extent, overcome this difficulty.

More specifically, the chief object of my present invention consists in the construction of an engine of compound type, combining both a steam engine and an internal combustion engine as part of a single motor whereby the unutilized heat generated by the internal combustion engine and ordinarily lost as exhaust gases is utilized to create steam to drive pistons in steam cylinders.

In this connection, a still further object of my invention and one of equal importance is the provision of a combined flash boiler and radiator so arranged and constructed that the exhaust gases from the explosion cylinders of the engine may be passed through it to create steam for operating the steam cylinders of the engine and still so arranged that it may operate efficiently as a radiator for cooling the water from the water jacketing of the internal combustion cylinders of the engine.

Another object of my invention resides in returning the water from the water jacketing of the explosion cylinders of the engine to the combined boiler and radiator at a point where it will assist in the creating of steam, and a still further object resides in returning the exhaust steam from the steam cylinders of the combined boiler and radiator so that it may assist in generating additional steam.

With these and other objects in view, the invention consists in certain novel features of construction, as hereinafter shown and described and then specifically pointed out in the claims; and in the drawings illustrative of the preferred embodiment of the invention.

In the drawings:

Figure 1 is a side elevation of my improved compound engine and its combined boiler and radiator as employed upon a motor vehicle, the motor vehicle being largely shown in section.

Fig. 2 is a central longitudinal sectional view taken through the engine and the combined boiler and radiator,

Fig. 3 is a perspective view of the combined boiler and radiator with its back plate removed,

Fig. 4 is a vertical sectional view taken at right angles to Fig. 2 and central to one of the steam cylinders of the engine.

While my improved compound engine and its correlated system may be employed as a stationary engine or as a power engine movable from place to place, I have, for the sake of clearly disclosing it, illustrated it as an automobile engine, as it is particularly adapted for this purpose.

Referring more particularly to Figs. 1 and 2 of the drawings it will be seen that the motor or engine proper includes a central pair of steam cylinders 10 and a pair of internal combustion cylinders 11 disposed in front and behind the steam cylinders. These cylinders may be cast in block, as shown, or may be formed in pairs or singly as preferred, and have a common crank casing 12, journaling the crank shaft 13 which is connected in the usual manner by connecting rods 14 with the pistons 15 of the steam cylinders and by the connecting rods 16 with the pistons 17 of the firing cylinders.

An explosive mixture is supplied to the firing cylinders by any suitable carbureter 18 through the usual intake manifold 19, while the exhaust gases are discharged from these firing cylinders through an exhaust manifold 20. Pipes 21 lead to the lower portions of the water jackets 22 of the firing

cylinders and, as will be later explained, supply water to such jackets, while pipes 23 lead from the upper portions of the jackets to discharge the water passing therethrough. As the remaining construction of these firing cylinders and their correlated parts, such as their valves and the like, is identical with that ordinarily employed in internal combustion engine practice, any detail description is unnecessary.

Steam is supplied through pipes 24 to the steam chest 25' of the steam cylinders and is exhausted from such steam chest through pipes 25, the admission of steam from the chest to the cylinders and from the cylinders to the chest being controlled by the usual steam slide valve 26 in the ordinary manner. Any means commonly employed in steam engine practice, may be utilized for governing and controlling the operation of the steam cylinders and any detail showing or description is therefore not required, my invention residing rather in the idea of combining steam cylinders and explosion cylinders in a single engine and the system by which the exhaust gases from the explosion cylinders are utilized to create steam for the steam cylinders.

In carrying out this idea, I provide a combined boiler and radiator, indicated as a whole by the numeral 27 which, if the engine is employed upon a motor vehicle, usually corresponds in shape to the ordinary radiator and is preferably similarly located. As best shown in Figs. 2 and 3 of the drawings, this radiator includes a metallic casing inclosed upon all sides and having a front wall 28, back wall 29, side walls 30, top wall 31 and bottom wall 32. The top wall is preferably provided with a spout 33 through which water may be admitted to the casing, this spout being normally closed by a cap 34. A drain pipe 35, which also serves as an exhaust pipe, leads from the bottom of the casing.

Disposed within this casing is a plurality of tubular water coils 36 of pipe of proper diameter and material, the coils being spaced one in front of the other with their convolutions extending transversely of the casing from side to side, sufficient convolutions being provided so that each coil in its entity will extend from top to bottom of the casing. The lower ends of the coils are all connected in any suitable manner, such as by a header 37 and their upper ends are connected in like manner by a header 38 which is preferably disposed centrally of the width of the casing. Projecting transversely of the casing and horizontally disposed are a plurality of baffle walls 39 each connected at one end to one of the side walls of the casing and each having its opposite end spaced from the other side wall of the casing, alternate baffle walls being connected to opposite sides of the casing so as to provide a tortuous passage from side to side of the casing throughout its entire height. Preferably such a wall is located between each two adjacent sections of the coils in the manner clearly shown in Fig. 3.

Water for this combined radiator and boiler is supplied from a tank 40 through a pipe 41 from which the pipes 21, previously mentioned, branch, the end of the pipe 41 being connected into the header 37. Preferably, a portion of this pipe is led through the dash of the vehicle and provided with a sight gage and controlling valve, as shown at 42, in order that the proper water level may be maintained in the coils 36 at all times, fresh water being supplied to the boiler and radiator as it is exhausted through its loss as steam and in the cooling system of the firing cylinders. A live steam pipe 43 connects the pipes 24 with the header 38 so that steam generated in the coils may pass to the valve chests of the steam cylinders. A pipe 44 is tapped into the rear wall of the casing 27 about three quarters the height of the radiator, as shown at 45 and connects with the steam exhaust pipes 25 so that exhaust steam from the steam cylinders will be returned to the casing. The pipe 23 leading from the cooling jackets of the firing cylinders is, in like manner, tapped into one or more of the coils 36, preferably at the level of the exhaust steam return pipe 44 but at a point below the water level in the combined boiler and radiator, the water level therein being at approximately three quarters the height of the boiler. The exhaust manifold 20 is connected by any suitable flexible coupling 46 to a tubular nipple 47 which communicates with the casing of the combined radiator and boiler at or near its top.

For use in case of emergencies and as a means for keeping the system from freezing during cold weather, I preferably provide a hydro-carbon burner 48 of any suitable type, the burner being supported in proper position beneath the bottom of the combined boiler and radiator.

In operation, the firing cylinders are put into action in the usual manner employed with internal combustion engines and the engine is thus run idle a short time. The exhaust gases from these firing cylinders passing from the intake manifold 20 into the top of the casing of the combined boiler and radiator and into the tortuous passages inclosing the coils, escape through the pipe 35. These exhaust gases highly heat the upper portions of the coils, which do not contain water so that at the point of water level steam is quickly generated upon the flash boiler principle. When sufficient pressure has thus been obtained, the steam cylinders come into operation and supplement

the explosion cylinders, so that all four cylinders work as a unit to drive the crank shaft.

It should be noted that it is very important that the exhaust gases be admitted to the casing of the boiler near its top in order that they may immediately come in contact with the empty upper portions of the boiler coils before they have had time to cool so that the water in the lower pipes rising into contact with the heated pipes will be flashed into steam immediately.

Another very important reason for applying the heat at the top instead of the bottom is, that the heat from the exhaust gases will be absorbed by the water at the top; and as this water becomes hotter it expands and becomes lighter, and under the influence of gravity it remains at the top while the cold water, being heavier, remains at the bottom. So there is no mixing of the hot water at the top and the cold water at the bottom, and the result is an accumulation, or concentration, of heat at the top which in a very short time converts this water into highly heated steam, and in a condition to run the engine while the water at the bottom is comparatively cool; and, as the cold water is fed in at the bottom, it absorbs the remainder of the heat in the exhaust gases. Whereas, if the heat be applied at the bottom, the water at the bottom will become heated first and will rise to the top and the cold water at the top will descend to take its place, which will cause the hot and cold water to mix; and by the law of convection, all the water in the boiler will be brought to the same temperature so that no steam can be generated in any part of the boiler until the entire contents are raised to the steaming point. Therefore, the remaining heat in the exhaust gases, which has a temperature equal to or less than the temperature of the steam, cannot be absorbed by the water in the boiler and would pass on out and be lost, which I have found to be a great percentage of loss.

Furthermore, due to the extremely large coil surfaces exposed, practically all of the heat of the exhaust gases is utilized and the water in the middle portions of the coils is preheated so that it is in better condition for steam generation when it reaches the upper portions of the coils. At the same time, the absorption of heat from the exhaust gases is so complete that the lower portions of the coils remain cool and a proper supply of suitably cooled water is assured for the cooling jackets of the explosion cylinders. Returning of the heated water from these cooling jackets to the preheated water in the coils just below the point of steam generation therein also serves to preheat the water just before it reaches such point of steam generation. Furthermore, the return of exhaust steam from the steam cylinders to the casing of the boiler, additionally assists in preheating the water in the boiler. It will therefore be appreciated that aside from loss through conduction and radiation, practically all heat generated by the explosions in the firing cylinders of the engine is utilized either in such cylinders or in the active production of live steam for the steam cylinders.

In addition to the increase in efficiency or effectiveness thus obtained, the engine is particularly well adapted for use upon motor vehicles for the reason that after it has once been in operation, it may be restarted without cranking after a short stop by merely admitting steam to the steam cylinders, sufficient steam pressure remaining in the boiler to permit this. Furthermore, in case of accident to the ignition system of the firing cylinders or injury to the cylinders such as would prevent generation of power therein, the engine may be operated entirely upon steam by use of the burner 48. This burner will also serve to prevent any freezing in the system during prolonged stops in cold weather and if desired, may be used to preheat the water in the boiler prior to the starting of the engine.

Having thus described the invention, what is claimed as new is:

1. In a motor, the combination with firing cylinders having water jackets, and steam cylinders, of a combined boiler and radiator including a casing and a conveyer within the casing, means for maintaining a constant water level in the conveyer, means including the lower portions of the conveyer for maintaining a circulation of water through the water jackets, means for leading exhaust gases from the firing cylinders into the upper portions of the casing to heat the water within the conveyer, means for leading steam from the upper ends of the conveyer to the steam cylinders, and means for conducting the exhaust steam from such cylinders to the interior of said casing at a point adjacent the water level of the same.

2. In a power system, in combination, an internal combustion engine having a water jacket and an exhaust, a steam engine having an exhaust, a steam generator including a series of coils, means for supplying water to the coils at the lower portion thereof, means establishing communication between the upper portion of the coils and the chest of the steam engine, means for conducting the exhaust from the internal combustion engine and directing the same against the upper portion of the coils, means for conducting water from the water jacket of the internal combustion engine to

an intermediate portion of the coils, and means for conducting exhaust steam from the steam engine to another intermediate portion of the coils and discharging the same thereagainst.

3. A power plant including an internal combustion engine having an exhaust and a water jacket, a steam engine having an exhaust, a vertical casing having an exhaust inlet at its upper portion and an exhaust outlet at its lower end, a water conveyer arranged within said casing and extending from the bottom to the top of the same and having communication with said steam engine, means to conduct the water from said water jacket to said conveyer at a point adjacent the water level of the same, and means for discharging the exhaust steam from said steam engine against said conveyer.

In testimony whereof I affix my signature.

THOMAS A. KILLMAN. [L. S.]