No. 50,062.

PATENTED SEPT. 19, 1865.

S. WILCOX, JR.

HOT AIR ENGINE.

Fig. 1.

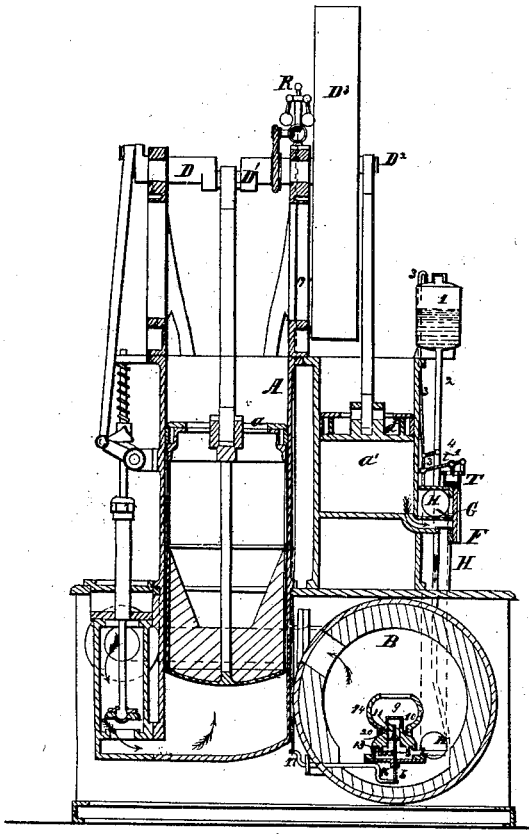


Fig. 2.

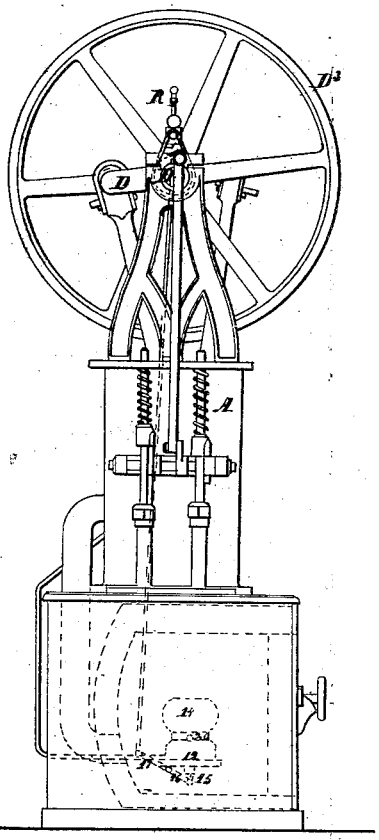
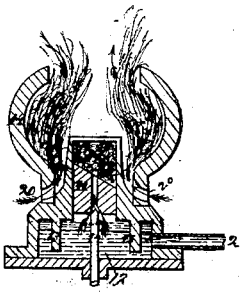


Fig. 3.



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STEPHEN WILCOX, JR., OF WESTERLY, RHODE ISLAND.

IMPROVEMENT IN HOT-AIR ENGINES.

Specification forming part of Letters Patent No. **50,062**, dated September 19, 1865.

To all whom it may concern:

Be it known that I, STEPHEN WILCOX, Jr., of Westerly, in the county of Washington, in the State of Rhode Island, have invented certain new and useful Improvements in Hot-Air Engines; and I do hereby declare that the following is a full and exact description thereof.

The accompanying drawings form a part of this specification.

Figure 1 is a vertical section on the line S S in Fig. 2. Fig. 2 is an end elevation. Fig. 3 is a section showing the burner on a larger scale.

Similar letters of reference indicate like parts in all the drawings.

My engine is of that class in which the combustion in the furnace is conducted under the working-pressure, so that the gaseous products of combustion may be made available to impel the piston. The air is pumped in by a suitable force-pump against the pressure in the furnace. It is expanded by heat and is worked off through the working-cylinder, giving out more power in its discharge than was required to force it in.

The extraordinary development of what is known as "petroleum-oil," and the several products obtained therefrom, make it practicable to produce and work very small engines on this plan.

My engine may be produced on a large scale, if desired, with the novel parts duplicated to any extent necessary; but it is more especially intended for small powers, such as from a half-horse power down to a half-man power, or even much smaller.

My invention consists, first, in means for urging in the hydrocarbon fluid, so as to neutralize the effect thereon of the pressure obtaining in the furnace; second, in means for regulating the admission of the hydrocarbon fluid according as the pressure in the furnace fluctuates, so as to admit more when the pressure becomes too low, and the reverse; third, in a certain arrangement of the parts for transmitting heat downward from the flame to the hydrocarbon, so as to evaporate more or less, in proportion as more or less is contained in the evaporating-pan; fourth, in means for regulating the escape of the vapor into the furnace according as the speed of the engine varies, so as to allow more to escape when the speed becomes too slow, and the reverse; fifth, in a certain arrangement of the parts by which the area of the discharge-passages for the vapor is varied immediately at the orifice where the jets escape, so as to eject large or small quantities with uniform force; sixth, in means for enabling the slight excess of pressure of the vapor in the burner over that in the other parts of the furnace, to aid in regulating the admission of the hydrocarbon to the evaporator, so as to retard it when the evaporation proceeds too fast; seventh, in certain means for defending the flame from the irregular blasts of air forced in by the pump and of causing the jets of vapor to draw into the defending and heat-receiving globe a proper amount of air to effect the combustion therein.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation by the aid of the drawings and of the letters of reference marked thereon.

A is the working-cylinder, *a* the working-piston, *a'* the supply-cylinder or force-pump, and a^2 the supply-piston. D is the main shaft; D' and D^2, the cranks, which are respectively connected to the working-piston and supply-piston, as represented; and D^3 is the fly-wheel. These parts, as also the main framing, the casing, the main connections, and the induction and eduction valves, and the means of operating them involve no important novelties, and as they are fully shown in the drawings they need not be particularly described.

1 is an elevated reservoir containing petroleum or other hydrocarbon. 2 is a pipe which conducts the petroleum down, and 3 is a pipe which puts the upper part of the vessel 1 in free communication with the interior of the furnace B. It follows that the pressure in the furnace B is always exactly balanced by the pressure in the upper part of the vessel 1, so that the petroleum may flow down through the pipe 2 into the furnace B under precisely the same conditions as if there were no pressure in the furnace.

4 is a stop-cock which controls the flow of the fluid through the pipe 2. 5 is a link connected to the lever of the stop-cock 4, and *t'* is a lever connected to the link 5 and also to the piston *t*, which is adapted to slide in the cylinder T and to receive the pressure of the

urnace B on its under surface, while its upper surface is exposed only to the pressure of the ordinary atmosphere. Whenever the pressure in furnace B exceeds the proper amount it overcomes the gravity of the piston *t* and its connections, and raising them, partially closes the stop-cock 4. This checks the descent of the petroleum into the furnace and diminishes the intensity of the fire, and consequently lowers the pressure in the furnace B. Whenever the pressure becomes too low a reverse movement of these parts supplies more petroleum and increases the fire and pressure.

9 is a hollow cylinder closed at the top, and provided with holes 10 to allow the escape of vapor in nearly horizontal jets, as indicated.

11 is a movable stop or piston having its upper face inclined, and having ample provision for the rise of the vapor through its interior.

12 is a broad vessel or pan of cast-iron or other suitable material, in which the petroleum or other volatile hydrocarbon fluid stored in the reservoir 1 is spread out and exposed to be evaporated.

13 represents spurs or legs descending from the heated burner 9 into the petroleum in the pan 12, in order the better to conduct heat downward thereto.

14 is hollow globe or shell of cast-iron, which is intensely heated by the jets of flame from the holes 10, and which conducts heat downward, as will be obvious. Provision is made by holes 20 for the induction of air at the base of the globe 14, and a capacious passage is provided for the escape of the hot gases at the top of this globe, to be diffused in the upper part of the furnace B.

15 is a link connecting the movable piece or piston 11 with an arm or bent portion of the slight rock-shaft 16.

17 is a rod, which connects another arm on this rock-shaft 16 with an ordinary fly-ball governor, R. When the engine runs too fast, so that the fly-balls in the governor R rise too high, they move the rod 17, and by rocking the rock-shaft 16 lift the connection 15 and the piston 11 and partially close the apertures 10, through which the jets of vapor are discharged. This reduces the intensity of the heat, and thus moderates the speed of the engine.

It is desirable that the vapor issuing through the jets 10 shall always escape with about the same velocity, whether a large or small quantity is allowed to issue in a given time. The fact that the passage from the evaporating-pan 12 into the upper part of the cylinder 9 is always entirely free, and that the movable stop or piston 11 controls the escape of the vapor immediately at the discharge-openings 10, insures this result. The discharge-openings 10 are practically enlarged and diminished with each fluctuation in the speed of the engine, while the pressure of the vapor at the openings is not greatly varied. Consequently the vapor issues with nearly the same velocity, but in currents which vary in size or number.

My globe 14 may be readily removed and a new one supplied if it becomes cracked, warped, or otherwise injuriously affected by long exposure to intense heat. To effect this it is only necessary to slightly jar the part with a hammer and lift it off and press down a new one. The surface in contact between the base of the globe 14 and the casting 9 below is sufficient to afford a very rapid conduction of the heat downward, and the points or spurs 13 and the exterior walls of the casting 9 conduct the heat downward to the evaporating-pan 12 with such freedom as to insure the rapid production of the vapor.

The operation of my invention will be understood with but few additional words. The expansion of the air pumped in by the compressing-piston a^2 impels the working-piston *a* and gives power to the engine, depending on the pressure of the air and other gases in the furnace B, which must be considerably above that of the external atmosphere. Every revolution of the shaft D delivers during the latter portion of the descent of a^2 a supply of compressed air to the furnace by driving it up through the valve G and thence down through the pipe H into the furnace B. It is heated in the furnace by the combustion of the vapor of the petroleum or other volatile fluid deposited in the elevated reservoir 1. The pressure in the chamber or space just above the valve G is the same as in the furnace B, and it is communicated through the pipe 3 to the top of the reservoir 1. The petroleum therefore descends by gravity in the pipe 2 and exerts a pressure to flow past the cock 4 proportional to the height or head. If the apertures 10 for the jets of vapor be very much contracted, the pressure of the vapor in the burner 9 and in the evaporating-pan 12 and its connections increases and retards the flow of the petroleum down through the cock 4, and if it be much opened and the pressure lessened—that is, if the piston 11 be much lowered, so as to uncover more of the openings 10—the pressure of the vapor decreases and the flow downward through 4 is promoted, so as to supply more petroleum in the pan 12 and raise the pressure again. The level of the volatile fluid in the evaporator 12 thus tends to adjust itself and supply the proper amount of vapor under all openings or degrees of opening of the apertures 10; but I introduce a regulation (independent of or additional to the regulation of the openings 10, which will be detailed directly) by causing the cock to open and close more or less, according, not to the pressure of the vapor within the burner 9, but to the pressure obtaining throughout the entire furnace B and its connections. Whenever the engine, through excess of heat in the furnace B or other cause, generates too great a working-pressure it is felt under the piston *t*, and it rises a little and partially closes the cock 4, so as

to choke the fall of the petroleum; or, if the pressure in the furnace becomes too little, the cock 4 opens wide, so as to promote the descent of a greater quantity of the fluid, and increases the fire.

The area of the openings 10, from which the jets issue, is made to depend on the speed of the engine. When the engine starts to turn too rapidly the balls of the regulator R in rising raise the piston 11, and thus cover the whole or a portion of one of the orifices 10—the one which is on the side of the burner 9, where the piston 11 is thickest, (the left side in Figs. 1 and 3.) If the speed still increases after one hole is thus stopped, others will begin to close by the further rising of the piston H, and the vapor-jets being thus reduced, the heat in the furnace is lessened and the engine loses power until the speed is properly reduced. A too slow speed induces a reverse of all these changes and the jets of vapor increase in size and number. A new jet, on being let on by the descent of the piston 11, is instantly ignited by the heat of the globe 14 and of the gases circulating therein in a state of ignition from the other jets, which have remained all the time open. Under all circumstances vapor is allowed to escape, and it does so under the full pressure obtaining in the evaporator 12 and its connections, and consequently throws itself with full force across and into the currents of fresh air and against the interior of the cast-iron globe 14.

The fresh air forced in by the action of the piston a^2 is not all thrown into the globe 14. On the contrary, the jets from the holes 10 draw in by their own action a small part—just the quantity which is required—of the fresh air. The rest of the fresh air goes up outside of the globe 14 and merely mingles with and dilutes the flame. The air to mingle with the gases, or rather vapor in the globe, is drawn in through the holes 20, in the base of the globe, by an action similar to that by which the blast-pipe in locomotives draws air from the tubes and hurries it up the chimney. The vapor from the openings 10 is mingled with the globe 14 with just sufficient air to make the combustion complete, or only a little in excess of that quantity, and however violent may be the current of dense air driven in at certain periods through the pipe H, and however directly it may impinge on the globe 14, it cannot blow out or seriously disturb the flame therein.

It is evident that in lieu of the single piston-valve 11 a number of openings might be controlled by cocks, part of which might be closed entirely and part left wide open, and thus practically reduce the area of the escape-openings. This would realize to some extent the advantages of my invention; but I prefer the construction represented. The globe or casting 14 surrounding the flame prevents it from being disturbed by the violent currents of air discharged at intervals into the furnace, and also prevents the access of an undue amount of air to the flame, and preserves a very high temperature at the point of combustion.

Some of the advantages due to certain features of my invention may be separately enumerated, as follows:

First, by reason of the fact that the pipe 3 connects the furnace B or the space above the delivery-valve, which space is in connection with the furnace, to the upper end of the reservoir 1, I am able to insure the same pressure on the surface of the petroleum as obtains in the furnace, however the working-pressure may vary.

Second, by reason of the fact that the cock 4 is closed by means of the devices represented in proportion as the pressure in the furnace B, and consequently in the reservoir 1, increases, I obtain (other things being equal) a reduced descent of petroleum into the pan 12 (thereby tending to reduce the production of vapor) in proportion as the working-pressure in the engine increases, and regulate the temperature in the furnace as the exigencies demand.

Third. By reason of the fact that my heat-conducting spurs 13, vapor-burner 9, and evaporating-pan 12 are arranged as shown, I am better able to produce vapor in proportion as the level of the petroleum rises, and vice versa.

Fourth, by reason of the fact that the speed-regulator R checks the escape of vapor into the furnace as the speed becomes too great, I am able to keep the motion nearly uniform and to insure under all ordinary circumstances a quantity of flame just proportioned to the demands, even without the aid of the petroleum-cock 4.

Fifth, by reason of the fact that the vapor is shut off by reducing the effective area of the openings 10, I am able to obtain the full velocity due to the pressure of the vapor, whether the several jets discharge a greater or less quantity, and thus obtain perfect combustion and throw the heat upon the globe 14, and induct the air through the holes 20 in the same manner under all conditions.

Sixth, by reason of the fact that my adjustable device 11 varies the flow of the vapor and that the petroleum or other hydrocarbon is gently urged into the evaporator 12 from the elevated reservoir 1 by gravity, as represented, I am able to insure that when the consumption of vapor is decreased, so as to increase the pressure in the burner 9, its pressure, acting backward through the pipe 2, shall obstruct the descent of the petroleum, causing it to descend through the opening of cock 4, be the same great or small, with rapidity and consequently to stand lower in the pan 12, thereby causing a lesser evaporation and tending to soon lower the pressure in the burner 9, and an increase of consumption of the vapor will have an opposite effect on the supply of petroleum.

Seventh, by reason of the fact that my jets 10 induct a just sufficient quantity of fresh air through the holes 20 and effect complete combustion within the metallic protection 14, I am

able to avoid the disturbing influence of the intermittent blasts through the pipe H and burn the fuel under the best conditions, and at the same time to receive and conduct downward the heat of the flame to evaporate the hydrocarbon very effectively.

Having now fully described my invention, what I claim as new therein, and desire to secure by Letters Patent, is as follows:

1. The pipe 3, connecting the interior of the furnace B with the upper portion of the reservoir 1, for the purposes herein set forth.

2. The loaded piston *t*, in combination with the cock 4, adapted to regulate the area of the orifice in the cock 4, through which the petroleum flows from the reservoir I to the furnace B, according to the fluctuations of pressure obtaining in the furnace B, substantially as and for the purpose herein set forth.

3. The arrangement of the heat-conducting spurs 13, burner 9, and evaporator 12, substantially as and for the purposes herein set forth.

4. Connecting and combining the fly-ball or equivalent speed-governor R with the piston 11, or its equivalent, for controlling the issue of hydrocarbon vapor into the furnace of an air-engine, substantially as and for the purpose herein specified.

5. In combination with an air-engine adapted for the use of hydrocarbon vapor in the manner substantially as specified, the jet-holes 10 and one or more pistons or stops 11, arranged immediately adjacent thereto, so as to jet with the full velocity, even when partly closed, all substantially as and for the purpose herein set forth.

6. The employment, in an air-engine, of an elevated reservoir 1, evaporating device 12, and a regulating device, 11, acting on the hydrocarbon after its change to the vaporous form, the several parts being arranged to operate together, substantially in the manner and for the purposes described.

7. The arrangement of the vapor-burner 9, metallic globe 14, fresh-air passages 20, and jets 10 relatively to each other and to the evaporating-pan 12, or its equivalent, adapted to receive heat from the metallic globe 14, substantially in the manner and for the purposes herein set forth.

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

STEPHEN WILCOX, JR.

Witnesses:
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D. W. STETSON.