(No Model.)

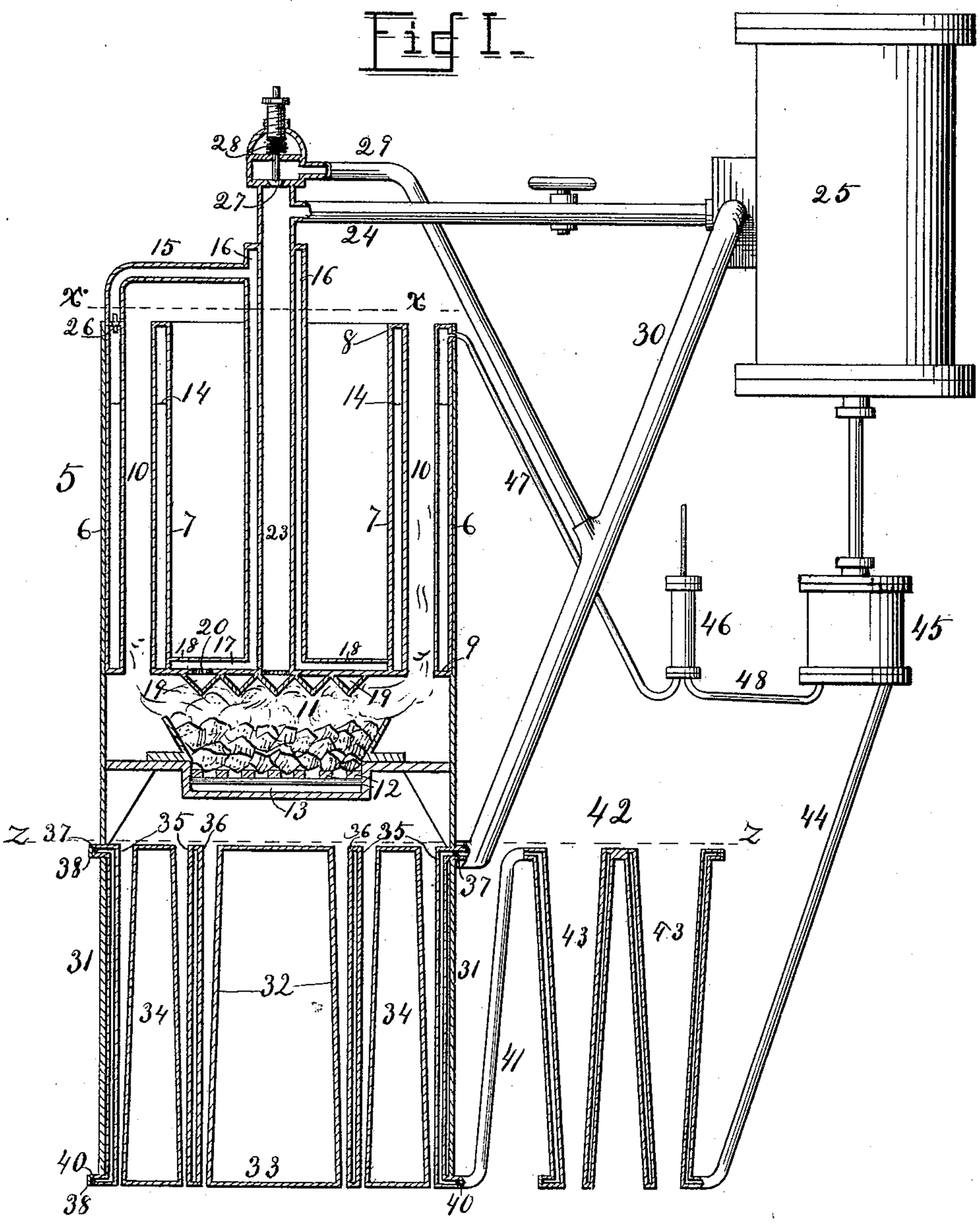
2 Sheets—Sheet 1.

A. HASBROUCK.

STEAM GENERATOR.

No. 405,837. Patented June 25, 1889.

Fig 1.



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(No Model.) 2 Sheets—Sheet 2.

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Fig II.

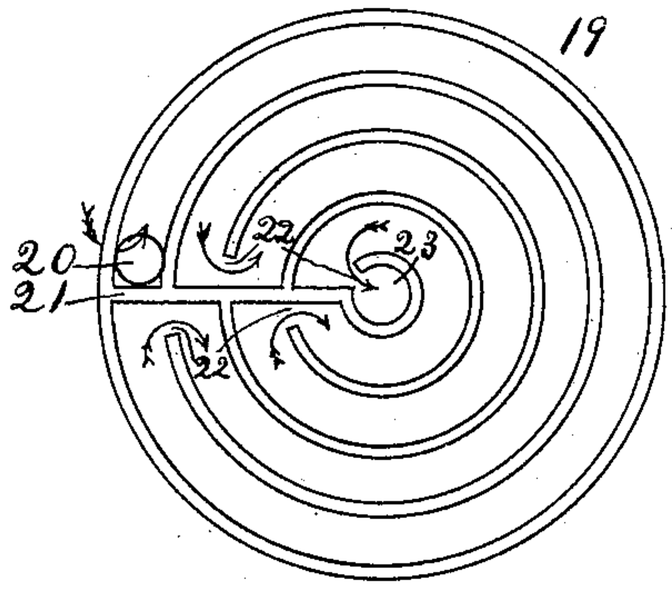


Fig III.

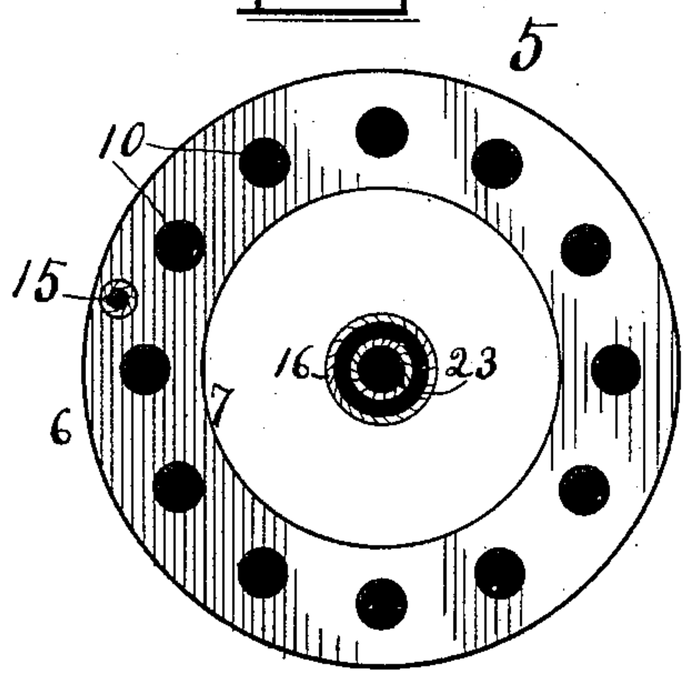
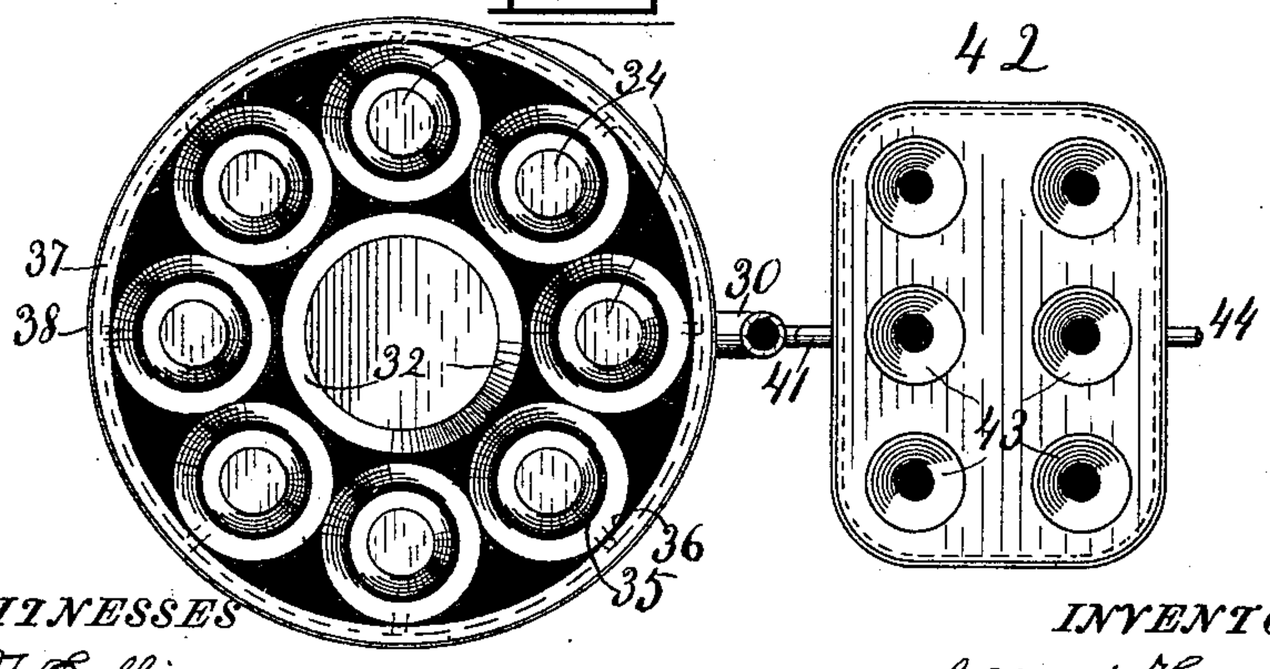


Fig IV.



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UNITED STATES PATENT OFFICE.

ALFRED HASBROUCK, OF ITHACA, NEW YORK.

STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 405,837, dated June 25, 1889.

Application filed March 20, 1889. Serial No. 303,956. (No model.)

To all whom it may concern:

Be it known that I, ALFRED HASBROUCK, a citizen of the United States, residing at Ithaca, in the county of Tompkins and State of New York, have invented certain new and useful Improvements in Steam-Generators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of my invention is to produce a steam-generator adapted for service on that class of locomotives which are designed to travel at large—that is, upon highways or fields—without the aid of supporting rails or tracks. The main obstacle at present recognized to this class of engineering is the great weight of the engine necessary to produce the amount of power required for self-propulsion and for service, and that weight is largely due to the great amount of water used in the boiler, and to the great thickness of the boiler required to sustain the high pressure of the steam as it has been used. In order to overcome these obstacles my object is to produce a steam-generator that shall develop the required amount of power by consuming the least practicable amount of water, thus requiring less water to be carried than heretofore, and that shall produce steam at a high degree of heat and consequent expansion without its exerting a high pressure on the boiler, thus permitting a lighter boiler to be used with safety. I base my invention on the principle that a small amount of water first converted into saturated steam in a boiler may be suddenly superheated after leaving the boiler proper and then be permitted to flow into the engine-cylinder at a pressure very little above normal atmospheric pressure, thereby producing a great increase in bulk for service at a perfectly safe pressure, and that this highly-superheated steam, holding so little water may consequently be easily and quickly condensed on the opposite side of the piston, thus producing a vacuum to aid in operating the piston, and that the small amount of water thus obtained may be readily returned to the boiler, while the large amount of heat unconsumed in service may be returned to the fire and utilized in the round of producing steam.

To this end my invention consists in the construction and combination of parts forming a steam-generator hereinafter described and claimed, reference being had to the accompanying drawings, in which—

Figure I represents a vertical section of my steam-generator, some parts being shown in side elevation and no regard being had for proper proportion of parts, the thickness of the material shown being proportionally too great and the size of the conducting-pipes in some instances too small. Fig. II represents the principal portion of the superheater uncovered in plan view on a larger scale than the other figures. Fig. III is a plan view taken at the line X X of Fig. I. Fig. IV is a horizontal section at the line Z Z of Fig. I.

5 represents the boiler, which is of annular form, bounded by an outer shell 6, an inner shell 7, a top 8, and a bottom 9. Vertically through the boiler ascends a number of flues 10, which form the draft from the furnace 11.

12 represents the fire-grate, and 13 the ash-pan below it.

The water in the boiler occupies the whole annular space within the shell 6 and around the draft-pipes 10 up to the line 14, above which is the space for saturated steam.

15 represents a pipe for conducting the steam to the vertical pipe 16, down which the steam flows to space 17 beneath a head 18. Thence the steam passes into the superheater 19 through the aperture 20, near the circumference thereof. The superheater is in the form of a series of pipes in circular coils, one within the other, and triangular or V-shaped in cross-section. The superheater is placed directly over the furnace 11, as close as is practicable to the burning fuel. The angles of the pipe project downward into the heat, presenting two-thirds of the whole surface of each pipe to the direct action of the most intense heat of the furnace.

21 represents a partition dividing each circle of the pipe, and 22 represents a series of holes near the partition communicating from one pipe to another, as shown by the curved arrows. The steam in its passage through the superheater goes to and fro around these

circles from the circumference at 20 to the central pipe 23, up which it may rise and pass to the cylinder 25 of the engine through the steam-pipe 24.

26 represents a check-valve, which prevents back-pressure between the superheater and the boiler.

27 represents the safety-valve, provided with an adjustable spring 28, whereby tension on the valve may be regulated to any number of pounds' pressure per square inch that may be desired. It is my intention to so regulate this valve that the pressure would be very little above normal atmospheric pressure. Should the steam be made more rapidly than it is consumed, this safety-valve will rise and permit the steam to escape through a discharge-pipe 29, leading to a pipe 30, which communicates with the condenser located below the furnace 11. The construction of the cylinder 25 is not a matter of any peculiarity so far as the present invention goes, and it may be of any usual form or construction. The pipe 30 is the exhaust-pipe, and communicates, as before stated, with the condenser, the effect of which is to produce a vacuum on the opposite side of the piston to that on which the live steam is acting at each stroke.

31 represents the outer shell of the condenser.

32 represents the inner shell, consisting of a cone-shaped pipe closed at both ends.

33 represents the base of the cone.

34 represents a series of cones of the same height and closed at both ends, located around the central cone 32. Each of the cones 34 is surrounded by an annular pipe formed of two walls 35 36, with the interior of which the exhaust-pipe 30 communicates by means of an annular groove 37 in the edge of the upper head. This groove is covered in by a hoop or band 38, which is brazed upon the edge of the said head, thereby forming the groove 37 into a steam-pipe. 39 represents a series of passages communicating between the said pipe 37 and the annular pipes 35 36. 40 is a similar groove around the lower head of the condenser, and similarly covered in, forming a pipe, which also communicates with all of the internal pipes 35 36 to receive water condensed in the said pipes, and 41 is a pipe communicating between the groove 40 and another condenser 42, which is also constructed of annular cone-shaped pipes 43. The base of these cone-shaped pipes is upward, there being a free passage for air vertically through them, and the annular space around the pipes being occupied by water which has been condensed from the steam.

44 is a pipe communicating between pipes 43 and the vacuum-pump 45.

46 is a pump connected with the boiler by pipe 47 and with the vacuum-pump by pipe 48.

The principle of operation is as follows: The water occupying the annular space in the boiler is heated barely enough to form it into steam, which rises through the pipe 15 and passes into the pipe 16, which carries it into the superheater 19, in which the steam is exposed to the intensest heat of the furnace and highly expanded. Thence the steam passes up the pipe 23 and through the pipe 24 to the engine-cylinder 25, which it enters in the usual manner, and the exhaust-pipe 30, communicating with the cylinder and with the condenser, forms a vacuum behind the piston at every stroke, whereby the engine is operated more by the vacuum than by actual pressure of the steam. The heat of the steam, being communicated by the process of condensation to the air surrounding the conical tubes 33 34, passes upward into the fire, and is again utilized. The conical form of the tubes 33 and 34 provides a very narrow inlet at the bottom for air and a very broad outlet at the top for the air, and the sides, being conical, deflect the air upward, thereby forming a very strong draft, and actually pressing the air into the furnace 12. The air being thus heated before it enters the furnace causes great economy in fuel. As that portion of the condenser which is immediately below the furnace may in the course of service become somewhat heated, I have provided an auxiliary condenser, consisting of the pipes 43, as hereinbefore described, through which the air may pass freely, in order that the steam may be sure to be completely condensed before its return to the boiler through the pipe 44, the pump 45, the pipe 48, the pump 46, and the pipe 47. By thus returning the water to the boiler at a heat very little below steam temperature, it may be again raised into steam by the addition of but a very small quantity of heat from the furnace; and by heating the steam to a high degree of temperature and permitting it to pass into the engine for service at a very low pressure, I have succeeded in producing work at a medium between the two extremes, whereby very little pressure on the boiler is required and a very light boiler is enabled to do the work; and by the same means of condensing highly superheated steam and returning the water thus condensed to the boiler at a temperature barely below steam heat I succeed in producing the desired amount of power with the least practicable consumption of water. The check-valve 26, placed in the steam-pipe 15 between the superheater 19 and the boiler 5, prevents any back-pressure into the boiler from the superheater. The safety-valve 27, being adjustable to the amount of pressure at which it is desired to work the steam and communicating with the condenser by means of the pipes 29 and 30, not only protects the engine from any possible danger of explosion, but it saves such surplus steam, or the heat therein, by returning it through the condenser, as before described, to the furnace. It will be seen that this system of using the steam at a very high heat and very low pressure practically results in the mere application of the caloric or heat to direct work or

service. The furnace, being located beneath the central opening of the annular boiler, does not give its direct and most intense heat to the boiler, and thus avoids raising the pressure within the boiler too high; but the superheater is located directly over the furnace to receive its most intense heat, whereby great expansion of steam is quickly obtained. By means of the exhaust-pump 45 the water resulting from the condensation of steam is quickly drawn from the condenser, and by means of the force-pump 46 that water is returned without loss to the boiler.

For the purpose of increasing the efficiency of the condenser-tubes I coat them with the product of the slow combustion of benzine and sulphur deposited upon the cold metal. There are other substances and compounds—such, for instance, as sulphur and iodine—which produce a similar effect, and I do not claim any of these as my invention.

Having thus fully described my invention, what I believe to be new, and desire to secure by Letters Patent, is the following:

1. The combination, in a steam-generator, of the annular vertical boiler 5, provided with the flues 10, the steam-pipes 15 and 16, and the check-valve 26 in the steam-pipe, the furnace 11, the superheater 19, located directly over the furnace, and the annular steam-compartment 17, located on the top of the superheater and communicating between the latter and the central pipe 23, substantially as shown and described.

2. The combination of an annular steam-boiler, a furnace located beneath its central opening, and a superheater located directly over the furnace and connected with the boiler by a pipe or pipes, and provided with a discharge-pipe, substantially as shown and described.

3. The combination of a vertical annular steam-boiler provided with flues passing through its annular portion, a furnace located beneath its central opening and communicating remotely with the said flues, a superheater located directly over the said furnace and beneath the said central opening of the boiler, a vertical pipe passing centrally down the said opening, and a steam-pipe between the boiler and the said vertical pipe, a check-valve in the last-named pipe, and another vertical pipe passing from the center of the superheater through the first-named vertical pipe, and a steam-pipe adapted to connect the latter vertical pipe with an engine, substantially as shown and described.

4. The combination of a vertical steam-boiler, a furnace below it, a steam-condenser directly below the furnace and provided with passages for air through it to the furnace, a steam-pipe between the boiler and the superheater, a steam-pipe adapted to lead from the superheater to an engine-cylinder, a safety-valve in the last-named conductor, and a steam-pipe from the outlet of the said safety-valve to the said condenser, substantially as shown and described.

5. The combination of a vertical steam-boiler, a furnace beneath it, a superheater directly over the furnace, an engine-cylinder, steam-conductors between the boiler and superheater, and between the superheater and the steam-ports of the said cylinder, a condenser beneath the furnace having openings or flues through which the draft to the furnace is admitted, an exhaust-pump and a force-pump, and pipes connecting the exhaust-ports of the cylinder and the condenser between the condenser and the exhaust-pump, between the two pumps, and between the force-pump and the boiler, whereby suction may be exerted on the exhaust-ports of the cylinder through the intermediate condenser, and whereby the water condensed from the exhaust-steam may be continually returned to the boiler.

6. The combination, in a steam-generator, of a furnace, a series of coils of pipe located one within another above the furnace, a partition across each pipe, a series of apertures communicating between adjacent pipes near the said partition, whereby a continuous passage for steam is obtained from the circumference to the center of the series of pipes, and an inlet near the circumference thereof and an outlet near the center, substantially as shown and described.

In testimony whereof I affix my signature in presence of two witnesses.

ALFRED HASBROUCK.

Witnesses:

EDWARD E. WILLIAMS,

C. H. BIERBAUM.