(No Model.) 3 Sheets—Sheet 1.

J. A. BACHMAN & A. C. GOETH.

EXHAUST STEAM CONDENSER.

No. 544,652. Patented Aug. 20, 1895.

FIG. 1.

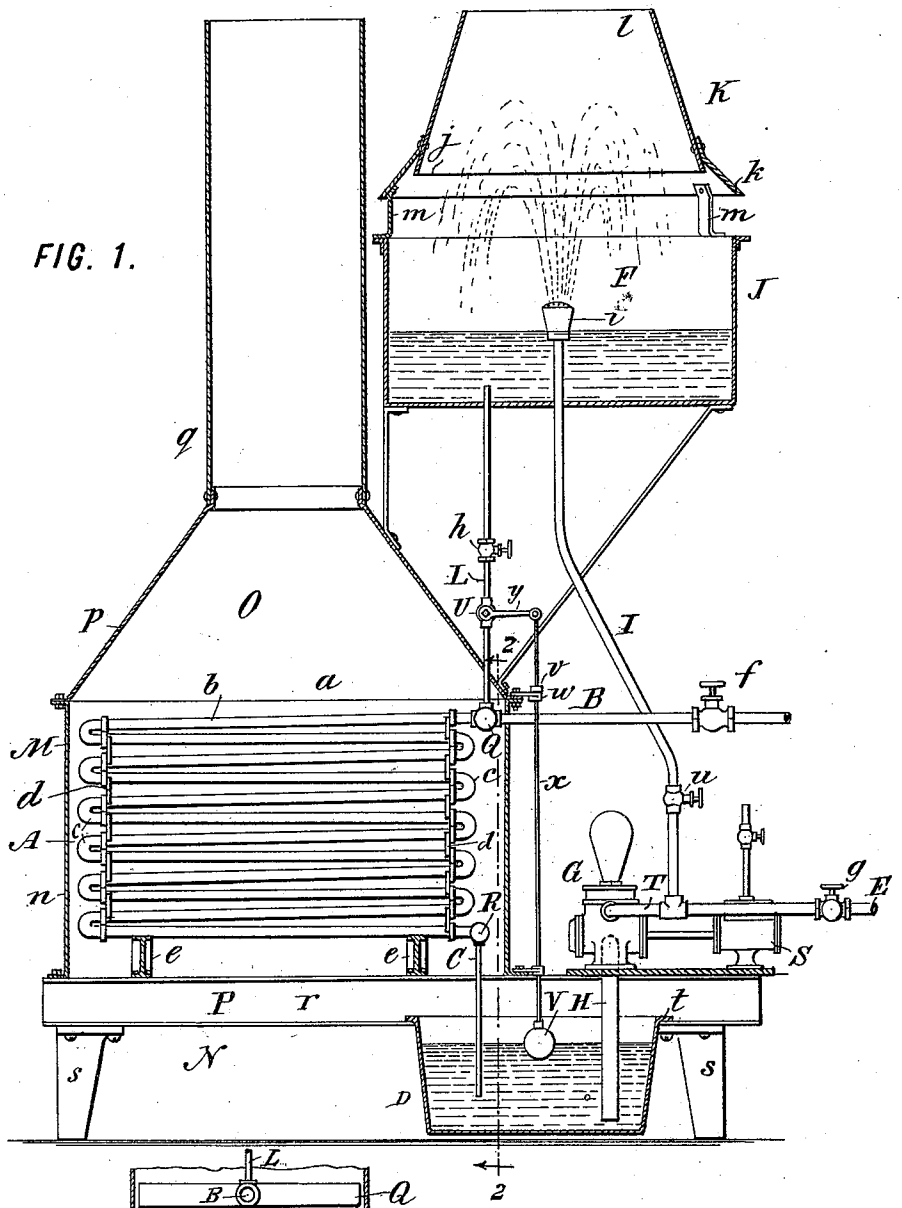

FIG. 2.

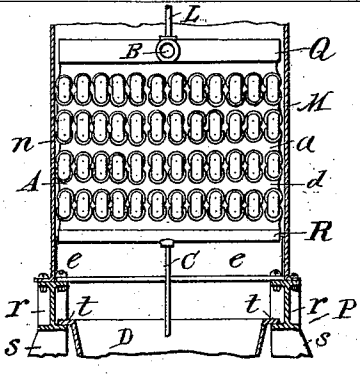

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FIG. 3.

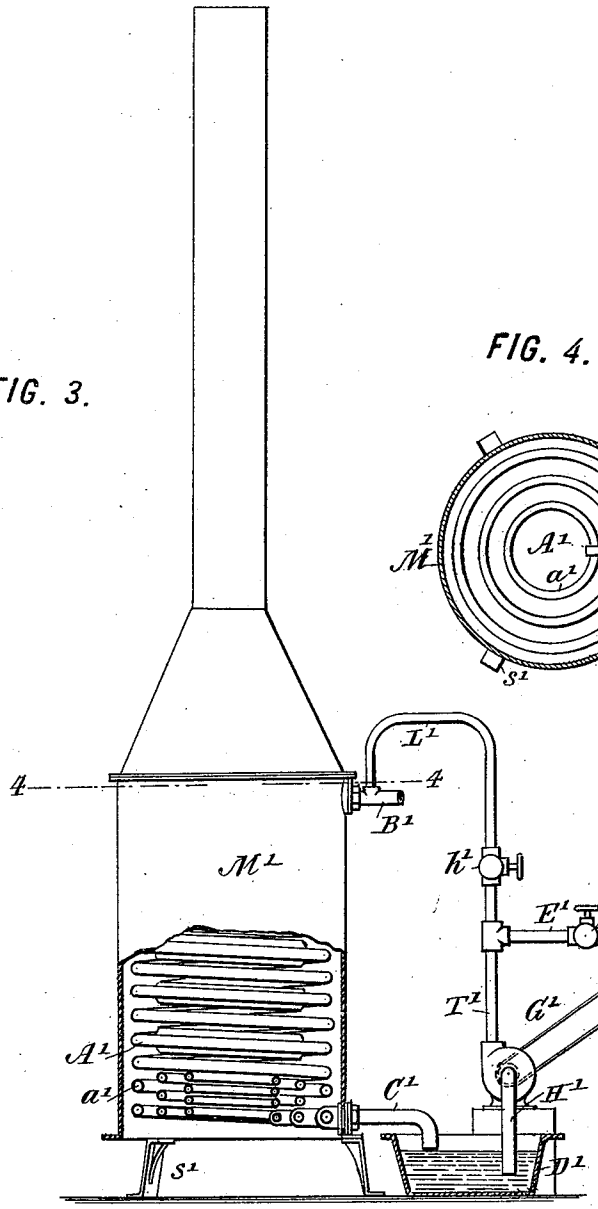

FIG. 4.

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EXHAUST STEAM CONDENSER.

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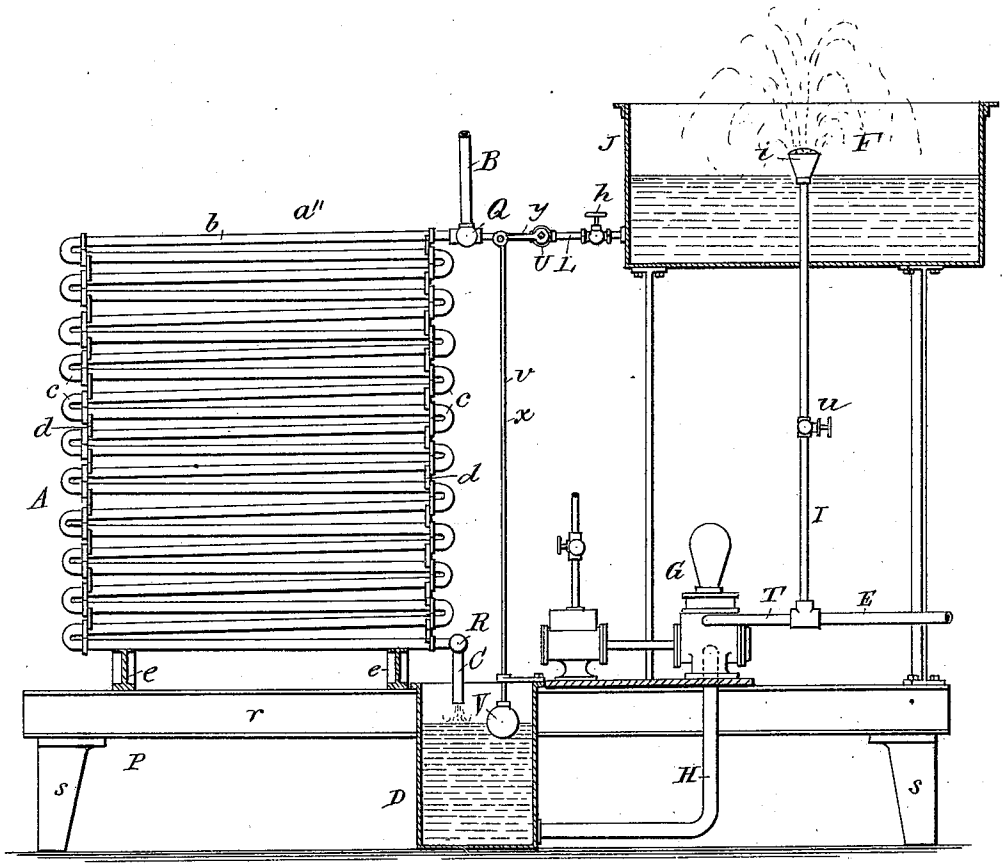
FIG. 5.



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UNITED STATES PATENT OFFICE.

JOSEPH A. BACHMAN AND ADOLF C. GOETH, OF AUSTIN, TEXAS.

EXHAUST-STEAM CONDENSER.

SPECIFICATION forming part of Letters Patent No. 544,652, dated August 20, 1895.

Application filed July 20, 1894. Serial No. 518,084. (No model.)

To all whom it may concern:

Be it known that we, JOSEPH A. BACHMAN and ADOLF C. GOETH, citizens of the United States, residing at Austin, in the county of Travis and State of Texas, have invented certain new and useful Improvements in Exhaust-Steam Condensers, of which the following is a specification.

This invention relates to surface condensers, particularly to the class of such condensers employed for condensing the steam of steam-engines at places where the scarcity of water makes the saving of the water of condensation important and prevents the use of water for cooling the surfaces of the condenser. Such condensers are particularly desirable for use with traction-engines or other steam-engines employed in dry or arid places or where the water existing is too impure for use in a steam-boiler.

Heretofore surface condensers have been employed in which a current of air has been forced or sucked by a blower through the spaces between the condensing-surfaces, in order that the flowing air might carry off the heat radiated from these surfaces and thereby preserve their temperature at a sufficiently low degree to insure condensation of the steam.

Our present invention aims to provide an improved condenser of simple construction and which will be more effective and convenient in operation than those heretofore employed. To this end, in carrying out the invention in its preferred embodiment, we employ a sinuous condensing surface—as a coil or coils, for example—an inclosing-casing for this surface, having air inlet and outlet apertures, the inlet-aperture being arranged to supply the coldest air at the coolest point of the condensing-surface, and the outlet-aperture being arranged to withdraw the air from the hottest or steam-inlet point of the condensing-surface, whereby the inflowing current of steam traverses the condensing-surface in opposite direction to the air-current, so that the latter in its flow meets successively hotter surfaces as it approaches the outlet, whereby an active circulation of air can be secured without the employment of pumps or blowers; and we also provide a collector for the water of condensation at the discharge end of the condensing-surface, a storage-tank for this water, means for cooling the water in the storage-tank, and means for feeding a small quantity of the cooled water through the condensing apparatus with the inflowing steam, whereby it expedites condensation. The condensation-tank is connected to the feed-pump of the boiler to supply the hottest water of condensation thereto, and the storage-tank is connected with the condensation-tank by a pipe through which the water of condensation is pumped and from which it is discharged in a fine spray into the air above the storage-tank, by which means the minute particles of water are cooled before being deposited in the storage-tank. A pipe leads from the storage-tank to the condenser and supplies a graduated stream of the cooled water to the latter.

In the accompanying drawings, Figure 1 is a vertical longitudinal section showing the preferred form of our improved condenser. Fig. 2 is a fragmentary cross-section thereof cut on the line 2 2. Fig. 3 is an elevation, partly in section, showing a modification. Fig. 4 is a fragmentary cross-section thereof on the line 4 4; and Fig. 5 is an elevation, partly in section, of another modification.

Referring to Figs. 1 and 2, we will first describe the preferred form of the invention. In these figures, A is the condensing-surface; B, the exhaust-steam pipe leading thereto; C, the discharge-pipe for water of condensation leading therefrom; D, the receiving-tank for this water; E, the feed-pipe taking water from this tank to an engine-boiler; F, the cooling apparatus for the condensed water; G, a pump for forcing the water from the tank D to a boiler and to the apparatus F; H, a pipe leading from the tank D to the pump G; I, a pipe leading from the pump G to the apparatus F; J, a storage-tank for the water discharged by the apparatus F; K, a hood thereover; L, a pipe supplying water from the tank J to the condensing-surface; M, a casing inclosing the surface A; N, the inlet-aperture of this casing; O, the outlet-aperture thereof, and P the supporting-frame of the apparatus.

The condensing-surface A is preferably composed of one or more coils of pipe *a*, arranged in such manner that they give a long sinuous or winding condensing surface or

passage from the inlet to the outlet of the coils. In the construction shown twelve coils are disposed side by side, each consisting of straight lengths of pipe *b*, oppositely inclined, united at their ends by elbows *c*, separated by intervening brackets *d*, and all connected at top by an inlet-union or cross-pipe Q and at bottom by an outlet-union or cross-pipe R. The coils are supported by cross-girders *e* at bottom, which form part of the frame P.

The exhaust-steam pipe B is provided with a suitable valve *f* and leads from the exhaust of an engine or from any suitable source of exhaust-steam to the union Q at the top of the coils. The inflowing steam passes into the union Q and there distributes itself into the twelve coils, downwardly through which it flows. The steam is hottest at the top pipes and condensation gradually takes place as it flows downwardly through the succeeding pipes to the discharge-union R, at which point the condensation is supposed to be complete and the pipes the coolest. The water of condensation in the several coils unites in the union R and flows downwardly through the pipe C to the tank D, where it collects. The pipe E leads from any suitable feed-pump to a steam-boiler, and hot water of condensation as it comes from the condenser may be taken through this pipe from the tank D to the boiler.

According to one feature of our invention a stream of pure water, preferably water of condensation, is fed through the condenser with the inflowing steam to facilitate condensation, and according to another feature the water used for this purpose is taken from the hot water in the discharge-tank of the condenser and cooled in some suitable manner before being fed again into the condenser. In this manner a graduated and constant current of relatively cool water is fed into the condenser, and as it is discharged therefrom with the water of condensation it is again cooled and used. In practice a continuous circulation of water is maintained through the condenser, flowing therethrough in the same direction as the steam. This is accomplished in the construction shown by the pump G, which is an ordinary pump driven by an engine S or in any suitable manner, the induction-pipe H of which pump takes water from the lower part of the tank D, and the eduction-pipe T of which pump discharges the water in part through the feed-pipe E to a boiler and in part into the tank J through the pipe I, from which it is drawn through the pipe L in a flow which is graduated by the valve *h* into the condenser at the top of the union Q, or to any other suitable point at which water can be mingled with the inflowing steam.

Our invention comprises improved means for cooling the water of condensation to be circulated through the condenser. According to this improvement the water is sprayed into the air, preferably under considerable pressure, and afterward collected in the tank J. To accomplish this we provide a spraying-nozzle *i* on the upper end of the discharge-pipe I of the pump and in about the center of the tank J, which nozzle discharges the upwardly-flowing stream of water in a fine spray or innumerable minute jets into the air above the tank. The spray or jets rise to a considerable distance in the air and then under the influence of gravitation fall into the tank. During this operation a large portion of the heat contained in the sprayed water is abstracted by the surrounding air, and also a slight evaporation takes place, which has a further cooling effect upon the particles of water, so that the water as it collects in the tank is comparatively cool.

To prevent loss of the sprayed water we prefer to provide a hood or shield K over the tank J. This is in the nature of a coned chimney open at top and bottom, elevated slightly above the top of the tank, and having a lip *j* within the vertical plane of the outer wall of the tank, from which lip any water collecting on the inner face of the shield may fall back into the tank. The shield protects the spray from being blown sidewise by the wind, and also serves to permit an upward draft or air-current through the spray, the air flowing in around the lower edge *k* of the shield and out of the open top *l* thereof. The shield is supported from the top of the tank J by legs *m*.

The inclosing-casing M is preferably a sheet-metal casing having a vertical body *n* closely surrounding the coils *a* of the condenser, having an inlet-opening N at bottom and an outlet-opening O at top. The inlet-opening is formed by leaving the bottom of the body A open, and the outlet at top is formed in the nature of an elongated chimney having a flaring base *p* bolted to the top of the body *n* and a tubular stack or chimney *q* carried on the top of this base. In this manner the construction of the shell tends to induce a natural draft upwardly through it, which draft must rise through the spaces between the condensing-surfaces and tend to cool the latter. This draft is opposed in direction to the course of the steam passing through the condenser, according to one feature of our invention, whereby the speed of the upward movement of the air is increased by reason of the progressively-increasing heat of the condenser-pipes from the bottom to the top, and the cooling effectiveness of the draft is augmented because the coldest air on entering the casing acts against the coldest pipes and as it rises through the condenser and is gradually heated it acts against gradually hotter pipes, thereby maintaining a substantially uniformly lower temperature for the air relatively to the pipes it successively passes, so that it serves to cool each in turn and to substantially the same extent.

The framework P may be any suitable supporting-frame, that shown having two longi-

tudinal beams r, to which the body n is bolted, two cross-beams e within the body, bolted to the tops of the beams r and carrying the coils a and legs s, bolted to the under sides of the beams r. The tank D is preferably a sheet-metal tank having flanges t, which support it by resting on the bottom flanges of the beams r.

In operation the exhaust-steam in flowing through the condenser will be reduced to water of condensation and collect in the tank D. In some instances and especially in cold weather the natural draft of air through the casing and the induced draft incident to the radiation of heat, as described, will be sufficient to effect complete condensation, and in such cases the auxiliary circulation of water of condensation through the condenser with the steam may be dispensed with. In general, however, it will be found desirable to maintain this circulation and cool the portion of the water of condensation employed therefor, either by the cooling apparatus F or in any other suitable manner. In such case the pump G will be operated to spray the water above the tank J, in which it will be collected and from which it will be drawn into the condenser through the pipe L.

It will be seen that our invention provides an improved surface condenser which can be conveniently and advantageously availed of, and which when desired can be used with practically no loss of the water of condensation.

It will be understood that the invention is not limited to the particular construction and arrangement set forth as its preferred form, as it may be availed of according to such modified details of construction or arrangement of the whole or any part of the apparatus as circumstances or the judgment of those skilled in the art may dictate without departing from the spirit of the invention.

Figs. 3 and 4 illustrate a modified construction in which the condensing-surface A′ is composed of a series of spiral coils a', the shell is a cylindrical shell M′, mounted on legs s', and the inlet-pipe B′ and water-pipe L′ are united at the outside of the casing. In this construction the tank D′ receives the discharge from the outlet C′, and the pump G′ draws the water from this tank and feeds it directly to the pipe L′ and to the feed-pipe E′, the flow being controlled through the latter by its valve g' and through the former by its valve h'.

The apparatus may be stationary or portable, depending upon its size or the character of steam-engine with which it is employed.

An automatic controller for the water flowing into the coil is preferably provided in the form of a valve U, operated by a float V in the tank D. By reducing this flow as the water in the tank rises, it prevents overflow in the latter.

Fig. 5 shows a construction substantially like that in Fig. 1, except that the coil a'' is not inclosed, but is exposed to the outer air, and the hood K is omitted. The other parts in this figure are designated by the same letters as the like parts in Fig. 1.

What we claim is—

1. In surface condensers, the combination with a condensing surface consisting of a tubular coil, having an inlet for exhaust steam at one end and an outlet for water of condensation at its other end, of a casing inclosing said coil and having an air inlet at its end adjacent to the outlet of said coil, and an air outlet at its end adjacent to the steam inlet to said coil, whereby a natural current of air is permitted through said casing about said coil, and the cool entering air first contacts with the coolest portion of said coil, and successively with hotter portions thereof, and finally near said outlet with the hottest portion of said coil, whereby an active circulation of air is maintained through said casing without the employment of air forcing devices, and the air current serves to cool the condensing surface a receptacle receiving the water of condensation from said surface, and a circulating system comprising said coil, said receptacle, and a connection between the latter and the inlet end of said coil taking such water from said receptacle and feeding it through said coil.

2. In a surface condenser, a condensing coil, an inlet for exhaust steam thereto, and a discharge for water of condensation therefrom, in combination with a water circulating system applying cool water to the top of said coil, and comprising a receptacle beneath said coil receiving the water thus applied thereto, a tank separate from said receptacle and receiving water therefrom, cooling apparatus between said receptacle and tank cooling the water in its passage from the former to the latter, and a discharge taking the cooled water from said tank and applying it to said coil, whereby as such water leaves the coil it is collected, cooled, again collected, and again applied to the coil.

3. In a surface condenser, a condensing coil, an inlet for exhaust steam thereto, and a discharge for water of condensation therefrom, in combination with a receptacle receiving the water of condensation, a circulating system communicating with said receptacle and with said coil, and taking water from said receptacle and supplying it to said coil, and cooling apparatus in said system between and separate from and externally of both said receptacle and coil cooling the water taken from said receptacle before it is supplied to said coil, said cooling apparatus consisting of a spraying device spraying the water in the air after it leaves said receptacle and before it is supplied to said coil, substantially as and for the purpose set forth.

4. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, and a tank receiving said discharge, in combination with a second tank above said coil, a pump taking

water from said first mentioned tank and delivering it to said second tank and a boiler and a pipe leading from said second tank to the steam inlet of said coil and supplying a stream of water of condensation within the latter, substantially as and for the purpose set forth.

5. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with a pump receiving water of condensation from said discharge, a water cooling apparatus receiving water from said pump, a tank containing the water cooled by said apparatus, and a pipe leading from said tank to the steam inlet of said coil and supplying the cooled water of condensation to the latter, substantially as and for the purpose set forth.

6. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with a water circulating system for supplying cool water to said coil, said system comprising a collecting tank beneath the coil, a pump taking water from said tank and elevating it above the coil, a water cooling apparatus separate from said receptacle and above the latter and said coil, receiving and cooling the water fed by said pump, and a pipe receiving the cooled water from said apparatus and supplying it to said coil at the top of the latter.

7. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with a water circulating system for circulating water to cool said coil, said system comprising a pump having a discharge pipe, a spraying nozzle at the discharge end of said pipe externally of said coil spraying the discharge therefrom into the outer air, a tank receiving the discharged spray, and a pipe leading from said tank and taking the water therefrom to said coil.

8. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with a tank D beneath said coil receiving the discharge therefrom, a tank F above said coil, a pump G taking water from said tank D leading to said tank J and having a spraying nozzle *i* therein through which the discharge from the pump is delivered above said tank J in the form of spray, a shield K above said tank J, a pipe L leading from said tank J to the steam inlet of said coil, and a feed pipe E leading from said tank D to a steam boiler, substantially as and for the purpose set forth.

9. In a surface condenser, a sinuous condensing coil having an inlet for exhaust steam at top and a discharge for water of condensation at bottom, in combination with an inclosing casing M surrounding said coil, open at bottom beneath said coil, and having an elongated vertical chimney at top above said coil, said coil and casing disposed to admit ingress of air to the casing beneath the coil and egress of air from the casing above the coil, whereby a natural draft through the casing is induced by the heat radiated from the coil, and such draft serves to cool the latter and a tank D below and receiving the water from said coil, a tank J above said coil, a pump having a suction communicating with said tank D, and a discharge into said tank J, and a valved pipe L leading from said tank J into said coil, whereby a graduated stream of water may be circulated through said coil with the steam in opposite direction to said draft, substantially as and for the purpose set forth.

10. In a condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with the water circulating system applying water to said coil and comprising a collecting tank beneath the coil, a discharge for the water above the coil, and a pump taking water from said tank to said discharge, and an adjustable controller in said system controlling the flow through said discharge.

11. In a condenser, a condensing coil, in combination with a water circulating system comprising a collecting tank beneath the coil, a discharge applying water at the top of the coil, and a pump taking water from said tank and supplying it to said discharge, and a regulator controlling the flow of water through said system and operating automatically in accordance with the accumulation of water in said tank, substantially as and for the purpose set forth.

12. In a surface condenser, a condensing coil having an inlet for exhaust steam and a discharge for water of condensation, in combination with a water or circulating system for circulating water to cool said coil, said system comprising a pump having two discharge pipes, one of said pipes leading to a boiler, a spraying nozzle at the discharge end of the other of said pipes spraying the discharge therefrom into the air, a tank receiving the discharged spray, and a pipe leading from said tank and taking the water therefrom to said coil.

In witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

JOSEPH A. BACHMAN.
ADOLF C. GOETH.

Witnesses:
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C. E. JONES.