

Jan. 10, 1933.

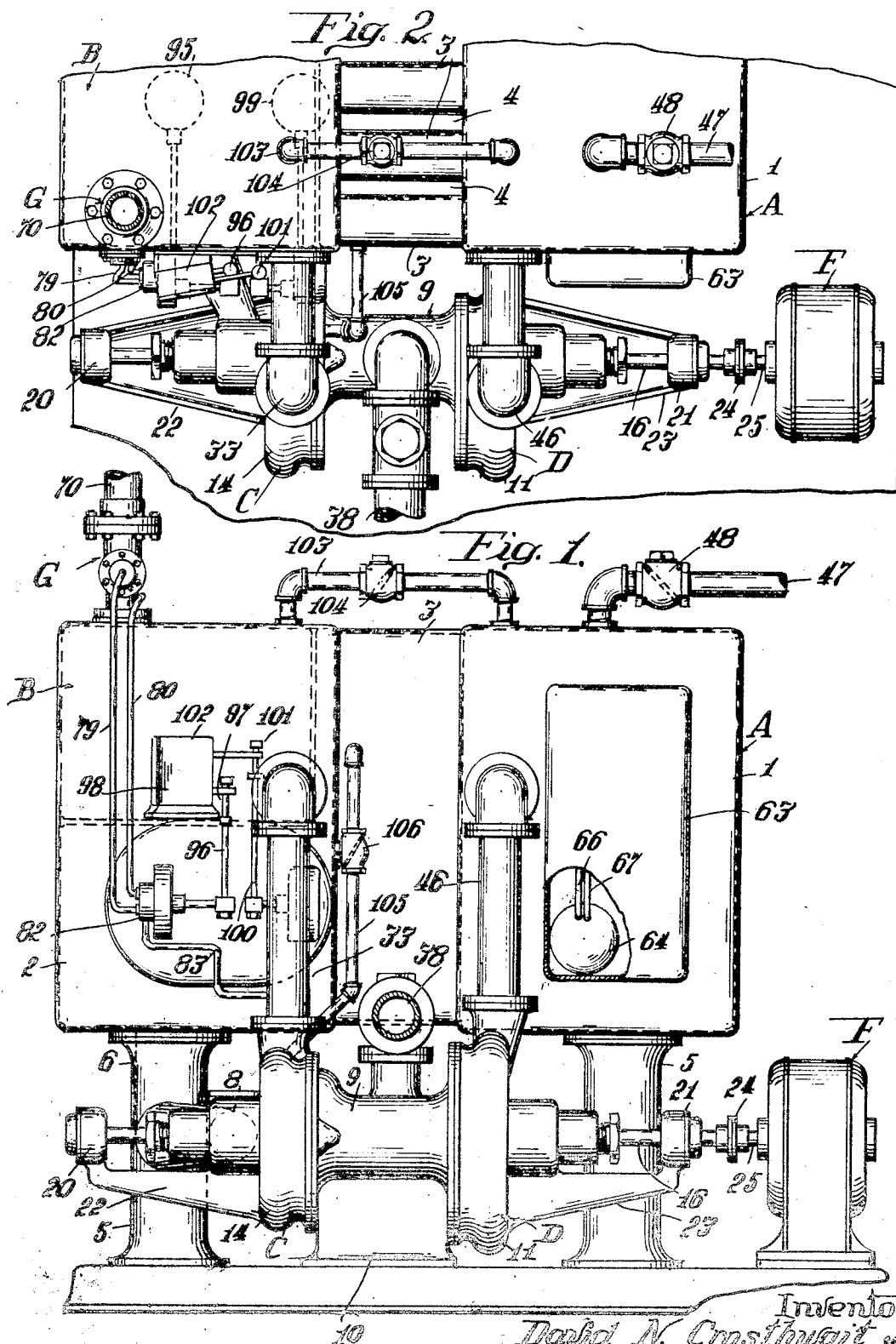
D. N. CROSTHWAIT, JR

**1,893,883**

## EXHAUSTING MECHANISM

Filed May 15, 1931

4 Sheets-Sheet 1



Inventor  
*David N. Crosthwait Jr.*

*Barnett & Ryan*  
*Attorneys.*

Jan. 10, 1933.

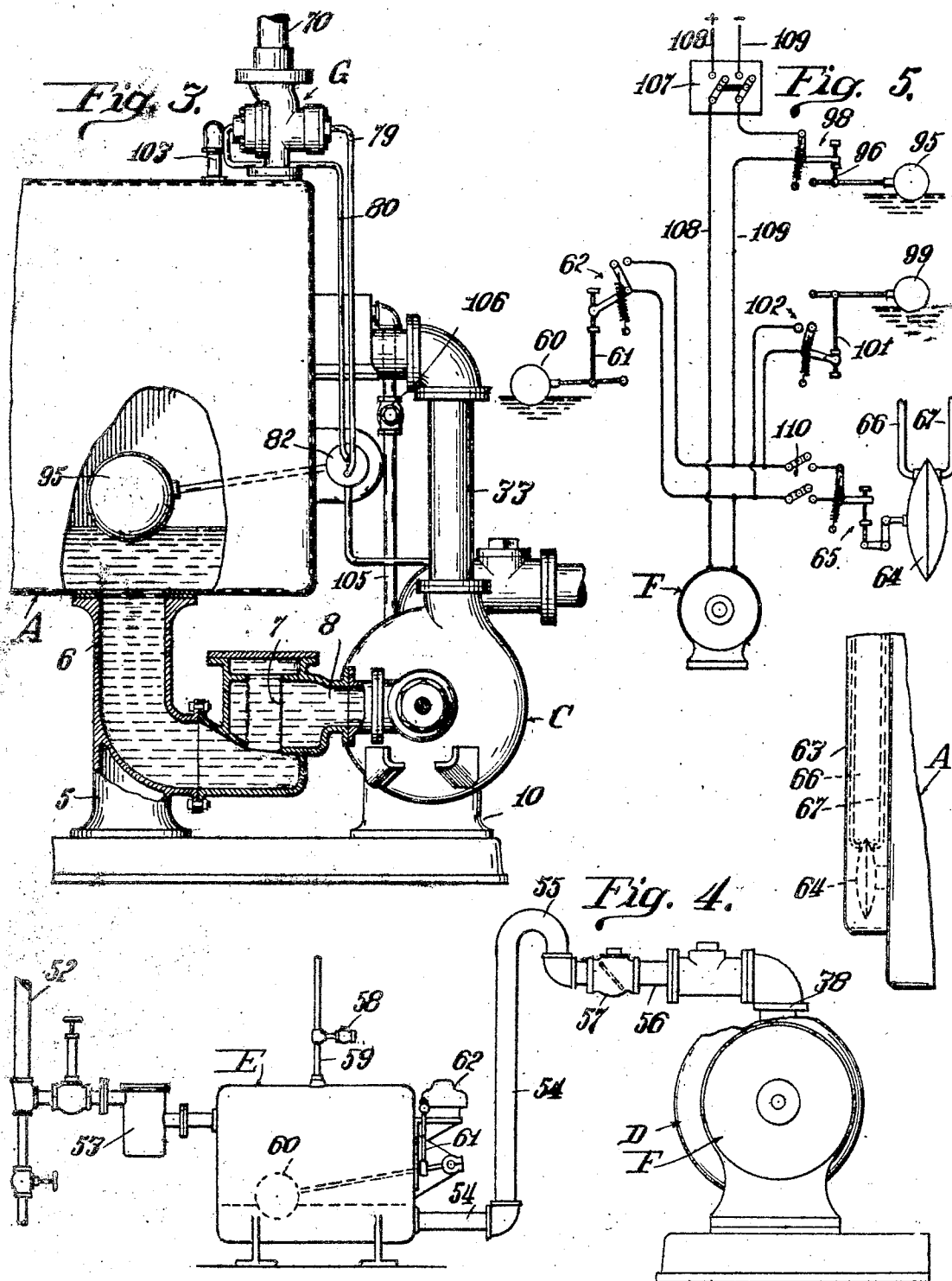
D. N. CROSTHWAIT, JR

1,893,883

EXHAUSTING MECHANISM

Filed May 15, 1931

4 Sheets-Sheet 2



Inventor  
David N. Crosthwait Jr.

Barnett & Truman  
Attorneys

Jan. 10, 1933.

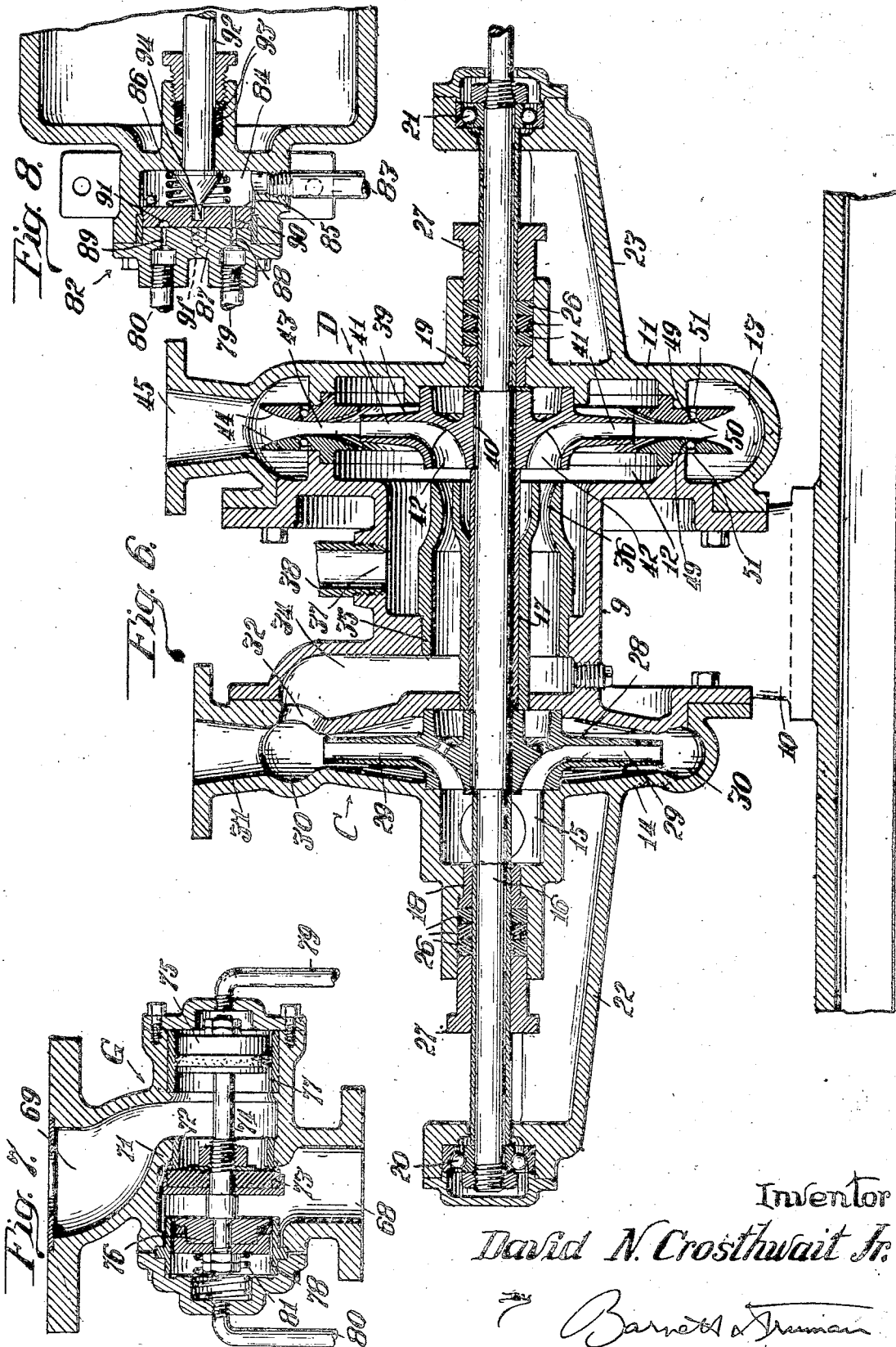
D. N. CROSTHWAIT, JR

1,893,883

EXHAUSTING MECHANISM

Filed May 15, 1931

4 Sheets-Sheet 3



Inventor  
David N. Crosthwait Jr.

Barnett & Truman  
Attorneys

Jan. 10, 1933.

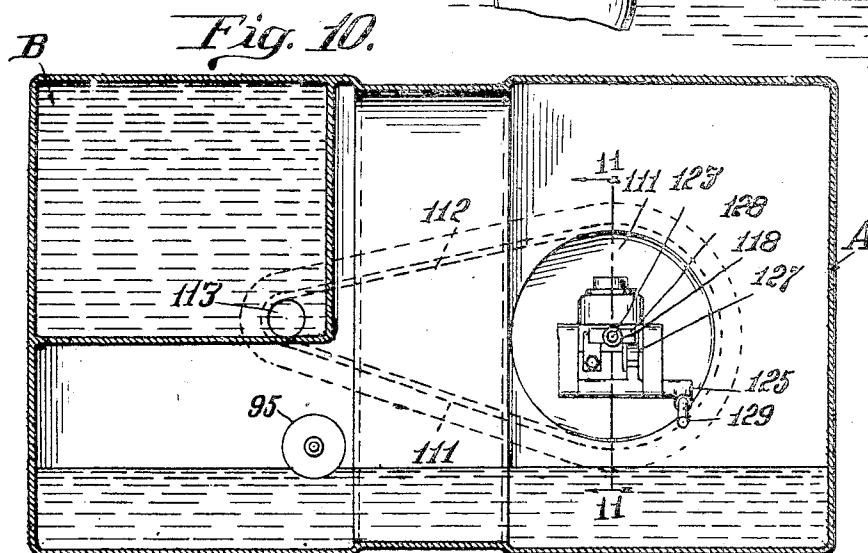
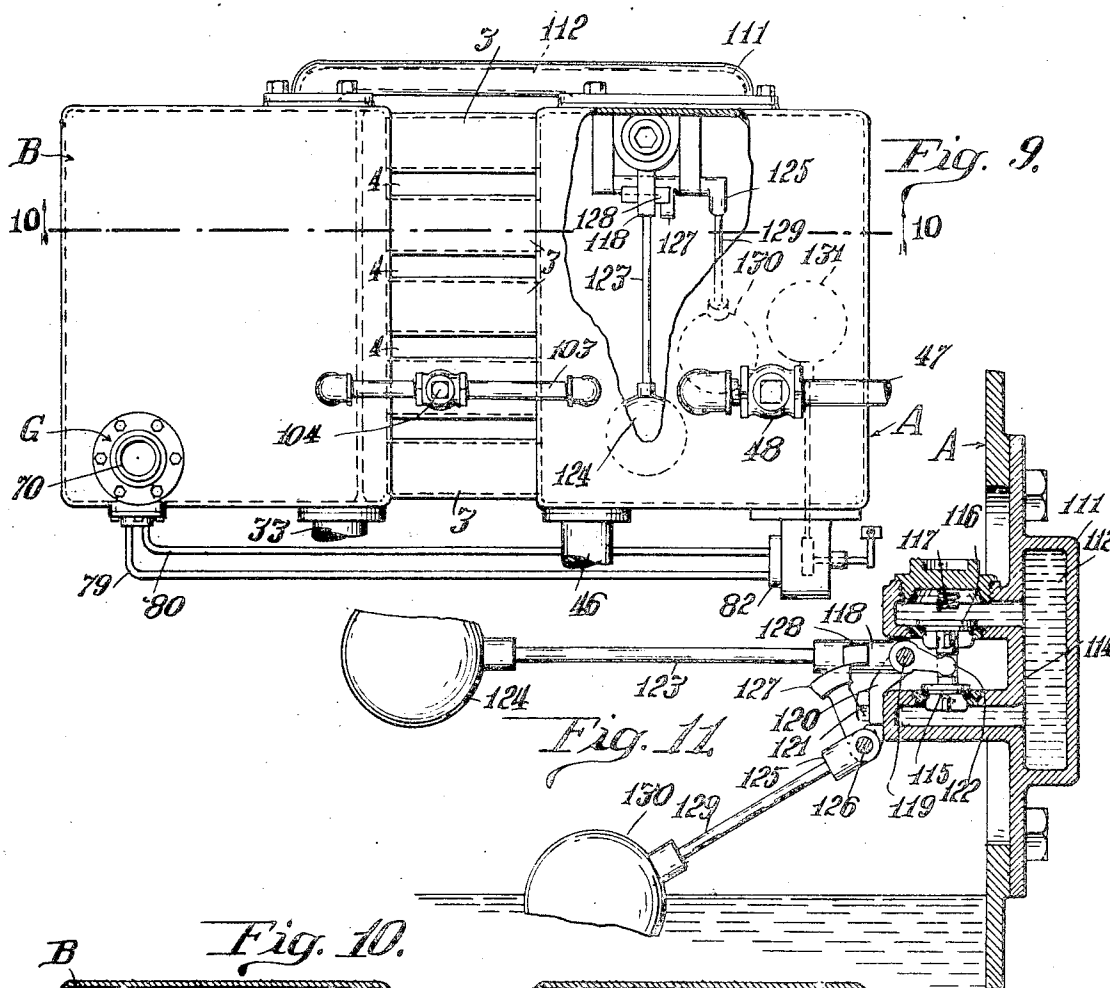
D. N. CROSTHWAIT, JR

1,893,883

EXHAUSTING MECHANISM

Filed May 15, 1931

4 Sheets-Sheet 4



Inventor  
David N. Crosthwait Jr.  
By *Barnett Truman*  
Attorneys

## UNITED STATES PATENT OFFICE

DAVID N. CROSTHWAIT, JR., OF MARSHALLTOWN, IOWA, ASSIGNOR TO C. A. DUNHAM COMPANY, OF MARSHALLTOWN, IOWA, A CORPORATION OF IOWA

## EXHAUSTING MECHANISM

Application filed May 15, 1931. Serial No. 537,633.

This invention relates to certain new and useful improvements in exhausting mechanism, more especially an exhausting mechanism adapted for use in a steam heating system for maintaining the desired pressure differences between different portions of the system, for withdrawing condensate and non-condensable gases from the radiating system, and for returning water to the boiler.

10 In the patent to Dunham No. 1,644,114, granted October 4, 1927, is disclosed one example of a heating system in which this improved exhausting mechanism is especially adapted for use, although it is to be understood that the improvements of this present invention might be used in other heating systems, or in other combinations than that disclosed by way of example in the Dunham patent referred to above. An exhausting mechanism of this type involves a motor-driven pump which draws a stream of water from a separating tank and forces a portion of this water through a jet exhauster, which latter serves to withdraw fluids from the heating system and carries these fluids, together with the circulating water stream, back into the separating tank. The gases are vented from this tank and as water accumulates in the tank beyond a maximum level, the excess water is forced by the pump to the boiler of the heating system. The present invention involves the use of a new and improved pumping and exhausting unit, an improved separating tank and auxiliary tank, and improved automatic control devices whereby the pumping mechanism will be started and stopped in accordance with changes in the liquid level in various portions of the apparatus, in accordance with changes in the pressure differential maintained by the pump will not lose its prime, and the continuous and safe operation of the system without injury to any portion thereof will be assured.

The general object of this invention is to provide a new method and apparatus for exhausting fluids from a heating system and returning condensate to the boiler, such as

briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide a new and improved form of motor-driven exhausting unit.

Another object is to provide an improved form of separating tank for holding the water supply for the exhausting system and separating gases therefrom.

Another object is to provide an improved auxiliary tank for maintaining a water supply to prime the pump.

Another object is to provide improved automatic float controlled devices for controlling the operation of the system in accordance with changes in liquid level in various portions of the system.

Another object is to provide an improved electric-control system for the pump motor.

Another object is to provide means for preventing siphoning of water from the reserve water tank to the boiler.

Another object is to provide improved means for preventing loss of water through the air-vent.

Another object is to provide improved means for adjusting the pressures between different portions of the exhausting apparatus so as to insure proper flow of fluids from one portion of the system to another.

Other objects and advantages of this invention will be more apparent from the following detailed description of certain approved forms of apparatus involving the principles of this invention.

In the accompanying drawings:

Fig. 1 is a front elevation of the assembled exhausting mechanism.

Fig. 2 is a plan view of a portion of the mechanism shown in Fig. 1.

Fig. 3 is an end elevation, looking from the left at Fig. 1, with parts broken away.

Fig. 4 is an elevation of the apparatus for conducting fluids from the heating system into the exhauster.

Fig. 5 is a wiring diagram of the electrical connections for controlling the pump motor.

Fig. 6 is a longitudinal vertical central

section through the preferred form of pump and exhauster mechanism.

Fig. 7 is a vertical section through the discharge valve in the boiler-feed pipe.

Fig. 8 is a central section through the distributing valve for controlling the flow of motor fluid to the discharge valve shown in Fig. 7.

Fig. 9 is a plan view of a modified form of separating and reserve tanks and float-controls therefor.

Fig. 10 is a vertical section taken substantially on the line 10—10 of Fig. 9.

Fig. 11 is a partial vertical section, on an enlarged scale, taken substantially on the line 11—11 of Fig. 10.

The principal elements of this mechanism comprise a separating tank or reservoir indicated at A, an auxiliary or reserve tank B, the centrifugal pump C, the improved jet exhauster D, the accumulator tank E, into which fluids drain from the heating system, the electric motor F for operating the pump and exhauster, the discharge valve G for controlling the flow of feed-water to the boiler and various control mechanisms for regulating the relative pressures between different portions of the system and the liquid levels in the different tanks.

The metallic separating tank A may be of generally rectangular form, and preferably consists of two main end sections 1 and 2 connected by a plurality of tubes or flat upright sections 3 with intervening air spaces 4 so as to increase the radiating surface and assist in dissipating heat. The auxiliary or reserve tank B is here shown as built integrally into the upper end portion of section 2 of the main tank, and this form is preferred as being more compact and economical, although the auxiliary tank might be made entirely separate from the first described tank A. It is essential, however, that the bottom of auxiliary tank B be positioned at a considerably higher level than the bottom of the separating tank A. The tanks A and B are supported by pedestals 5 at such a height that the supply water for pump C can flow by gravity from tank A through the conduit 6, which may be formed partially within one of the pedestals 5. Preferably a strainer 7 is positioned in the conduit 6 to remove sediment from the water before it enters pump C through inlet 8.

In the preferred form here shown, the pump C and exhauster D are formed as a single unit, as best shown in Fig. 6. This particular form of exhausting unit is shown more in detail and claimed in a copending application of Crosthwait, Ser'al No. 537,634, filed of even date herewith. While this particular form of combined pump and exhauster is especially adapted for use in the combination shown and claimed in the present application, it is to be understood

that other forms of pumps and jet exhausters could be used.

Referring more especially to Figs. 1, 2 and 6, a central casing member 9 provided with a supporting base 10 is adapted to house a portion of the separate pump and exhauster chambers, and also the connecting passages therebetween. A casing member 11 co-operates with main casing 9 to enclose the exhauster chamber 12, and an annular volute discharge conduit 13 which surrounds the chamber 12. The casing member 14 cooperates with main casing 9 to enclose a pump chamber 15 which is similar to that of the usual centrifugal pump. A rotary shaft 16 extends through the pump and exhauster chambers and is journaled in bearing 17 intermediate these chambers and in bearings 18 and 19 at the outer sides of each chamber, and the projecting end portions of the shaft are preferably mounted in ball or roller bearings 20 and 21 carried by extending brackets 22 and 23 of the casings 14 and 11, respectively. One end of shaft 16 is directly coupled through connection 24 with the drive shaft 25 of electric motor F. Where the rotary shaft passes through the outer walls of the respective pump and exhauster chambers, a packing 26 and gland 27 are provided to prevent the flow of fluids along the rotary shaft.

A centrifugal pump impeller 28 of usual form provided with a plurality of outwardly extending passages 29 is keyed on shaft 16 within the pump chamber 15, and water entering chamber 15 through inlet 8 is forced outwardly by this impeller into the annular (preferably volute) passage 30 which is provided with two outlets 31 and 32. From the upper outlet 31 a conduit 33 leads upwardly and discharges into the reserve tank B adjacent the bottom thereof. The other outlet 32 connects through passage 34 with the discharge tube 35 which is positioned in casing 9 around shaft 16 and projects into the exhauster chamber 12. A restricted annular nozzle 36 at the end of tube 35 projects the water under pressure into the exhauster chamber 12 in the form of an annular jet, or circular series of jets, centered around the axis of shaft 16.

An inlet port 37 to exhauster chamber 12 is provided, with which is connected pipe 38, through which fluids from the heating system or other space to be exhausted, are drawn into the exhauster chamber 12. The exhauster impeller 39 is keyed on shaft 16 within chamber 12, so as to be positively rotated within this chamber when the motor F is in operation. This impeller is formed with a circular series of substantially radially extending channels or passages 41 having their inlets 42 merging in a circular channel at one side of the impeller so as to receive the annular jet projected from nozzle 36. The water

of the jet received from nozzle 36 is dispersed amongst the several channels 41 and deflected outwardly, and the dispersed water particles are projected with added velocity 5 from the rotating impeller through the restricted annular channel 43 formed between the two inwardly convexed rings 44 and thence into the discharge conduit 13. Some of the fluids from exhauster chamber 12 are 10 first entrained with the liquid of the jet projected from nozzle 36 and carried into and through the impeller and additional fluids from chamber 12 are entrained with the water particles of the actuating stream which are 15 projected as a sheet into and through the outlet channel 43. The upper portion of annular discharge conduit 13 is provided with an outlet 45 which connects with conduit 46 leading up and discharging into the upper 20 portion of separating tank A. The non-condensable gases thus carried into tank A are vented through a pipe 47 leading from the upper portion of this tank and provided with outwardly opening check-valve 48. A portion of the water which collects in tank A 25 flows back through supply conduit 6 to the pump C, thus completing the liquid circuit. It will be apparent that this supply of water is continually being increased by the condensate drawn in from the heating system, and this excess water is discharged from the 30 pump through the other outlet conduit 33, as hereinafter described.

In the form shown in Fig. 6, each ring 44 is 35 formed with a circular interior conduit or passage 49 having an annular outlet channel 50 communicating with the outwardly flared discharge portion of passage 43 between the rings. A circular series of inlet ports 51 40 lead to the channel 49 from the outer discharge conduit 13. When, for any reason, the pressure in the passage 43 decreases, water from conduit 13 will flow through inlets 51, channel 49 and channel 50 into the pas- 45 sage 43 to increase the liquid flow through the channel. In this way, fluctuations in pressure or vacuum are compensated for.

It will be noted that the above described exhauster unit comprises a single rotating 50 assembly mounted on a single power-driven shaft, the centrifugal pump furnishing the fluid pressure for the initial liquid jet which is projected into the rotary impeller of the exhauster, this impeller serving to disperse 55 this jet and impart additional velocity thereto so as to entrain a maximum portion of fluids from the chamber 12. While this form of exhausting unit is preferred, it will be apparent as the description proceeds that other 60 forms of exhausters could be used with the improved liquid tanks and flow control mechanism herein described.

Referring now to Fig. 4, the connections through which fluids are drawn into the ex- 65 hauster D from the heating system are dis-

closed, this portion of the mechanism being substantially the same as is disclosed in the Dunham Patent 1,644,114, hereinabove referred to. These fluids are drawn down by 70 gravity and by the suction produced by the exhauster through return pipe 52 and strainer 53 into the accumulator tank E, which is preferably positioned at the lowest point in the system so that a gravity flow is provid- 75 ed from all of the radiators. Fluids are drawn from tank E through outlet conduit 54 leading from the lowest portion of this tank, thence upwardly, and provided with the siphon loop 55, thence through pipe 56 and pipe 80 connection 38 into the chamber 12 of exhauster D. Check valve 57 in pipe connection 56 prevents the return flow of fluids away from the exhauster. The siphon loop 55 is for the purpose of providing space for the water to 85 accumulate after reaching the top and to prevent the water slug, which is the form in which the liquid is lifted from the accumulator tank E, from breaking up and running back down the vertical section of pipe 54. An 90 air-release check valve 58 is connected through pipe 59 with the upper portion of accumulator tank E for the purpose of venting gases from this tank when the system happens to be operating under pressures 95 above atmospheric. Normally the valve 58 will remain closed. A float 60 positioned within tank E operates through lost motion connections 61, a snap switch 62, which is 100 connected in the control circuit of motor F, as diagrammatically illustrated in Fig. 5 and hereinafter described. The operation is such that when a sufficient quantity of liquid has 105 accumulated in tank E, the switch 62 will be closed to start the motor F (and consequently exhauster D) in operation, providing the exhauster is not already operating. In this manner the fluids from tank E (both liquids and gases) will be withdrawn into the ex- 110 hauster D and projected therefrom into separating tank A, from which the gases pass out through vent pipe 47, as already described.

A control box 63, which may be conveniently positioned on the front wall of tank A, 115 houses the usual starting mechanism for motor F, as well as the differential-pressure controller 64 and the snap switch 65 operated thereby (shown diagrammatically in Fig. 5). This differential-pressure controller is con- 120 nected through control pipes 66 and 67 with the supply and return sides of the heating system so as to be responsive to the pressure difference existing therebetween, and is adapted in the usual manner to operate snap 125 switch 65, so as to close the switch and start the exhausting mechanism in operation whenever the pressure differential falls below a predetermined minimum, and to open the switch when this pressure differential has 130 been restored to the desired maximum. The

operation of this portion of the mechanism is substantially the same as in the Dunham patent hereinabove referred to.

The discharge valve G (shown in section in Fig. 7) has a lower inlet port 68 leading from the top of reserve tank B, and an upper outlet 69 connected with pipe 70 which carries the feed water to the boiler. The central web 71 within the valve housing is formed with valve passage 72 which may be closed by the movable valve member 73 mounted on valve stem 74. At the respective ends of valve stem 74 are mounted the pistons 75 and 76 movable in the pressure cylinders 77 and 78, respectively. Pipes 79 and 80 lead into the respective cylinders 77 and 78 for supplying pressure fluid to these cylinders for moving the valve to open or closed positions. The compression spring 81 positioned behind piston 76 tends to normally hold the valve closed.

The pipes 79 and 80 lead from the distributor valve 82 (shown in section in Fig. 8). A pipe 83 leading from the pressure side of pump C conducts water under pressure into the chamber 84 of valve 82. A rotary valve plate 85 positioned within chamber 84 is held by spring 86 against the fixed valve plate 87 provided with ports 88 and 89 leading to the respective outlet pipes 79 and 80. Valve plate 85 is formed with a pair of ports 90, spaced less than 180° apart, and an intermediate arcuate port 91 which latter is always in communication with an outlet passage 91' provided with connections discharging into tank A. When the valve is in the position shown in Fig. 8, pressure fluid will flow from chamber 84 through one of the ports 90 and port 88 into pipe 79, and thence to discharge valve G, so as to fill cylinder 77 with water under pressure and force the piston 75 toward the left (Fig. 7) so as to open the discharge valve. The other port 89 will be in communication with arcuate port 91 so as to discharge the pressure fluid from cylinder 78. When valve plate 85 is rotated to a different position, pipe 80 will be placed in communication with chamber 84 so as to supply liquid under pressure to the other cylinder 78 and thus close the discharge valve. An oscillatory shaft 92 projects through packing 93 into chamber 84 and is slidably keyed at 94 with movable valve plate 85 so that as shaft 92 is oscillated the distributing valve 82 will function to deliver pressure fluid to one or the other of the cylinders of the discharge valve and move this valve to open or closed positions. Shaft 92 is operated by a float 95 positioned in tank A and movable in response to changes in the liquid level within this tank. When this liquid level has risen to a predetermined maximum, the distributing valve 82 will operate to open the discharge valve G so that excess water can be forced from the system through pipe 70 to the boiler. When the water level within tank A falls to a prede-

termined minimum, the discharge valve G will be closed. The float 95 also operates a rod 96 having lost motion connections 97 with a snap switch 98 positioned in the motor-control circuit, as hereinafter described. As long as the water level within tank A is above a predetermined minimum, the switch 98 will remain closed so as not to interfere with the operation of the exhausting mechanism. However, when the water level falls below this predetermined minimum, switch 98 will be opened so that the motor F will be stopped and the exhausting mechanism no longer permitted to operate, regardless of what other conditions may exist within the system.

A second float 99 positioned within tank A operates through rod 100 and lost motion connections 101, a second snap switch 102 also positioned in the motor-control circuits. The function of this float 99 is to prevent the water level from rising too high, for any reason, within tank A, so that water might be forced out and lost through air vent 47.

It will now be apparent that the auxiliary or reserve supply tank B really constitutes an enlarged portion of the conduit through which feed water is forced from pump C to the boiler, this reserve tank being positioned between the pump and the discharge valve G. This tank B must be completely filled with water before any water can be forced through pipe 70 to the boiler, and the tank B will be maintained full of water as long as the exhausting mechanism is in normal operation. When the pump C ceases to operate, this reserve supply of water in tank B is free to flow back through conduit 33 and thus prime the pump and exhausting mechanism. A pipe connection 103 connects the upper portions of tanks A and B, there being a check valve 104 in this pipe opening toward the reserve tank B. As long as there is pump pressure within tank B, the check valve 104 will remain closed. If, however, a partial vacuum should form in tank B or in the boiler at such times as discharge valve G is open, air from tank A can flow through pipe connection 103 to reserve tank B to break the vacuum and prevent the liquid in tank B from being siphoned to the boiler. This connection also serves to equalize the pressures between tanks A and B and permit the flow of water from tank B into the pump and exhauster to prime the pump, as hereinabove described.

A pipe 105 leads from the top of the casing of pump C into the air space of separating tank A. In this pipe is a check valve 106 which will be held closed when pump pressure exists in pipe 105, but which opens downwardly by gravity when the pump is not in operation. This connection facilitates the priming of the pump by giving an addition means for air to be displaced from the topmost portion of the pump casing.

Referring now to Fig. 5, the electric power

and control connections for motor F will be described. The snap-switches and the float-operated connections are indicated diagrammatically in this figure, and it is to be understood that additional relays and starting rheostats are provided, as usual in such installations. For the sake of simplicity, the main power circuit has been illustrated as passing directly through the control switches.

The main cut-out switch 107 is positioned in the power leads 108 and 109, lead 108 extending directly to motor F. Lead 109 extends through snap switch 98 operated by the minimum water-level float 95. Switch 62 operated by float 60 in accumulator tank E, switch 102 operated by maximum water-level float 99, and switch 65 operated by differential controller 64, are all connected in parallel so that the circuit through lead 109 may be completed through any one of these three switches. A manually operable switch 110 is provided whereby the differential controller may be rendered operative or inoperative as desired. In normal operation, the switch 98 will remain closed as long as an adequate supply of water for the hurling circuit of the pump and exhauster remains in separating tank A. The switch 62 will be closed to start the exhauster in operation whenever a sufficient quantity of liquid accumulates in tank E. Whenever the pressure differential falls below the desired minimum, switch 65 will be closed to start the exhausting mechanism in operation. When this desired pressure differential has been established, switch 65 will be opened, but if at this time, there is an excess accumulation of liquid in tank E, switch 62 will remain closed and the exhauster will continue to operate until the excess liquid has been withdrawn from tank E, into tank A. When the system is not being operated at subatmospheric pressures, and the controller 64 is thrown out of operation by opening switch 110, the exhauster will only be started at such intervals as are necessary to withdraw the accumulated liquid from tank E. Switch 102 is normally open, but this switch will be closed whenever an excessive accumulation of liquid occurs in tank A, and this switch will remain closed to keep the pump in operation so as to force this excess liquid back to the boiler until the water level in tank A has been reduced below this predetermined maximum level. It will be noted that this maximum level float 99 and switch 102 are operative to keep the pump in operation even though there is no accumulation of liquid in tank E and the pressure differential has been established and both switches 62 and 65 are open. If, at any time, the water supply in tank A tends to become exhausted and the water level falls below a predetermined minimum, float 95 will open switch 98 so as to break the motor circuit and prevent further

operation of the pump. The motor circuit will be positively broken by switch 98 even though any one or all of the other switches 62, 102 and 65 are closed. It is thus impossible to operate the pump and exhauster when there is an insufficient supply of actuating liquid in the system. When this situation arises, the pump will be stopped and the reserve supply of water in tank B will flow down through conduit 33, as already described, to prime the pump and replenish the supply of actuating liquid for the hurling circuit. The reserve supply of water in tank B is sufficient to cause the water level in tank A to rise sufficiently to close switch 98 and permit the system to continue its operations.

In the modified form of the invention shown in Figs. 9, 10 and 11, means are provided whereby the reserve supply of water in tank B may be automatically transferred into main tank A whenever the water level in tank A falls below a predetermined minimum, this being accomplished without the necessity of stopping the operation of the pump. The tanks A and B may be substantially the same as already described. A plate 111 attached over suitable openings in the rear walls of tanks B and A houses a discharge conduit 112 having an inlet port 113 at its upper end communicating with the lower portion of tank B. A pair of vertically aligned outlet ports are formed in the web 114, these ports being closed by the semi-balanced valves 115 and 116. The slight excess pressure on the top of valve 116 tends to hold the valves closed. A buffer spring 117 prevents shocks when the valves are opened. A valve-operating lever 118 is pivoted on shaft 119 carried by bracket arm 120 secured to plate 111 at 121. The inwardly extending arm 122 of lever 118 has a loose connection with the stem connecting valves 115 and 116. The rod extension 123 of lever 118 carries a float 124. The bell crank lever 125 pivoted on shaft 126 carried by a downwardly projecting portion of bracket 120, carries an arcuate cam 127 at the upper end of its upwardly extending arm, this cam being adapted to engage either above or below a similar arcuate cam 128 fixed on the side of lever 118. The rod extension 129 of the lower arm of bell crank 125 carries the float 130.

With the parts in the normal position shown in Fig. 11, the valves are closed and communication is cut off between conduit 112 and tank A, the reserve supply of water being held within tank B and within conduit 112. The locking float 130 rests on the water in tank A, but the locking cam 127 is beneath the cam 128 on operating lever 118, so that float 124 is held in the elevated position shown in Fig. 11. As the water level rises or falls in tank A, the float 130 will swing cam 127 in one direction or the other beneath fixed cam 128, but float 124 will be held

elevated and the valves 115 and 116 will be held closed. However, if the water level in tank A falls below a predetermined minimum, cam 127 will swing out from under cam 128, thus allowing the float 124 to drop, opening the valves 115 and 116, and discharging the contents of reserve tank B into the main tank A. This will again raise the floats 130 and 124 to some extent, but the respective lengths of the lever arms 129 and 123 are such that the cam 127 will now be swung over the cam 128 and lock the float 124 in its lowered position so as to hold the valves 115 and 116 open. The float 130 will continue to rise as the water level rises in tank A, but float 124 will be held submerged. In this manner, reserve tank B is left in open communication with tank A, so that all water discharged from the pump into tank A will flow back through conduit 112 into tank A and no accumulation will occur in tank B, nor can any water be forced to the boiler. This action will continue until a sufficient quantity of water has accumulated in tank A to raise the water level to such a height that cam 127 will be swung completely to the right from above fixed cam 128, thus permitting float 124 to rise to the surface and close valves 115 and 116. The proportioning of the moving parts are such that when the water level starts to lower, cam 127 will again move in under cam 128 and lock the valves closed, as shown in Fig. 11. It will be noted that the pump C and exhauster D may remain continuously in operation throughout these changes in the positioning of the float controlled valves. The operation is such that when the water level in tank A has been reduced to a certain minimum, the valves 115 and 116 will be opened, and will be held opened, so as to dump the reserve water from tank B into tank A and keep these tanks in open communication with one another until the liquid level in tank A has again been built up to a certain maximum. During this period there is no accumulation of water in tank B and no water is forced to the boiler through discharge valve G. When, however, a sufficient accumulation of water has taken place in tank A, the valves 115 and 116 will be automatically closed, and will be held closed until the water level has again receded to the predetermined minimum. After these valves are closed, the continued action of the pump and exhauster serves to again fill the reserve tank B; and after this tank has been filled, if there is still a sufficient accumulation of water in tank A, or after such accumulation occurs, float 131 will operate pilot valve 82 and discharge valve G so as to open the conduit leading to the boiler and permit the excess of water to be forced through boiler feed pipe 70. Either a maximum water level switch, such as 102, previously described, or a

minimum water level switch 98, or both, can also be controlled from float 131.

The modification shown in Figs. 9, 10 and 11 and just described has the advantage that it is not necessary to stop the operation of the pump in order to replenish the water supply from the reserve tank B. However, it will be noted that in both forms of the apparatus a certain reserve supply of water is held by pump pressure in an elevated position, so that it may be discharged back into the pumping and exhausting mechanism to prime same and replenish the water supply whenever the normal supply in the main tank tends to become exhausted. Whenever, as is more usually the case, the supply of water in tank A increases above a desired maximum, due to the addition thereto of condensate from the heating system, this excess of water is forced out to the boiler. This discharge of water is, however, forced through the reserve tank B, so that the reserve of water therein will be maintained at all times before any additional water can be discharged from the system.

I claim:

1. In combination with a pump, a jet exhauster and a separating tank from which liquid is drawn to supply the actuating stream circulated by the pump through the jet exhauster and back to the tank, together with fluids drawn in by the exhauster, a reserve tank filled with liquid by the pump and adapted to automatically replenish the liquid supply in the separating tank when the liquid level therein falls to a predetermined minimum.

2. In combination with a pump, a jet exhauster and a separating tank from which liquid is drawn to supply the actuating stream circulated by the pump through the jet exhauster and back to the tank together with fluids drawn in by the exhauster, a second outlet conduit leading from the pump in which excess liquid is discharged from the liquid circuit, a reserve tank positioned in this last conduit, and means for automatically returning the liquid from the reserve tank into the liquid in circulation whenever the supply therein falls to a predetermined minimum.

3. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, an auxiliary tank with its bottom positioned at a higher level than the pump, an outlet conduit leading from the pump into the lower portion of the auxiliary tank, and an outlet con-

duit leading from the upper portion of the auxiliary tank to discharge liquids therefrom under pump pressure.

4. The combination with a pump and a jet  
5 exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the jet ex-  
10 hauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, an auxiliary tank with its bottom positioned at a  
15 higher level than the pump, an outlet conduit leading from the pump into the lower portion of the auxiliary tank, an outlet conduit leading from the upper portion of the tank, a discharge valve in said conduit, a float in  
20 the separating tank, and connections between the flow and discharge valve whereby the valve will be opened when a predetermined maximum water level is reached in the separating tank and closed when a minimum water  
25 level is established.

5. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading  
30 from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the  
35 upper portion of the separating tank, an auxiliary tank with its bottom positioned at a higher level than the pump, an outlet conduit leading from the pump into the lower portion of the auxiliary tank, an outlet conduit  
40 leading from the upper portion of the tank, a discharge valve in said conduit, a float in the separating tank, connections between the flow and discharge valve whereby the valve will be opened when a predetermined  
45 maximum water level is reached in the separating tank and closed when a minimum water level is established, a switch controlling the motor, and means whereby the float opens the switch to stop the motor when a  
50 minimum liquid level is reached in the separating tank.

6. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading  
55 from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the  
60 upper portion of the separating tank, an auxiliary tank with its bottom positioned at a higher level than the pump, an outlet conduit leading from the pump into the lower  
65 portion of the auxiliary tank, an air-release

pipe leading from the pump to the upper portion of the separating tank, a check-valve in this pipe opening by gravity but normally held closed by the pump pressure, an outlet conduit leading from the upper portion of  
70 the tank, a discharge valve in said conduit, a float in the separating tank, and connections between the float and discharge valve whereby the valve will be opened when a predetermined maximum water level is reached in the separating tank and closed  
75 when a minimum water level is established.

7. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading  
80 from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, an auxiliary tank with its bottom positioned at a  
85 higher level than the pump, an outlet conduit leading from the pump into the lower portion of the auxiliary tank, an outlet conduit leading from the upper portion of the auxiliary tank to discharge liquids therefrom under pump pressure, a pressure-equalizing  
90 pipe connecting the upper portions of the separating tank and auxiliary tank, and a check-valve in the pipe opening toward the auxiliary tank.

8. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading  
100 from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, a discharge conduit leading upwardly from the  
105 pump, and an auxiliary reservoir for liquid positioned in this discharge conduit at a higher level than the pump.

9. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a motor for actuating the pump, a separating tank, a supply conduit leading  
115 from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, a discharge conduit leading upwardly from the  
120 pump, a discharge valve in this conduit, a float in the separating tank for opening and closing the discharge valve when the liquid level rises or falls in the separating tank, and a reservoir for liquid positioned in the discharge conduit between the pump and discharge  
125 valve.

10. The combination with a pump and a jet  
exhauster furnished with actuating liquid  
by said pump, a motor for actuating the  
pump, a separating tank with its bottom posi-  
5 tioned at a higher level than the pump, an  
auxiliary tank formed within the upper por-  
tion of the main tank, a supply conduit lead-  
ing from the lower portion of the main tank  
to the pump, a conduit leading into the jet  
10 exhauster for introducing fluids to be ex-  
hausted, a conduit leading from the jet ex-  
hauster into the upper portion of the main  
tank for discharging thereinto the actuating  
liquid together with the fluids drawn in by  
15 the exhauster, a vent for gases in the upper  
portion of the main tank, an outlet conduit  
leading from the pump into the lower portion  
of the auxiliary tank, and an outlet conduit  
leading from the upper portion of the auxil-  
20 iary tank to discharge liquid therefrom under  
pump pressure.

11. The combination with a pump and a jet  
exhauster furnished with actuating liquid  
by said pump, a motor for actuating the  
25 pump, a separating tank with its bottom po-  
sitioned at a higher level than the pump, an  
auxiliary tank formed within the upper por-  
tion of the main tank, a supply conduit lead-  
ing from the lower portion of the main tank  
30 to the pump, a conduit leading into the jet  
exhauster for introducing fluids to be ex-  
hausted, a conduit leading from the jet ex-  
hauster into the upper portion of the main  
tank for discharging thereinto the actuating  
35 liquid together with the fluids drawn in by  
the exhauster, a vent for gases in the upper  
portion of the main tank, an outlet conduit  
leading from the pump into the lower portion  
of the auxiliary tank, an outlet conduit lead-  
40 ing from the upper portion of the auxiliary  
tank, a discharge valve in this latter conduit,  
a float in the main separating tank, and con-  
nections between the float and discharge  
valve for opening and closing the valve as  
45 the water level rises and falls in the main  
tank.

12. The combination with a pump and a jet  
exhauster furnished with actuating liquid by  
said pump, a motor for actuating the pump,  
50 a separating tank with its bottom positioned  
at a higher level than the pump, an auxiliary  
tank formed within the upper portion of the  
main tank, a supply conduit leading from the  
lower portion of the main tank to the pump,  
55 a conduit leading into the jet exhauster for  
introducing fluids to be exhausted, a conduit  
leading from the jet exhauster into the upper  
portion of the main tank for discharging  
thereinto the actuating liquid together with  
60 the fluids drawn in by the exhauster, a vent  
for gases in the upper portion of the main  
tank, an outlet conduit leading from the  
pump into the lower portion of the auxiliary  
tank, an outlet conduit leading from the up-  
65 per portion of the auxiliary tank, a discharge

valve in this latter conduit, a float in the main  
separating tank, connections between the  
float and discharge valve for opening and  
closing the valve as the water level rises and  
falls in the main tank, a switch controlling  
70 the motor, and means whereby the float opens  
this switch to stop the motor when a mini-  
mum liquid level is reached in the main tank.

13. The combination with a pump and a  
jet exhauster furnished with actuating liquid  
75 by said pump, a motor for actuating the  
pump, a separating tank with its bottom po-  
sitioned at a higher level than the pump, an  
auxiliary tank formed within the upper por-  
tion of the main tank, a supply conduit lead-  
80 ing from the lower portion of the main tank  
to the pump, a conduit leading into the jet  
exhauster for introducing fluids to be ex-  
hausted, a conduit leading from the jet ex-  
hauster into the upper portion of the main  
85 tank for discharging thereinto the actuating  
liquid together with the fluids drawn in by  
the exhauster, a vent for gases in the upper  
portion of the main tank, an outlet conduit  
leading from the pump into the lower por-  
90 tion of the auxiliary tank, an air-release  
valve leading from the pump to the upper  
portion of the separating tank, a check-valve  
in this pipe opening by gravity but normally  
held closed by pump pressure, and an out-  
95 let conduit leading from the upper portion  
of the auxiliary tank to discharge liquid  
therefrom under pump pressure.

14. The combination with a pump and a  
jet exhauster furnished with actuating liquid  
100 by said pump, a motor for actuating the  
pump, a separating tank with its bottom  
positioned at a higher level than the pump,  
an auxiliary tank formed within the upper  
portion of the main tank, a supply conduit  
105 leading from the lower portion of the main  
tank to the pump, a conduit leading into the  
jet exhauster for introducing fluids to be  
exhausted, a conduit leading from the jet  
exhauster into the upper portion of the main  
110 tank for discharging thereinto the actuating  
liquid together with the fluids drawn in by  
the exhauster, a vent for gases in the upper  
portion of the main tank, an outlet conduit  
leading from the pump into the lower por-  
115 tion of the auxiliary tank, an outlet conduit  
leading from the upper portion of the auxil-  
iary tank to discharge liquid therefrom under  
pump pressure, a pressure-equalizing pipe  
connecting the upper portions of the sepa-  
120 rating tank and auxiliary tank, and a check-  
valve in this pipe opening toward the  
auxiliary tank.

15. The combination of a pump and a jet  
exhauster furnished with actuating liquid by  
125 the pump, a motor for driving the pump, a  
power circuit for the motor, a separating  
tank, means for venting gases from the tank,  
a supply conduit leading from the lower por-  
tion of the tank to the pump, a conduit lead-  
130

ing from the jet exhauster for discharging into the tank the actuating liquid together with fluids drawn by the exhauster from the space to be exhausted, a discharge conduit  
5 leading from the pump, a normally closed switch for completing the motor circuit, a float in the tank, and connections whereby the switch will be opened and the operation of the pump stopped when the liquid level  
10 in the tank is below a predetermined minimum level.

16. The combination of a pump and a jet exhauster furnished with actuating liquid by the pump, a motor for driving the pump,  
15 a power circuit for the motor, a separating tank, means for venting gases from the tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging  
20 into the tank the actuating liquid together with fluids drawn by the exhauster from the space to be exhausted, a discharge conduit leading from the pump, a pressure-controlled switch mechanism for opening and  
25 closing the motor power-circuit in accordance with variations in a pressure differential maintained by the exhauster, a second normally closed switch in the power circuit, and a float in the tank for opening the second  
30 switch whenever the level of liquid in the tank is below a predetermined minimum.

17. The combination of a pump and a jet exhauster furnished with actuating liquid by the pump, a motor for driving the pump, a  
35 power circuit for the motor, a separating tank, means for venting gases from the tank, a supply conduit leading from the lower portion of the tank to the pump, an accumulator tank into which fluids drain by gravity  
40 from a space to be exhausted, a conduit through which fluids are drawn from this tank into the jet exhauster, a conduit through which fluids from the accumulator tank and the actuating liquid is forced from the jet  
45 exhauster into the separating tank, a discharge conduit leading from the pump, a float-controlled switch for closing the motor circuit when a predetermined liquid level is reached in the accumulator tank, a pressure-  
50 controlled switch mechanism for opening and closing the motor circuit in accordance with variations in a pressure-differential maintained by the exhauster, a third normally closed switch in the motor circuit, and  
55 a float in the separating tank for opening the third switch whenever the level of liquid in the tank is below a predetermined minimum.

18. The combination with a pump and a jet exhauster furnished with actuating liquid  
60 by the pump, a motor for driving the pump, a power circuit for the motor, a separating tank, a means for venting gases from the tank, a supply conduit leading from the lower portion of the tank to the pump, an  
65 auxiliary tank with its bottom positioned at

a higher level than the pump, an outlet conduit leading from the pump into the lower portion of the auxiliary tank, a discharge conduit leading from the upper portion of  
70 the auxiliary tank, a discharge valve in the latter conduit, mechanism comprising a float in the separating tank for opening and closing the discharge valve as the liquid level rises and falls in the separating tank, an accumulator tank into which fluids drain by  
75 gravity from a space to be exhausted, a conduit through which fluids are drawn from this accumulator tank into the jet exhauster, a conduit through which these fluids and the actuating liquid from the pump are forced into the separating tank, a float-controlled  
80 switch for closing the motor circuit when a predetermined liquid level is reached in the accumulator-tank, a pressure-controlled switch mechanism for opening and closing the motor circuit in accordance with variations in a pressure-differential maintained by the exhauster, a third switch for completing the motor circuit and maintaining the pump  
85 in operation even though one or both of the two previously mentioned switch mechanisms are open, a float in the separating tank for closing the third switch as long as the level of liquid in the tank is above a predetermined maximum, and an additional  
90 switch mechanism actuated by the first mentioned float for breaking the operating circuit of the motor irrespective of any of the conditions imposed by the other switch mechanisms whenever the liquid level in the separating tank falls below a predetermined  
95 minimum.

19. The combination with a pump and a jet exhauster furnished with actuating liquid  
100 by said pump, a separating tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid from the pump together with fluids drawn in by the exhauster,  
105 a vent for gases in the upper portion of the separating tank, a reserve tank with its bottom positioned at a higher level than the bottom of the main tank, an outlet conduit leading from the pump into the lower portion  
110 of the reserve tank, a conduit leading from the lower portion of the reserve tank into the separating tank, a valve at the outlet of this conduit, and float-controlled means for opening and closing this valve in accordance with changes in liquid level in the separating tank.  
115

20. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a separating tank, a supply conduit leading from the lower portion  
120 of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid from the pump together with fluids drawn in by the exhaust-  
125

er, a vent for gases in the upper portion of the separating tank, a reserve tank with its bottom positioned at a higher level than the bottom of the main tank, an outlet conduit  
5 leading from the pump into the lower portion of the reserve tank, a conduit leading from the lower portion of the reserve tank into the separating tank, a valve at the outlet of this conduit, and float-controlled means for opening  
10 this valve when the water level in the separating tank falls to a predetermined minimum and for holding the valve open until the level has risen to a predetermined maximum.

15 21. The combination with a pump and a jet exhauster furnished with actuating liquid by said pump, a separating tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the  
20 jet exhauster for discharging into the tank the actuating liquid from the pump together with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, a reserve tank with its bottom positioned at a higher level than the bottom of  
25 the main tank, an outlet conduit leading from the pump into the lower portion of the reserve tank, a conduit leading from the lower portion of the reserve tank into the separating tank, a valve at the outlet of this conduit, a float in the separating tank for opening the  
30 valve when the liquid level in this tank falls to a predetermined minimum and for closing the valve when the level rises to a predetermined maximum, and a second float for locking the valve in each of its closed and open  
35 positions.

22. The combination with a pump and a jet exhauster furnished with actuating liquid  
40 by said pump, a separating tank, a supply conduit leading from the lower portion of the tank to the pump, a conduit leading from the jet exhauster for discharging into the tank the actuating liquid from the pump together  
45 with fluids drawn in by the exhauster, a vent for gases in the upper portion of the separating tank, a reserve tank with its bottom positioned at a higher level than the bottom of the main tank, an outlet conduit leading from the pump into the lower portion of  
50 the reserve tank, an outlet conduit leading from the upper portion of the reserve tank for discharging liquid therefrom under pump pressure, a discharge valve in this conduit, float-controlled means for opening this valve  
55 when a predetermined quantity of liquid has accumulated in the separating tank, a conduit leading from the lower portion of the reserve tank into the separating tank, a valve at the outlet of this conduit, and float-controlled means for opening and closing this  
60 valve in accordance with changes in liquid level in the separating tank.

DAVID N. CROSTHWAIT, Jr.