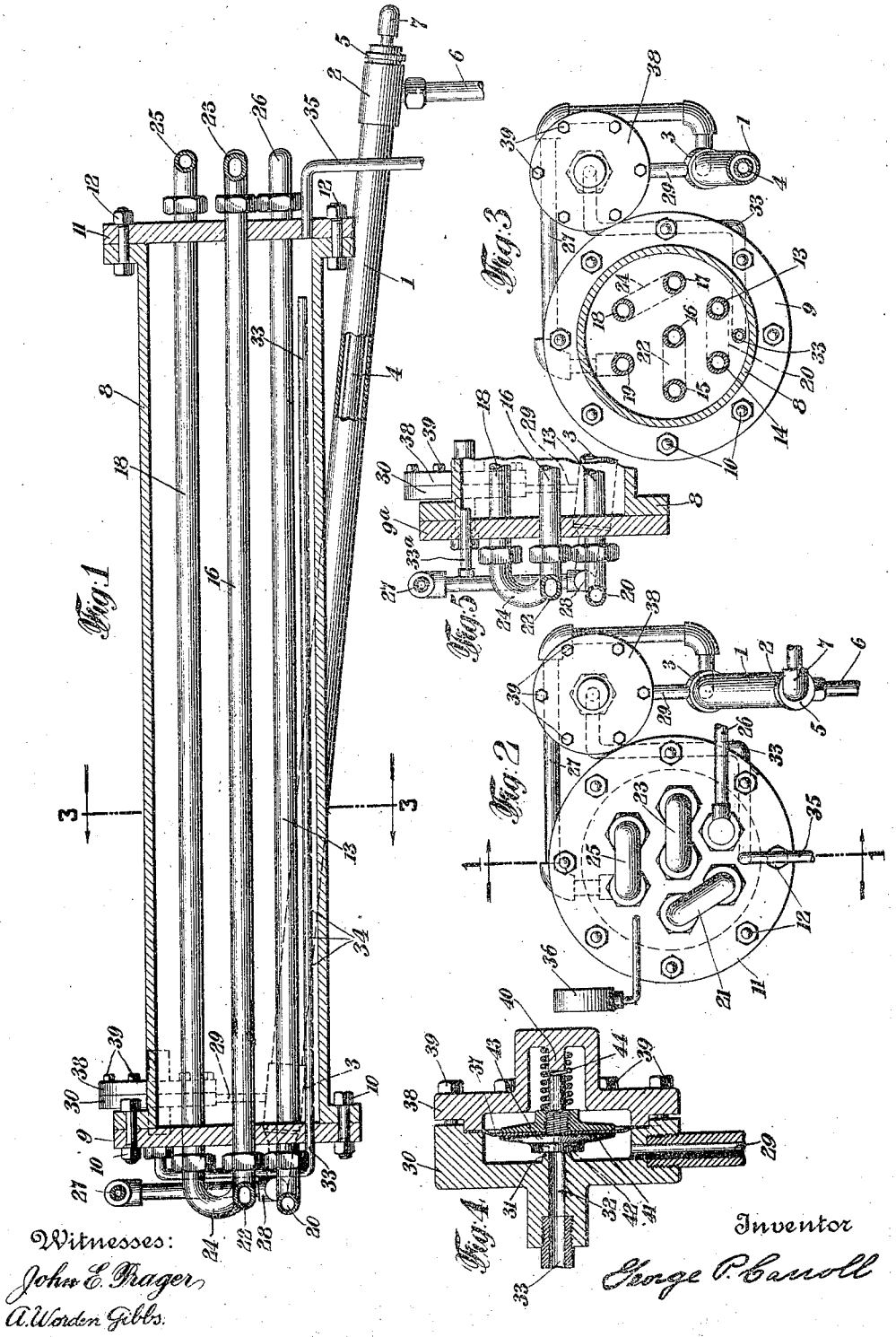
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CONDENSER.

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1,219,535.

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Witnesses:

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CONDENSER.

1,219,535. Specification of Letters Patent. Patented Mar. 20, 1917.

Application filed November 4, 1913. Serial No. 799,094.

To all whom it may concern:

Be it known that I, GEORGE P. CARROLL, a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented a new and useful Condenser, of which the following is a specification.

My invention relates to improvements in apparatus for condensing liquefiable gases, such as ammonia, sulfur dioxid and the like, especially when used in connection with other component parts of absorption refrigerating machines. The purpose of my invention is to construct a condenser that will be economical of cooling water, that will discharge the liquefiable gas into the main part of the condenser practically freed of any entrained water or lubricating oil, and that will be simple and compact. The means employed for accomplishing this purpose are disclosed in the accompanying drawings and in the description relating thereto.

In the drawings, Figure 1 is a partial front elevation and a partial vertical section of my invention, through the line 1—1 of Fig. 2, looking toward the right. Fig. 2 is a right end elevation of the structure of the preceding figure. Fig. 3 is a vertical section through the line 3—3 of Fig. 1, looking toward the left. Fig. 4 is an enlarged vertical section of a check valve and adjacent parts, shown in the preceding figure, with, however, some of the parts in front elevation. Fig. 5 is an alternative construction of part of the structure shown in Fig. 1.

First considering the construction of Figs. 1 to 4 inclusive: A slightly ascending gas pipe 1, at its right and lower end, is secured into the correspondingly ascending left end of a casing 2, and, at its left and upper end, it is secured into the correspondingly descending right end of a casing 3. A water pipe 4 occupies the axial center of the pipe 1, so as to leave an annular space between itself and the latter pipe, and extends, at its upper end, through the casing 3, leaving a similar annular space, and, at its lower end, extends through the casing 2, leaving a similar annular space. A suitable union 5 surrounds the outer and lower end of the pipe 4 and closes the right end of the casing 2. A delivery gas pipe 6 leads vertically upward into the lower part of the casing 2. From the extreme lower end of the pipe 4 a coupling and pipe 7 leads to the waste.

A large tube 8, flanged at both ends, occupies a horizontal position in front of the pipe 1 and slightly above its left and upper part. A head 9 is secured, by means of bolts and nuts 10, to the flanged left end of the tube 8. A head 11 is secured, by means of bolts and nuts 12 to the flanged right end of the tube 8. A pipe 13 extends through the heads 9 and 11 and between the heads occupies a horizontal position near the lowest part of the tube 8, just back of its central vertical plane. A pipe 14 extends through the heads 9 and 11 and between the heads occupies a horizontal position near the lowest part of the tube 8, just in front of its central vertical plane and in the horizontal plane of the pipe 13, as shown in Fig. 3. Similarly pipes 15, 16 and 17 extend through the heads 9 and 11 and between the heads occupy horizontal positions in a plane a little above the plane of the pipes 13 and 14. Similarly pipes 18 and 19 extend through the heads 9 and 11 and between the heads occupy horizontal positions in a plane a little above the plane of the pipes 15, 16 and 17. The pipes 13, 14, 15, 16 and 17, as shown in Fig. 3, occupy the lower half of the tube 8. A return bend 20 is coupled to the left exterior ends of the pipes 13 and 14. A return bend 21 is coupled to the right exterior ends of the pipes 14 and 15. A return bend 22 is coupled to the left exterior ends of the pipes 15 and 16. A return bend 23 is coupled to the right exterior ends of the pipes 16 and 17. A return bend 24 is coupled to the left exterior ends of the pipes 17 and 18. A return bend 25 is coupled to the right exterior ends of the pipes 18 and 19. A pipe 26, adapted to lead from a source of cooling water, is coupled to the right end of the pipe 13. Pipe connections 27 lead from the pipe 19 to the left end of a special connection 28. The connection 28 surrounds the left end of the pipe 4, closes the left end of the casing 3 and permits a flow of water from the connections 27 into the pipe 4. The parts 1, 2, 3, 4, 5, and 28, in an absorption refrigerating machine, are termed a dehydrator.

From the upper part of the casing 3, a short pipe 29 leads into the lower part of a casing 30, located back of the upper left end of the tube 8. As shown in Fig. 4, the casing 30 has, at the right, a convex valve seat 31, in a vertical plane, with a horizontal passage 32, extending through the seat and through the left end of the casing. A pipe 33 leads downward from the passage 32, passes

through the head 9, near the lower edge of the latter, and extends along near the bottom of the tube 8, nearly as far as the head 11. Within the tube, 8, the pipe 33 has frequent openings 34, extending all along its lower side. Through a horizontal opening in the head 11, at the lowest part of the tube 8, a small liquid transmitting pipe 35 extends horizontally and then downward and is adapted for connection with an expansion valve, not shown. A pressure gage 36 is connected with the upper interior of the tube 8 by an opening through the head 11.

A centrally perforated diaphragm 37, preferably of very thin vanadium steel, at its circumference, rests in a recess at the right of the casing 30. A casing 38, by means of bolts 39, clamps the circumference of the diaphragm 37 with the casing 30, and it has a hollow boss, at its right end, with a cylindrical projection 40, extending inward from its right wall. A check valve member 41 has, at the right, a sleeve, threaded for a short distance, and then plain and of reduced diameter, extending through the opening in the diaphragm 37; it has, at the right, an annular flat surface resting against the left surface of the diaphragm around the opening therein and extending radially toward the clamped part of the diaphragm; it has, at the left, an annular recess containing a ring 42, that is adapted for seating on the seat 31; and it has an opening extending from end to end through its center and in axial coincidence with the passage 32. The ring 42 may be of tin or half and half solder. A flanged sleeve 43 is internally threaded so that it screws around the threaded part of the sleeve of the member 41 and with its flange clamps together the member and the diaphragm 37. A helical compression spring 44 surrounds the projection 40 and the plain part of the sleeve of the member 41 and bears, at the right, against the right end wall of the casing 38 and, at the left, against the sleeve 43. The spring 44 therefore has a constant tendency, through the intermediate parts, to seat the ring 42 upon the seat 31 and thus to close the passage 32.

The parts 37 to 44 inclusive constitute a form of check valve that I prefer to use in connection with my invention. The construction and operation of this check valve is similar to those set forth in the applications of Carroll and Roehrich, Ser. No. 761,173, filed Apr. 15, 1913, and of Roehrich, Ser. No. 767,036, filed May 12, 1913, each entitled Check valve mechanism. I am not, however, limited to the use of any particular form of check valve in connection with my invention.

The method of operation is as follows: Let it be assumed that the parts above described constitute parts of an absorption refrigerating machine using water as the absorbent and ammonia as the refrigerant. As the still, or generator, of the machine is heated, ammonia gas ascends into the pipe 6 and passes through the parts 2, 1, 3 and 29 into the casing 30. With the parts in the positions shown in Fig. 4, the check valve is closed. This is because the pressure of the ammonia in the passage 32, in the opening through the member 41 and in the casing 38, acting upon the sleeve 43 and the diaphragm 37, assisted by the spring 44, exerts a greater force to keep the valve closed than does the pressure of the ammonia in the casing 30 to open it. But as the pressure in the casing 30 increases, it finally acts upon the member 41 and the diaphragm 37 with sufficient force to overcome the opposing forces and to open the valve. The spring 44 may be of such strength that a pressure in the casing 30 of two pounds in excess of the pressure in the casing 38 is sufficient to open the valve. It may be remarked, that to keep the valve closed until there is such an excess, the spring 44 has to be quite heavy, since the pressure in the casing 30 is exerted on a considerable number of square inches of surface of the member 41 and the diaphragm 37.

With an opening of the check valve, gas passes from the casing 30 through the seat 31 and the passage 32 into the pipe 33. From the openings 34 and from the opening at the right end of the pipe 33, the gas is free to pass into the main part of the condenser, within the tube 8 and the heads 9 and 11. To secure the full efficiency of which the condenser is capable, it is also assumed that the main part of the condenser always contains a certain quantity of liquefied ammonia. If the machine is of the continuously acting type, such as one with an absorber separate from the still or generator, where as much refrigerant is drawn from the condenser in liquid form as is delivered thereto to be liquefied, the machine should be so charged that the liquid ammonia will always just cover the pipes 15, 16 and 17. In practice, as is common with ordinary refrigerant receivers, one end of the main part of the condenser has connected with it a liquid level gage for indicating the height of liquid ammonia therein. If the machine is of the intermittent type, where one or more stills, on being heated, accumulate a supply of liquid ammonia, in the condenser, to be drawn off prior to the next heating, the machine should be so proportioned and charged that, at the beginning of such heating, liquid ammonia will touch or cover the pipes 13 and 14, and at the end of the heating, will rise to about three-quarters of the internal height of the tube 8. In either case, the gas emerging from the pipe 33 strikes the liquid already in the tube 8 and mingling therewith is liquefied thereby, principally in consequence of the cooling

effect of a flow of water that will now be explained.

It is further assumed, while gas is passing upward through the pipe 6, that, either by automatic or by hand regulation, cooling water is flowing through the parts 26, 13, 20, 14, 21, 15, 22, 16, 23, 17, 24, 18, 25, 19, 27, 28, 4 and 7 to the waste. Consequently the coolest water, being in the pipes in the lowest part of the tube 8, cools the liquid ammonia in the lowest part of the tube, with which the gas from the pipe 23 comes in contact. This liquid ammonia is thus kept as cool as possible and is very effective in quickly liquefying the incoming gas. A large measure of heat is thus imparted to the cooling water at the very outset. The water, as it progresses upward through the piping, continues to take up heat from the liquid or vaporous ammonia in the tube 8 until it emerges through the connection 27. Then, as the water, already quite warm flows into the connection 28 and through the pipe 4, it takes up still more heat from the hot gas entering the casing 2 and passing upward in the dehydrator through the annular space around the pipe 4. The water emerging from the coupling and pipe 7 is much heated. The hot gas, entering the dehydrator from the pipe 6, flows past the warmest water, flowing in the contrary direction, and thus, at first, is gradually cooled. Whatever water may have passed upward with the gas into the dehydrator is, almost entirely, condensed as it flows along the outside of the pipe 4, and, as the dehydrator is inclined, it trickles back along the inside of the pipe 6. Any remaining water entrained over into the tube 8 sinks to the bottom, as a part of the solution of exceedingly strong aqua ammonia, and flows out through the pipe 35 at the earliest opportunity. With the construction shown, there is also some radiation of heat from the parts 1, 3 and 33, and from the return bends outside of the heads 9 and 11, and also from the larger parts of the condenser. But practically the water is the all important factor in accomplishing the condensing of the ammonia gas, and it acts most efficiently on the liquid ammonia already in the tube 8 so that the latter is the direct means of condensing the incoming gas.

When ammonia gas no longer enters the dehydrator from the pipe 6, the pressure in the casing 30 begins to drop. Thereupon the spring 44, assisted by pressure in the casing 38 upon the sleeve 43 and the diaphragm 37, closes the check valve and prevents a back flow from the passage 32 through the seat 31. Any water in the annular part of the dehydrator, and in the connections leading therefrom up as far as the check valve, drains back into the pipe 6. Any water in the pipe 33, as before, sinks to the bottom of the tube 8. The only pocket, where water may accumulate, is in the lower half of the casing 38. But such an accumulation does no harm.

In case the parts described constitute parts of a compression refrigerating machine, the method of operation is substantially the same, except that, instead of water being entrained upward from the pipe 6 and trickling back or being carried over into the tube 8, lubricating oil so entrains upward and trickles back or is carried over. In case of a compression machine the check valve is liable to open and close, in correspondence with the opening and closing of the discharge valve of the compressor, and hence should be omitted, unless, indeed, as is preferable, there is space for a sufficient volume of gas between the compressor and the check valve to prevent the latter from hammering on the seat 31.

Finally considering the construction of Fig. 5: Here the parts that are the same as in the preceding figures are indicated by the same reference numerals. The only difference is that a head 9^a, inclosing the left hand of the tube 8, instead of having an opening through its lower part for the passage of the incoming gas pipe, has an opening, as high as possible, through its upper part, and a pipe 33^a, similar to the pipe 33, passes through this opening and discharges the incoming ammonia gas into the tube and above the liquid ammonia already there. Consequently, while the liquid ammonia in the tube 8 is cooled as before, it exerts its own cooling effect on the incoming gas by means of its upper surface only. Such cooling is very efficient, but is not quite so efficient as with the previous construction.

The condenser, in either form, is several times more economical of cooling water than is the usual counter current, gas cooling condenser. The gas enters the main part of the condenser almost entirely free of entrained water or lubricating oil, as the case may be. By uncoupling the connections of the pipes 13 to 19 inclusive, outside of the heads 9 and 11, the pipes, when necessary, can be readily cleaned. The positioning of the major part of the pipes 13 to 19 inclusive in the lower half of the tube 8 is very effectual in cooling the liquefied gas therein. And the entire structure is simple and compact, entirely dispensing with a receiver separate from the upper part of the condenser.

My application Ser. No. 424,517, filed Apr. 1, 1908, entitled Refrigerating machine, discloses, in Figs. 35–38, a cooling water pipe leading from the main part of a condenser and longitudinally traversing an ascending gas pipe leading into such main part, so as to constitute a dehydrator, and a check valve, for the gas, interposed at the highest part of the dehydrator. In so far as this application

has those features of construction, it is a continuation of said application and has the same filing date. My application Ser. No. 595,453, filed Dec. 3, 1910, entitled Refrigerating machine, discloses a horizontal condenser casing with horizontal lengths of cooling water pipes therein, connected in an ascending series by sections of shorter lengths, said series entering the lower part of the casing and emerging above the place of entrance. In so far as this application has these latter features of construction, it is a continuation of said latter application and has the same filing date. My application Ser. No. 748,589, filed Feb. 15, 1913, entitled Refrigerating machine, has the above mentioned features of construction of my application Ser. No. 595,453 and also dispenses with a separate refrigerant receiver beneath the main and upper part of the condenser. In so far as this application has the distinctive features of my application Ser. No. 748,589, just indicated, it is a continuation of said latter application and has the same filing date. My application Ser. No. 794,583, filed Oct. 11, 1913, entitled Refrigerating machine, has the above mentioned features of construction of my application Ser. No. 748,589, and also has the horizontal lengths of cooling water pipe extending through both heads of the main horizontal condenser casing and connected in series by return bends outside of the heads. In so far as this application has the distinctive features of my application Ser. No. 794,583, just indicated, it is a continuation of said latter application and has the same filing date.

What I have invented and what I desire to have protected by Letters Patent is expressed in claims as follows: I claim:

1. In combination a tank having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit leading into said tank through said inlet, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of said gas conduit outside of said tank for a distance and emerging therefrom.

2. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, and a gas conduit descending into said tank and discharging near the bottom thereof.

3. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit descending into said tank and discharging near the bottom thereof, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom.

4. In combination a horizontal tank with heads at opposite ends, having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, a gas conduit leading into said tank through said inlet, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom.

5. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, and a gas conduit descending into said tank and discharging near the bottom thereof.

6. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, a gas conduit descending into said tank and discharging near the bottom thereof, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom.

7. In combination a tank having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit leading into said tank through said inlet, a

water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom, and a check valve interposed in said gas conduit at substantially the highest part thereof.

8. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit descending into said tank and discharging near the bottom thereof, and a check valve interposed in said gas conduit at substantially the highest part thereof.

9. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit descending into said tank and discharging near the bottom thereof, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom, and a check valve interposed in said gas conduit at substantially the highest part thereof.

10. In combination a horizontal tank with heads at opposite ends, having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, a gas conduit leading into said tank through said inlet, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom, and a check valve interposed in said gas conduit at substantially the highest part thereof.

11. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, a gas conduit descending into said tank and discharging near the bottom thereof, and a check valve interposed in said gas conduit at substantially the highest part thereof.

12. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series outside of the heads, a gas conduit descending into said tank and discharging near the bottom thereof, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing a part of the gas conduit outside of said tank for a distance and emerging therefrom, and a check valve interposed in said gas conduit at substantially the highest part thereof.

13. In combination a tank having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit ascending to a point above said inlet and thence descending and leading into said tank through the inlet, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance.

14. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit ascending for a distance and thence descending into said tank and discharging near the bottom thereof, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance.

15. In combination a horizontal tank with heads at opposite ends, having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series by other sections outside of the heads, a gas conduit ascending to a point above said inlet and thence descending and leading into said tank through the inlet, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally

traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance.

16. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series by other sections outside of the heads, a gas conduit ascending for a distance and thence descending into said tank and discharging near the bottom thereof, and a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance.

17. In combination a tank having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit ascending to a point above said inlet and thence descending and leading into said tank through the inlet, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance, and a check valve interposed in said gas conduit at substantially the highest part thereof.

18. In combination a tank having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections in substantially horizontal positions in the tank connected in series by other sections, a gas conduit ascending for a distance and thence descending into said tank and discharging near the bottom thereof, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance, and a check valve interposed in said gas conduit at substantially the highest part thereof.

19. In combination a horizontal tank with heads at opposite ends, having an inlet and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series by other sections outside of the heads, a gas conduit ascending to a point above said inlet and thence descending and leading into said tank through the inlet, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance, and a check valve interposed in said gas conduit at substantially the highest part thereof.

20. In combination a horizontal tank with heads at opposite ends and having an outlet from its bottom, a water conduit entering said tank near the bottom thereof, emerging therefrom at a place higher than the place of entrance and consisting of sections extending through said heads, in substantially horizontal positions and connected in series by other sections outside of the heads, a gas conduit ascending for a distance and thence descending into said tank and discharging near the bottom thereof, a water pipe leading from the outlet end of said water conduit, entering said gas conduit, longitudinally traversing the ascending part of the gas conduit for a distance and emerging therefrom at a place below the place of entrance, and a check valve interposed in said gas conduit at substantially the highest part thereof.

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