W. G. ABBOTT, Jr.

APPARATUS FOR PUMPING AIR AND GASES.

APPLICATION FILED NOV. 28, 1905.

899,820. Patented Sept. 29, 1908.

3 SHEETS—SHEET 1.

Fig. 1.

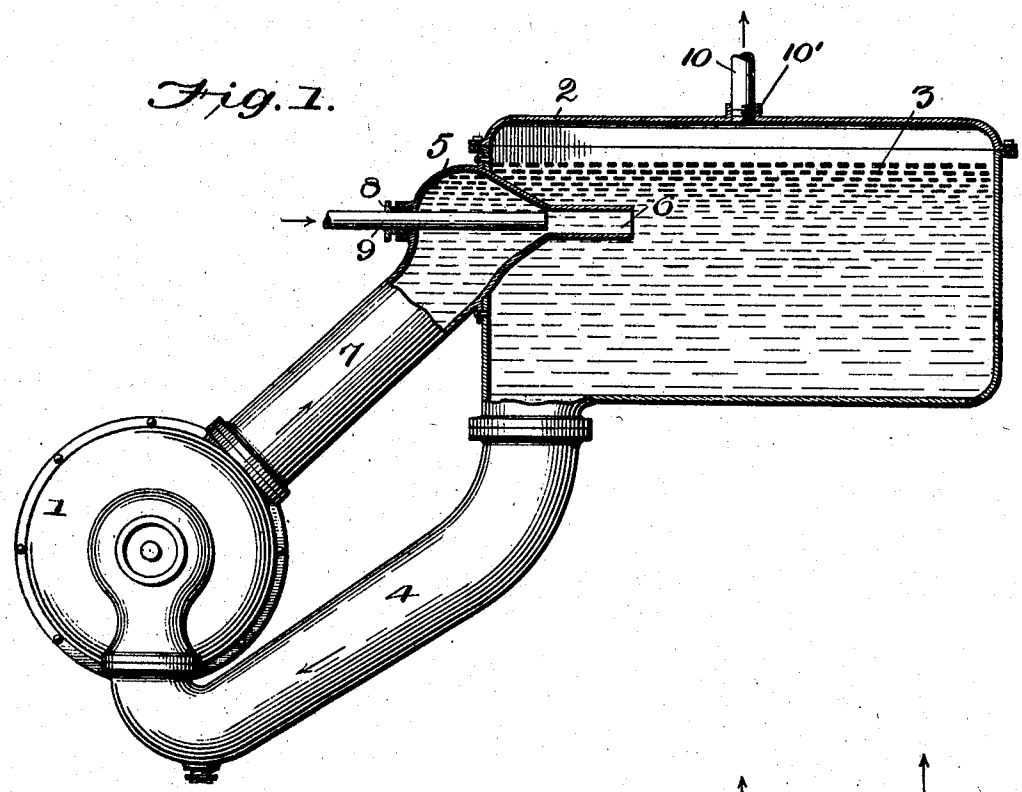
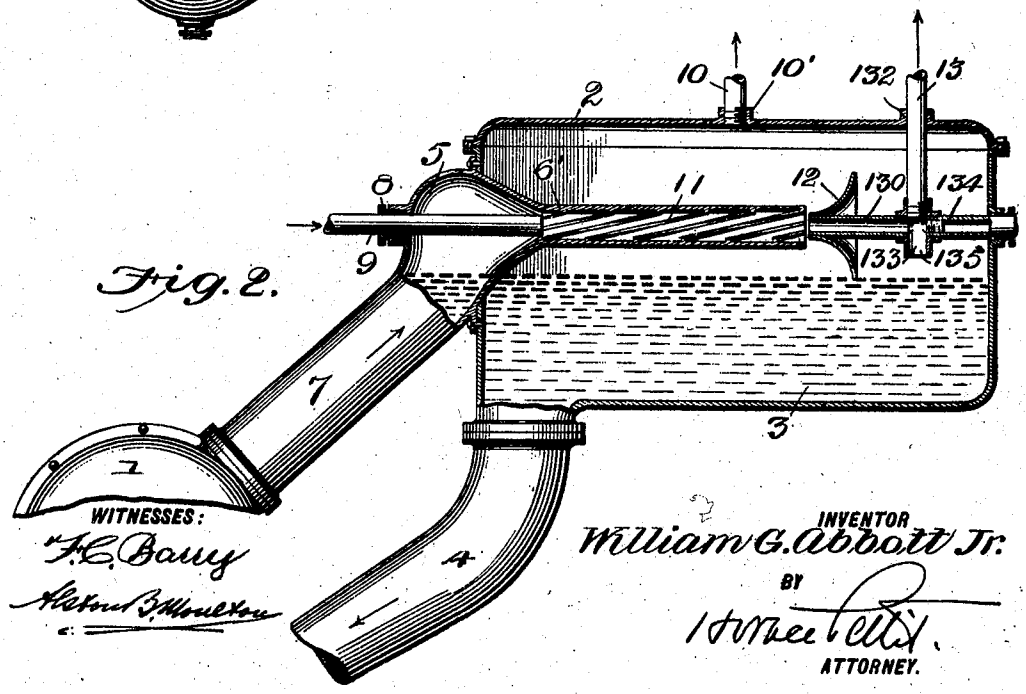


Fig. 2.



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3 SHEETS—SHEET 2.

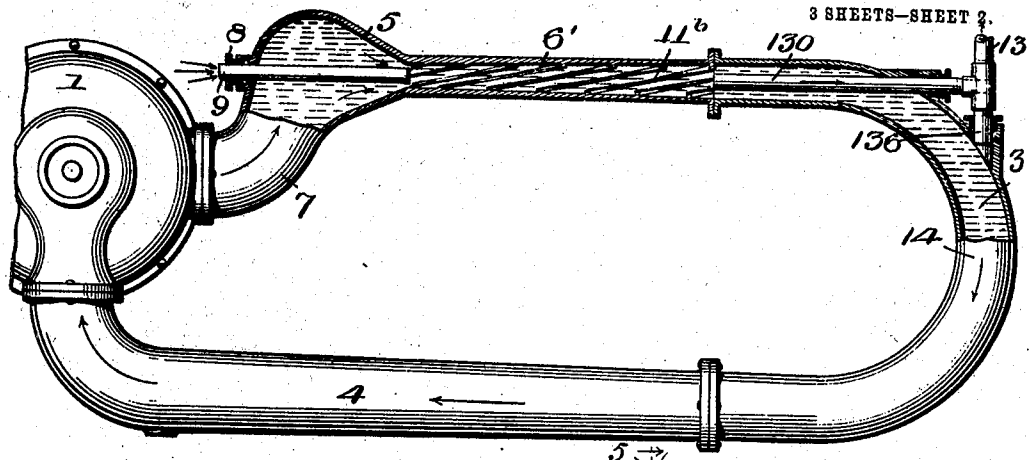

Fig. 3.

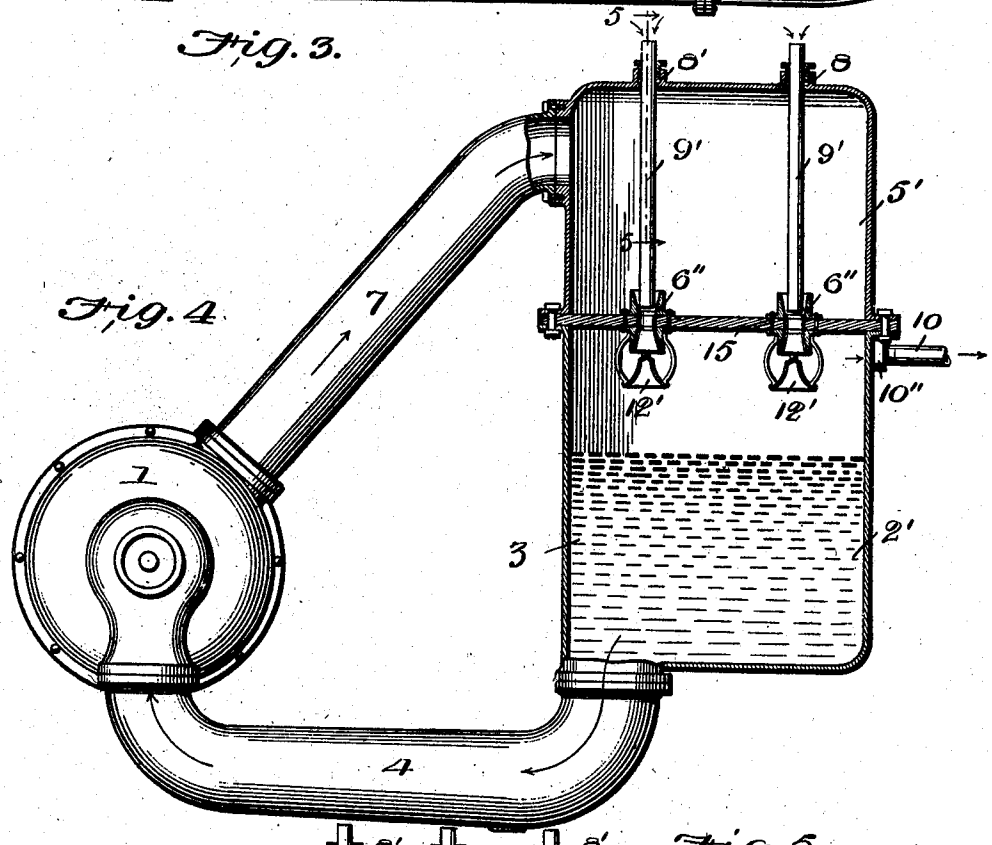

Fig. 4

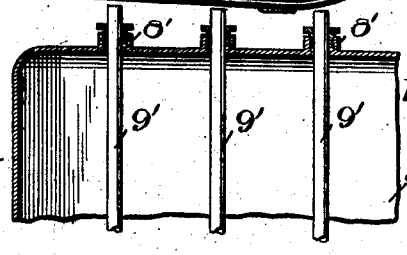

Fig. 5

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3 SHEETS—SHEET 3.

Fig. 6.

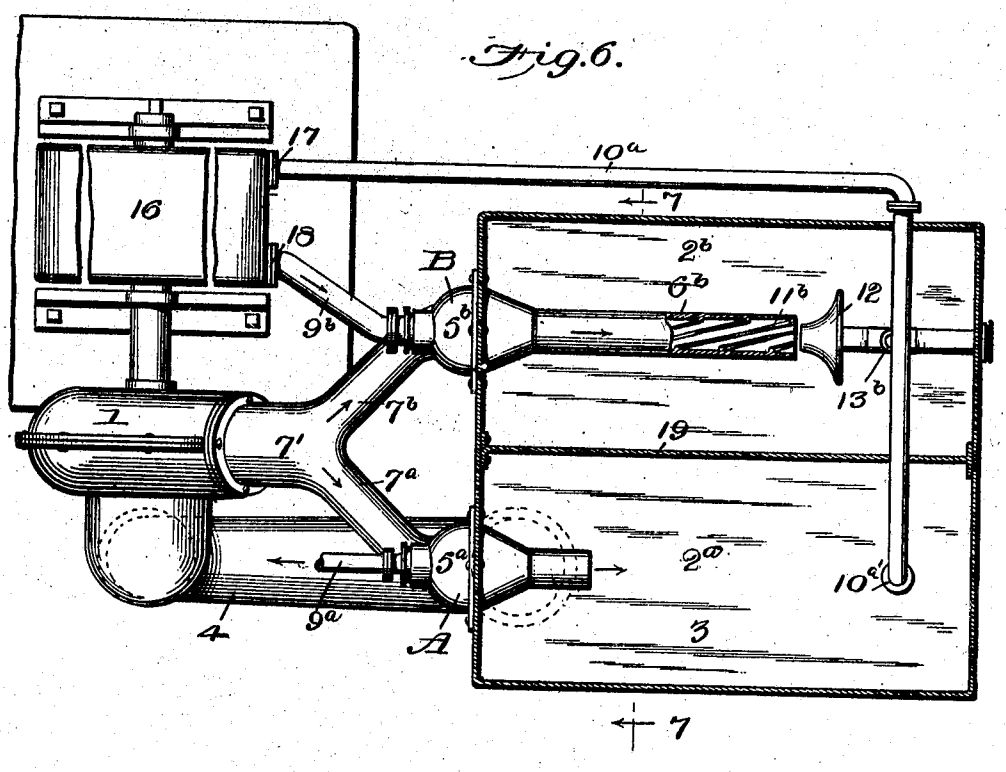
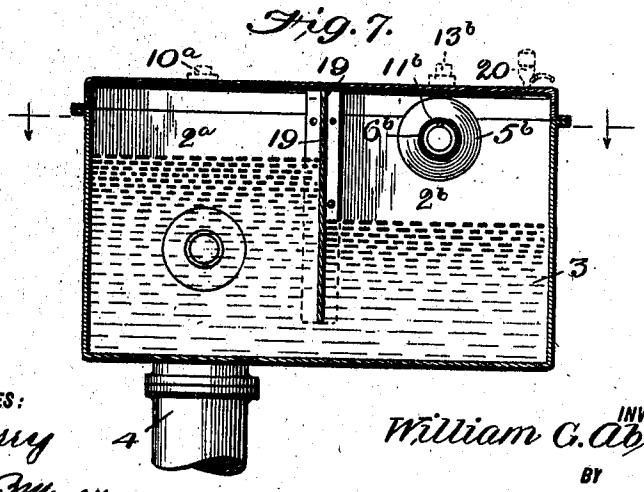


Fig. 7.



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APPARATUS FOR PUMPING AIR AND GASES.

No. 899,820. Specification of Letters Patent. Patented Sept. 29, 1908.

Application filed November 28, 1905. Serial No. 289,403.

To all whom it may concern:

Be it known that I, WILLIAM G. ABBOTT, Jr., a citizen of the United States, and a resident of Philadelphia, county of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Pumping Air and Gases, of which the following is a full, clear, and complete disclosure.

My invention relates to an improved form of apparatus for pumping air and gases, in which a gaseous fluid, in any quantity, may be compressed to any desired pressure by connecting the apparatus to a prime mover, the speed of which may greatly vary, and my invention relates especially to the construction of a pumping apparatus which may be coupled directly to a high speed prime mover, and which may be adapted for many purposes, as, for instance, for accumulating and storing air or gas under pressure, for purifying and compressing gas produced at illuminating plants, for compressing air and gas mixture for constant pressure gas engines or turbines, or for removing the back pressure of an internal combustion engine or turbine by maintaining a partial vacuum into which the waste gases are exhausted.

One object of my invention is to dispense with all reciprocating parts and with all valves, such as are usually found in pumping apparatus, and to employ a return circulating fluid to accumulate or pump the air or gas to be handled.

A further object of my invention is to construct an apparatus in which the efficiency is nearly constant, irrespective of the pressure or the quantity of air and gas being handled.

A further object of my invention is to effectively separate the air or gas from the carrying or pumping fluid.

A further object of my invention is to produce a pumping apparatus which is simple, easily constructed, and capable of working economically under varying conditions.

For a full, clear and exact description of my invention reference may be had to the accompanying drawings, forming a part of this specification, in which

Figure 1 illustrates one form of my invention as applied for the purpose of accumulating and storing air or any other gaseous fluid, under pressure, or as a suction pump for producing a partial vacuum; Figs. 2, 3 and 4 show different modified forms of my invention; Fig. 5 is a sectional view of Fig. 4 taken on the line 5—5 of Fig. 4; Fig. 6 is a view showing my improved pumping apparatus as applied to a constant pressure internal combustion turbine; and Fig. 7 is a sectional view of Fig. 6 taken on the line 7—7 of Fig. 6.

Referring to Fig. 1 of the drawings, 1 indicates a well known type of centrifugal or turbine pump provided with a suitable driving pulley 1′ mounted on a driving shaft 1″; 2 a tank in which a pre-determined quantity of water or other suitable liquid 3 is maintained; 4 a pipe leading from the bottom of the tank 2 to the inlet of said pump 1; and 5 an injector chamber secured to one side of tank 2, said chamber communicating with the tank through the nozzle 6, and with the discharge of the pump 1 through the pipe or conduit 7. Entering the injector chamber 5, through a gland or stuffing box 8, in axial alinement with the nozzle 6 is the air or gas supply pipe 9. 10 indicates a pipe leading from an opening 10′ in the top of the tank 2, through which the air or gas which has been pumped through the nozzle 6 may be conducted to any desired place. The operation of this form of my apparatus is as follows:—The pump 1 being set in motion from any suitable source of power supply, water is delivered under pressure to the injector chamber 5, and discharging through the pumping chamber 6 into the tank 2, carries with it the air or gas drawn into the nozzle 6, through the air or gas supply pipe 9. Upon emerging from the nozzle 6, the gas rises above the level of the liquid in the tank. When this apparatus is used for compressing air or gas, the gas is allowed to accumulate between the level of the water and the top of the tank, and is drawn off as desired through the discharge pipe 10. In this case both the supply and discharge ends of the pump being connected to the tank, the pressure in the tank has no resistance to the circulation of the fluid through the pipes 4 and 7, and consequently all the work which is performed by the pump is that of forcing the bubbles of air delivered from the air or gas supply pipe 9 through the nozzle 6 against the pressure of the tank, and that of overcoming the friction of the circulating water with the sides of the conduits plus the friction of the pump. When used as a suction pump, the gas delivered from the nozzle 6 will be allowed to es-

cape directly into the atmosphere, and a pressure less than the pressure of the atmosphere will be maintained in the gas supply pipe 9.

In the modification shown in Fig. 2, the nozzle 6′ is provided with spirally arranged ribs or vanes 11 and with walls which taper in the direction of its length, so that the diameter of the nozzle constantly increases toward the discharge end thereof. Secured in any suitable manner, and in axial alinement with the discharge end of the nozzle is a bell shaped separator 12 connected through the pipe 130 and coupling 133 with the pipe 13 passing through the opening 132 in the top of said tank. The pipe 13 may act as a discharge pipe for the compressed gas in which case the coupling 133 may be a four-way coupling as shown in Fig. 2, the plugged pipe 134 acting to hold the separator 12 rigidly in position while the lower openings 135 of the coupling permits whatever liquid is driven into the pipe 130 to be returned to the tank. The operation of this modification is similar to the operation of the structure shown in Fig. 1, except that the carrying fluid in traversing the nozzle 6′ has imparted to it a whirling motion around the inside of said nozzle in addition to its longitudinal motion due to the velocity of the liquid issuing from the injector chamber. By this arrangement the liquid will be kept in contact with the sides of the nozzle 6 by the centrifugal force imparted to it by the whirling effect of the vanes 11, and since the diameter of the nozzle at the discharge end thereof is greater than it is adjacent the injector chamber, the compressed gas will accumulate around the axis of said nozzle, from which it may be drawn off through the pipe 13, while the water issuing from the discharge end of said nozzle will be deflected by the separator 12 and delivered to the tank. If the level of the water in the tank should fall below the nozzle 6′, the water issuing from the discharge end of said nozzle will practically seal the space between the inner end of the deflector and the inner end of the nozzle, and the compressed gas may still be conducted away through the pipe 13. It is evident, however, that some of the gas must necessarily be carried in the form of small bubbles with the water deflected by the separator 12, and will accumulate in the top of the tank, from which it may be drawn off through the pipe 10.

In Fig. 3, I have dispensed entirely with a storage tank and have made provision for removing the compressed air accumulated at the center of the nozzle 6′. In this case the pipe 130 is made of the size of the air chamber formed in the nozzle 6′ and the discharge end of the said nozzle is connected directly by a curved U shaped pipe 14 with the supply pipe 4 of the pump or turbine 1. The pipe 130 may be connected to the upright pipe 13 and the liquid carried over into the pipe 130, returned through pipe 136 to the tube 4 to which it is connected together in the manner shown in Fig. 3. The advantage of this form of my invention resides in the fact that the momentum of the water is not lost by discharge into a tank from which it may be drawn to the pump, as is the case in Figs. 1 and 2, but a constant volume of water is kept moving at constantly the same velocity throughout the cycle.

In Figs. 4 and 5, I have arranged the injector chamber 15 above the storage tank 2′, and have located the nozzles 6″ in the partition 5′ between the tank and the injector chamber. I have also provided deflectors 12′ adjacent the discharge end of said nozzles for the purpose of enabling the bubbles of air to more readily escape from the water projected into the tank. As indicated in Fig. 5, I may have a series of inlet pipes 9′ passing through the glands 8′ on the top of the injector chamber 5′ and in axial alinement with the nozzles 6″. The air or gas which has been pumped through the nozzle 6″ is delivered from the tank 2′ through the opening 10″ to the conduit 10.

In Fig. 6, I have shown a gas turbine 16, provided with two forms of my improved pumping apparatus, one of which A is adapted to compress an air and gas mixture and supply it to the turbine 16, while the other B, is used to remove the back pressure from the exhaust of the turbine by maintaining a partial vacuum within the supply pipe 9^b. The injector chamber 5^a of the pump A is connected with the centrifugal pump 1 by means of one branch 7^a of the Y discharge pipe 7′, while the chamber 5^b of the pump B is connected with the other branch 7^b of the discharge pipe 7′. I have shown the pump A as of the type illustrated in Fig. 1, and the pump B of the form shown in Fig. 2. The discharge opening $10^{a'}$ from the top of the compartment, in compressing the air and gas mixture, communicates through the pipe 10^a with the supply port 17 of the turbine 16. In the pump B, the gas supply pipe 9^b is connected with the exhaust port of the turbine and discharges through the chamber 5^b and nozzle 6^b into the tank 2^b and pipe 13^b.

In Fig. 7, I have shown a section of a duplex tank which may be used in connection with the structure disclosed in Fig. 6, although, of course, each pump A and B may be connected to an independent tank. The partition 19 extends to a point near the bottom of the tank and one return pipe 4 will suffice to return the water from both chambers 2^a and 2^b. In order to keep the water in each chamber at the proper level, I provide the chamber 2^b with a pop valve 20 set to a pressure greater or less than that to be maintained in the compression tank 2^a. The

operation of this modification is as follows:— The pump 1 directly coupled to the shaft of the turbine 16, draws the liquid from the chambers 2^a and 2^b through the pipe 4 and delivers it under pressure through the branch pipes 7^a and 7^b to the injector chambers 5^a and 5^b. In the chamber 5^a the gas and air supply is admitted through the pipe 9^a and is compressed in the top of the chamber 2^a when drawn through the opening $10^{a'}$ and the pipe 10^a to the supply port 17 of the turbine 16. The exhaust gases are delivered through the exhaust port 18, and the pipe 9^b to the injector chamber 5^b and are carried by the water, or carrying fluid, into the nozzle 6^b, where it is separated from the water, or carrying fluid, by means of vanes 11^b, which give the fluid the rotary motion explained in connection with Fig. 2. Through the pipe 13^b, these exhaust gases are conveyed to any desired point.

As was explained in connection with Fig. 2, there will be an accumulation of some gas in the top of the chamber 2^b, and this is desirable, for otherwise there might be considerable difficulty in keeping the water, or carrying fluid, in the two chambers at the proper levels. The pop valve 20, however, when set to the pressure to be maintained in the chamber 2^a and connected with the chamber 2^b will permit the accumulated gas in the chambers 2^b to balance the pressure of the gas in the chamber 2^a, whereby the level of the water, or carrying fluid, in the two chambers may be maintained approximately the same. If the pop valve 20 is set at a greater or lesser pressure than the pressure to be maintained in the compression chamber, the water may be held at predetermined levels in the different chambers.

My pumping apparatus, as arranged and applied to a constant pressure gas engine or turbine, using a gas and steam mixture, forms a very effective compressor for these types of motors, since the circulating water, which is heated by the compressing of the air and gas mixture, is allowed to vaporize directly in the compressor reservoir, or to be atomized in the compression chamber of the engine or turbine. This super-heated mixture is more suited for use in turbines or multi-expansion engines, than is a dry gas mixture, and in my form of apparatus the heat of compression is directly returned to the cycle. My invention is also especially applicable for use with a condenser for steam motors and also for gas motors using a mixture of gas and steam, since the steam contained in the exhaust gases from such motors is almost immediately condensed by the water circulating in the pumping chamber and greatly assists in reducing and maintaining a low back pressure on the motor.

It has hitherto been impossible to couple a gas compressor directly to the shaft of a high speed motor, but my device is especially adapted for this purpose, and is, moreover, simple and efficient.

My apparatus is capable of being put to a large variety of uses under different conditions, without substantial change or modification.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:—

1. In a pumping apparatus, the combination with an injector provided with a nozzle, of a liquid, and means connected with both ends of said nozzle for circulating said liquid therethrough, means for admitting a gaseous fluid to said injector, and flaring means for separating from said liquid the gaseous fluid delivered from said nozzle.

2. In a pumping apparatus, the combination of an injector, means for circulating a fixed quantity of liquid through said injector, means for imparting a whirling motion to the liquid as it passes through said injector, means for supplying a gaseous fluid to said injector and means for carrying away the gaseous fluid delivered from said injector.

3. In a pumping apparatus, the combination of a storage tank, an injector adjacent said tank, a nozzle extending into said tank and provided with spirally arranged ribs, a liquid and means for drawing said liquid from said tank, and returning the same thereto through said injector.

4. In a pumping apparatus, the combination with a storage tank, an injector provided with a nozzle adjacent said tank, a liquid, means for drawing the liquid from said tank and returning the same thereto through said injector and means for imparting to the liquid a whirling motion as it traverses said pumping chamber.

5. In a pumping apparatus, the combination with a tank, of an injector chamber adjacent said tank, a nozzle extending into said tank, a liquid, means for drawing said liquid from said tank and returning the same thereto through said injector and means for imparting to the liquid in the pumping chamber a motion of rotation.

6. In a pumping apparatus, the combination with a storage tank, of an injector chamber adjacent said tank, provided with a nozzle, a gas inlet pipe passing through said injector chamber to said nozzle, a liquid, means for drawing said liquid from the tank and returning the same thereto through said injector chamber, and means for imparting to the liquid a whirling motion as it traverses said nozzle.

7. In a pumping apparatus, the combination with a storage tank, an injector chamber, a nozzle, a gas inlet pipe passing through said injector chamber to said nozzle, a liquid, means for drawing said liquid from the tank and returning the same thereto through said

nozzle, and spirally arranged ribs located in said nozzle for imparting to the liquid a whirling motion.

8. In a pumping apparatus, the combination with a nozzle, the diameter of which constantly increases toward the discharge end thereof, of means for impelling a liquid through said nozzle, means for throwing said liquid adjacent the walls of said nozzle by centrifugal force to form a space adjacent the discharge end of said nozzle for the accumulation of the gas drawn therethrough, and means for conveying away the gas accumulating along the axis of said nozzle.

9. In a pumping apparatus, the combination of a nozzle, increasing in diameter toward the discharge end thereof, means for supplying a gaseous fluid at the smaller end of said nozzle, means for circulating a liquid longitudinally through said nozzle, means for imparting to the liquid passing through said nozzle a rotary motion whereby the centrifugal force developed by said motion throws the liquid at the discharge end of said nozzle adjacent the walls thereof, and forms a space at the center of said nozzle for the accumulation of gaseous fluid pumped therethrough, and means adjacent the discharge end of said nozzle for drawing off said gaseous fluid.

10. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, and a flaring separator arranged adjacent the discharge end of said nozzle for separating the gaseous fluid from the liquid.

11. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, and means for imparting a whirling motion to said liquid with respect to said nozzle as it passes therethrough.

12. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, means for imparting a whirling motion to said liquid with respect to said nozzle as it passes therethrough, and a bell shaped separator converging toward the discharge end of said nozzle for separating the gas from the liquid.

13. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, means for imparting a whirling motion to said liquid with respect to said nozzle as it passes therethrough, a bell shaped separator converging toward the discharge end of said nozzle and provided with a central passage for conveying away the gas concentrated by the nozzle and issuing from the center thereof.

14. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, means for imparting a whirling motion to said liquid with respect to said nozzle as it passes therethrough, a bell shaped separator converging toward the discharge end of said nozzle and provided with a central passage for conveying away the gas concentrated by the nozzle and issuing from the center thereof, said central passage communicating with an upwardly extending duct for the gaseous fluid and a downwardly extending duct for any liquid carried by the gas through said central passage.

15. In a pumping apparatus, the combination of an injector, means for circulating a fixed quantity of liquid through said injector, means for imparting a whirling motion to the liquid as it passes from said injector, means for supplying a gaseous fluid to said injector, and means for confining the gaseous fluid delivered from said injector.

16. In a pumping apparatus, the combination of a closed storage tank, an injector adjacent to said tank, a nozzle extending from said injector into said tank and provided with spirally arranged internal ribs, means for supplying a gaseous fluid to said injector, and means for forcing a liquid from said tank and returning the same thereto through said injector.

17. In a pumping apparatus, the combination with a closed storage tank, of an injector chamber, a nozzle, a gas inlet pipe passing through said injector chamber into said nozzle, means for drawing a liquid from said tank and returning the same thereto through said nozzle and spirally arranged ribs located in said nozzle for imparting to the liquid a whirling motion.

18. In a pumping apparatus, the combination with a nozzle, of means for forcing a liquid therethrough, a pipe opening within said nozzle for supplying a gaseous fluid therethrough, and a flaring separator arranged adjacent the discharge end of said nozzle for separating the gaseous fluid from the liquid.

19. In a pumping apparatus, the combination with a nozzle, of means for forcing a mixture of gas and liquid therethrough, a flaring separator converging toward the discharge end of said nozzle for separating the gas from the liquid, and means extending axially and rearwardly from said deflector for supporting the same.

In witness whereof I have hereunto set my hand this 14th day of November, A. D. 1905.

WILLIAM G. ABBOTT, JR.

Witnesses:
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ALSTON B. MOULTON.