E. J. MOLERA & J. C. CEBRIAN.

System of Pumping and Cooling.

No. 212,967. Patented Mar. 4, 1879.

Fig. 1.

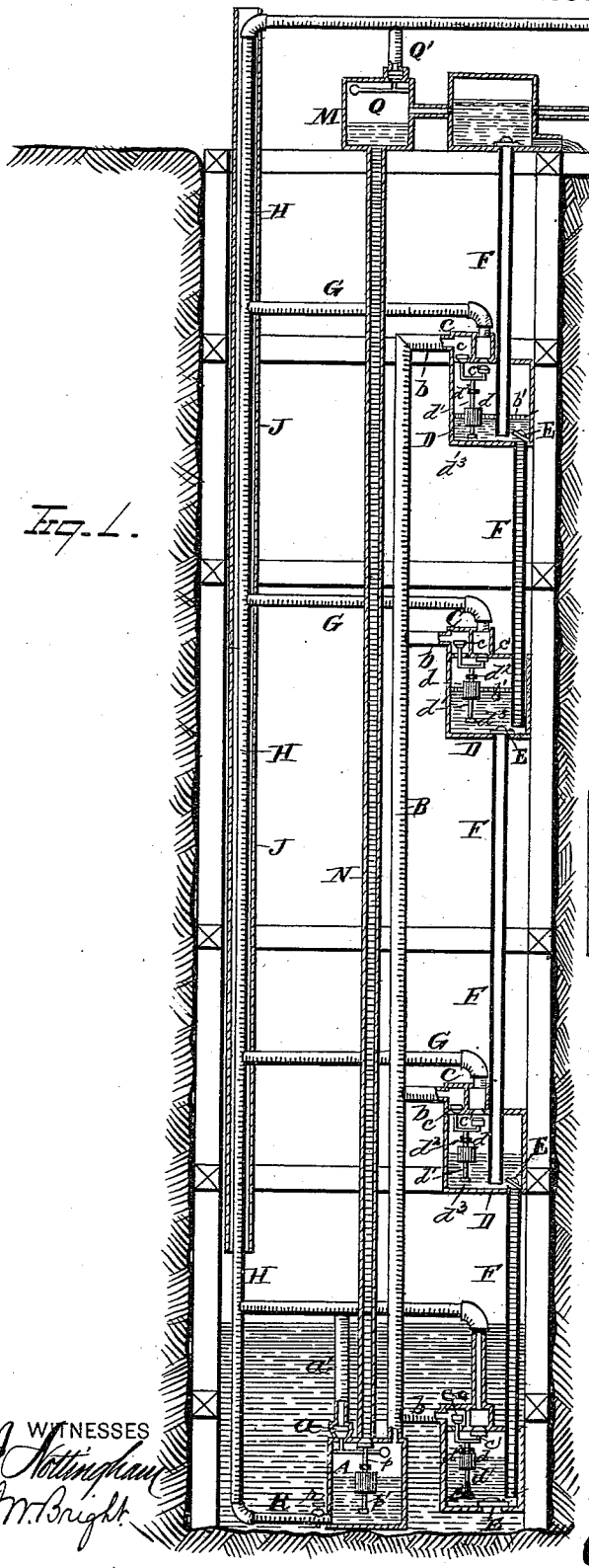
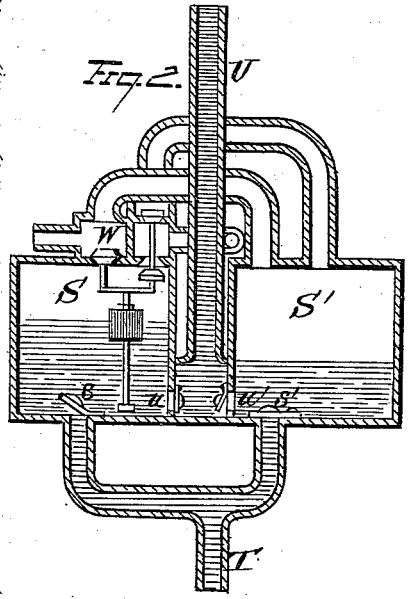


Fig. 2.



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IMPROVEMENT IN SYSTEMS OF PUMPING AND COOLING.

Specification forming part of Letters Patent No. **212,967**, dated March 4, 1879; application filed September 3, 1878.

To all whom it may concern:

Be it known that we, EUSEBIUS J. MOLERA and JOHN C. CEBRIAN, of San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Systems of Pumping and Cooling; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

Our invention relates to an improved system of pumping and cooling, and is adapted for use so that the two processes may be carried on simultaneously, or either one singly, to the exclusion of the other.

The invention is especially applicable for mines and subterranean shafts, but is also intended for any purpose or use to which it may be adapted.

Heretofore the process of pumping has been carried on by huge, costly, complicated, and defective machinery; and when the pumping is connected with mining or subterranean works the above disadvantages are increased by the difficulty of ventilating and cooling said works.

The object of our invention is fourfold: first, to simplify the pumping machinery, and thereby lessen its initial cost; second, to economize the running expenses of said machinery by lessening the cost of its fuel; third, to ventilate the mine or shaft by creating a current of pure cold air, which is drawn into said mine or shaft; fourth, to utilize any natural source of heat which may be at hand, even though the same be of a temperature insufficient to aid in generating steam in ordinary steam-boilers.

While our invention is capable of accomplishing these several purposes all simultaneously, it is also adapted to perform part of the said results in exclusion of the others, if desirable. Thus, if a natural source of heat be not used, any artificial heat may be substituted, and in such case our invention would serve the first three purposes above set forth. If, however, no cooling or ventilation is needed, then the invention would answer the first, second, and fourth objects, or only the first and second, as desired. In case that the pumping is unnecessary or is stopped, then either one or both of the third and fourth objects would be answered.

The invention employs as motive power the expansional force of certain gases, which at comparatively low temperatures acquire great tension, such as ammoniacal gas, sulphurous acid, ether, carbonic acid, and other gases. Such gases are subjected, under suitable conditions, to heating influences, and are then introduced into pumping-chambers as active agents.

For convenience in reference thereto, we will hereinafter speak of the motive power simply as a gas, though any suitable vapor may be used; and the vessel in which the same is heated, though of any desired character, we will call a "boiler;" and the substance which is pumped from the mine, shaft, or other locality we will speak of as "water." We desire, however, to be understood in that it is our full meaning, purpose, and invention to use as a motor any gas, vapor, mixture of the two, or combination of different gases or vapors; and the same will all act in an analogous manner, though the difference in their relative tensional power, or the difference in the amount of heat necessary to bring them to a certain tensional force, will correspondingly make a difference in the practical and economical results in using one kind or another of the same. So, too, it must be remembered that our system of pumping may be applied not only to elevating water, but also any other liquid, and also many kinds of muds, mixtures of liquids and solids, or substances in general. These different applications of its use may require slight modifications; but the same are all within the scope of the general principle governing our improvement.

Our invention relates, first, to a process of pumping, consisting in expanding a gas, introducing it under regulation into a suitable pumping-chamber, exhausting, and finally condensing the same. This process economizes the expense in running pumping machinery, since the amount of heat necessary to start the same in operation is much less

than is required in other processes; thus about one-fourth the amount of heat is necessary to disengage gas from liquid ammonia that is required to generate steam; also, low temperatures which would produce no result in generating steam when applied as a heating influence in the above process will cause gas tensions of great power. Hence we may utilize almost any natural source of heat. Hot springs will frequently suffice to produce the required gas expansion. Even the solar heat, if properly collected, will impart a very high power of expansion, whereas the same amount of heat when applied to steam might even condense it. And in instance of mining purposes, the water to be pumped is not infrequently of a temperature which, while it would not hasten the generation of steam, would be amply sufficient as a heating agent in our process. In many subterranean works the atmospheric temperature is very high, and could be used in said process, while it would be of no avail whatever in the formation of steam.

Our invention relates, secondly, to a process of cooling mines or subterranean shafts, consisting in expanding gas under suitable conditions within the same, passing it up through a draft-opening under confinement, condensing, and finally returning the same to be again passed through said process. The ascending current of gas will tend naturally to expand, which will require a corresponding quantity of heat to be taken from surrounding objects. Heat being thus taken from the air within the draft-opening, through which latter the gas passes within pipe-inclosure, the same is cooled in equal ratio, and by its increased gravity over the lower strata of heated air descending currents of cold air are created, which draft down into the mine or shaft. These currents may be utilized in any suitable manner for purposes of cooling and ventilation.

Our invention relates, thirdly, to a combined process of pumping and cooling, consisting in introducing expansional gas in a state of tension and under due conditions into a pumping-chamber, exhausting the same after it has duly operated therein, and passing said exhaust-gas under confinement up through a draft-opening, and then condensing the same.

This process prevents the loss or waste of any part of the expansional power of the motor used in pumping after it has acted upon one or more pumping-chambers, since at that stage all of the expansional power of the gas is used in creating the cold drafts of air, which latter purpose is in many cases scarcely secondary to the pumping.

Aside from this process, however, it should be observed that in cases where such cooling and ventilation are not required a very prominent feature of the economy obtained by our invention is in the fact that the expansional power of the exhaust-gas is not lost. Inasmuch as the gas must be liquefied before being used over again, the greater its tension after it has performed its pumping work the less will be the labor and expense in liquefying it anew; whereas in steam pumping-engines all exhaust-steam is wasted, and hence the work, heat, and expense required in bringing said steam to that point of tension which it possesses at the time of leaving the engine is totally lost.

Our invention relates, fourthly, to a process of pumping, consisting in introducing, under due regulation, expansional gas in a state of tension within a pumping-chamber, said gas operating upon a liquid piston, which latter is interposed between the same and the liquid or other substance to be pumped. This process has many advantages in regard to simplicity and cheapness of the pumping machinery. First, by using a liquid piston we may construct the pumping chambers of any form whatever, avoiding the boring of perfectly-true cylinders. We also are thereby enabled to use pumping-chambers of much larger size, and may employ material other than iron. Secondly, the same pumping-chamber serves both as steam-cylinder and pumping-cylinder. Thirdly, we avoid the construction, expense, and perfect maintenance of steam-packed pistons and water-plungers. Fourthly, we avoid the use of piston and plunger rods, together with their stuffing-boxes. Fifthly, the many and large leakages of motor and water that is pumped, which inevitably occur by using the above-mentioned mechanical parts, whether in steam or gas engines, are prevented by our process. Sixthly, the valve-rods, their stuffing-boxes, and the attendant leakage, are avoided. Seventhly, all connecting mechanism between the above-mentioned pieces of machinery is avoided. Eighthly, we therefore diminish considerably the running expenses of the machinery.

Our invention further relates to the mechanism used in carrying out the foregoing processes, and consists in the same, as appears from the description and claims which follow.

Referring to the drawings, Figure 1 is a view in vertical sectional elevation of one form of mechanism illustrating our invention, the same being applied to the pumping-compartment of a mining-shaft, and representing a vertical series of pumping-chambers, together with their connections. Fig. 2 is a sectional view, in detail, of a modification of the pumping-chambers.

It is supposed in this case that the mine is supplied with hot water, and that the gas-boiler is immersed therein.

The gas to be used in any particular instance is placed in a boiler, A, which is located at any suitable point inside or outside the shaft. This boiler is provided with a delivery-pipe, B, which passes upward and communicates by suitable connections *b* with the valve-chests C of the several pumping-chambers D. These pumping-chambers are each provided with a float, *d*, adapted by its varying height in the chamber, as it rises or falls with the different depth of water therein, to automati-

cally regulate the delivery and exhaust valves *c c'*. Both said valves are secured by their independent stems to a common valve-rod, d^1, upon which said float has a sliding vertical movement to a certain extent. Stops d^2 d^3 are formed at suitable points upon said valve-rod above and below the float. These stops are adapted by their position to cause the float to strike against them, respectively, when the pumping-chamber is practically filled and emptied of water; hence when the chamber is sufficiently filled with water, the float being raised by the latter will engage with the upper stop, d^2, which will cause the valve-rod to move upward, and to open delivery-valve *c* and close exhaust-valve *c'*. The suction-valve E of the corresponding pumping-chamber being closed, the water is caused by the pressure of the expanding gas upon the surface of the same to be forced up through its discharge-pipe F and out from said chamber.

After the latter is practically emptied, the fall of water causes the float to engage with the lower stop, d^3, and the valve-rod operates to close delivery-valve *c*, and therewith to open exhaust-valve *c'*. The gas enters through exhaust-pipe G into the main draft-pipe H, which latter passes up through a suitable draft opening or conduit, J, and conducts the gas into a condenser, K, from whence it is passed into a receiver, and remains therein in the form of liquid, subject to the call of the boiler. A force-pump, L, operated by the current of drained water, or in any other way, converts the gas, after it leaves the condenser, into such liquid form, and the process of liquefying is preferably carried on within the receiver M.

A feed-pipe, N, provides interior connection between the receiver and the boiler, and a feed-valve, P, controls such connection. Instead of this valve being located in the boiler, it may be placed in the receiver, or at any point intermediate between the two. In any instance, however, said valve is provided with a valve-rod, *p*, of corresponding length, so that it may extend from the valve-seat, wherever formed, down into the boiler, said rod being provided with a float, *p'*, which is acted upon by the varying quantity of liquefied gas in the boiler, whereby the valve is opened when the liquefied gas is consumed below a certain level, and is correspondingly closed as long as the same is above such level. This feed-valve may be conical, slide, or of other appropriate construction: if it is made conical, the upper and lower faces thereof are accurately made of such respective area that the pressure from above and below the valve may be nearly balanced in their action upon the latter, so that any tendency of movement imparted to it by the float may sensibly affect it.

The receiver is provided with a safety-valve, Q, and pipe-connection Q' with the condenser. If desired, this receiver, discharge-pipe, or any other parts of the apparatus may be felted over or incased with any non-conductor of heat. The boiler is also provided with a suitable safety-valve, *a*, and pipe-connection *a'* with the condenser. Both of these safety-valves may be of any description, and are internal or covered up; by means of the same the surplus gas may be directed into the condenser respectively from the boiler and receiver. That which proceeds from the boiler passes through the draft-pipe H, and thus serves the function of cooling the air in the draft-opening J during its course to said condenser. The boiler is also connected with the condenser by means of a pipe, R, which is provided with a suitable valve, *r*, at any point of its length. The object and function of this pipe are to utilize the expansional power of the gas for cooling or draft purposes when the pumps are not working, or are working at a rate of speed less than that of their usual capacity. This pipe also is preferably connected with the main draft-pipe H, so as to avoid the necessity of a separate pipe in passing said gas up through the draft-opening.

In this connection we would observe that the several exhaust-pipes leading from their respective pumping-chambers may be connected or disconnected; and, instead of each of the same communicating with the main draft-pipe, any or all of them may communicate with each other or with independent draft-pipes leading to the condenser.

Returning to the process of pumping, the operation is repeated by which the expanding gas from the boiler is introduced into the pumping-chamber; and since the exhaust together with the suction valve of said chamber is closed, the pressure of the gas forces the water out through the discharge-pipe.

In the accompanying drawings the discharge-pipe of each of the lower pumping-chambers empties into the chamber next above, while the last chamber discharges the water finally from the shaft. Hence the suction-valves of all but the lowest chamber control the upper openings of the several discharge-pipes which empty into their respective chambers, and only the suction-valve of the lowest chamber communicates directly with the water in the bottom of the shaft.

If, however, such a vertical series of pumping-chambers be unnecessary or not used, then it is apparent that the gas-delivery and water-discharge apparatus or connections would be correspondingly changed to adapt the invention to but a single pumping-chamber, or to two or more chambers, as the case may be.

While we have shown the several valves operating in connection with the pumping-chambers as conical, we desire to be understood in that we may substitute for any or all of the same other forms of valve adapted to accomplish the end in view; and instead of moving the valves by means of the floats and valve-rods provided with float-engaging stops, as herein set forth, we may substitute any other suitable mechanism adapted to be operated from the interior or exterior of the pump-

ing-chamber. In any instance in which the pressure of the expanding gas cannot readily be imparted to the water or other substance which is to be pumped by direct and simple contact, as is the case with gases which are absorbed by the same, we use a liquid piston. This liquid piston may be any suitable liquid or mixture of liquids placed between the substance to be pumped and the gas or vapor, and has no reciprocal chemical action, either with the latter or with the gas which is used as a motor. For instance, if water is being pumped, and ammoniacal gas is the motor used, then the liquid piston may be petroleum, since neither water nor said gas has any reciprocal action with petroleum. The thickness of this piston may vary from a very thin film, which covers all the transverse section of the pumping-chamber up to any desired degree of depth. Suitable precaution should be exercised that this liquid piston does not reach the opening of the discharge-pipe, or that of the valve-chest, so as to escape from the chamber. In case of using the floats previously described, the stops on the valve-rod may be placed at points thereon adapted to cause the mechanism in the valve-chest to operate so as to prevent such escape.

The two upper pumping-chambers in the drawings are represented as being provided with liquid pistons, lettered *b'*.

Instead of keeping the gas which is used as a motor in a liquid state previous to passing it into the boiler, the same may be kept in an aqueous or other liquid solution.

In using gases thus held in suitable solutions, instead of being liquefied, the well-known property of certain gases—such as the chloride of methyl, the ammoniacal gas, and others of analogous nature—to dissolve in large quantities of alcohol, water, glycerine, or other liquids, is taken advantage of. As soon as the temperature of any of these solutions is raised the gases readily disengage themselves, and are employed as active agents, the same as is the case with the expanding gas produced from a liquefied instead of a dissolved gas. If the same liquid which formerly held the gas in solution is again cooled it may be used over again continuously to reabsorb the exhaust-gas. To accomplish this the liquid may or may not be passed through a worm surrounded by cold water, and the exhaust-gas which was formerly disengaged from it, or any other equal volume of gas, be introduced therein under suitable conditions.

One feature in the use of dissolved gas needs explanation, as provision must be made whereby the solvent liquid which remains in the boiler after the gas is expended from the latter may be emptied therefrom in order to permit of a recharging of the boiler with a new solution. Since this solvent liquid is of greater density than the solution, it collects at the bottom of the boiler, whence it will be forced by the internal pressure of said boiler to the condenser. Should it, however, be the case that the specific gravity of the solvent should be such as to render it impossible to thus automatically force the same entirely up to said condenser, then suitable mechanism can be employed to force the solvent from such point as it is carried by the boiler-pressure up through the remaining distance into said condenser. As before intimated, the condenser will, in such case, act as an absorber, and it may be desirable at times, in order to quicken the process of absorption, to employ refrigerating apparatus, through which the solvent liquid passes before entering said condenser or absorber.

The pumping-chambers thus far described are on the principle of single-acting-pumps; but, if desired, other forms of pump-action may be substituted for the same; thus, in Fig. 2, a modification is shown of a chamber in detail which operates as a continuously-acting pump. Any number of such chambers might be employed in a vertical series.

Twin pumping-chambers S S' are provided with suction-valves *s s'*, which control openings of branches of a single suction-pipe, T. They are also, respectively, provided with discharge-valves *n n'*, controlling communication with the branches of a common discharge-pipe, U. If a series of these chambers is used this discharge-pipe will constitute the suction-pipe for the chamber next above.

The valve-chest W has a gasway communicating with the boiler and an exhaust-way communicating with the condenser. Each of these ways is provided with openings into both of the twin chambers, the same being independent of one another, and provided with valve mechanism adapted to cause one of said chambers to be in active communication with the boiler, while simultaneously therewith the other twin chamber is in active communication with the condenser. Hence it is apparent that one of the chambers will be more or less filled with water, and be actively pumping the same, while the other chamber is more or less empty of water, and not in active pumping operation. As this relative condition of operation will obtain in continuous alternate succession with the twin chambers, a constant stream of water will flow through the suction and discharge pipes instead of an intermittent flow, as was first described with the pumping-chambers working on the principle of a single-acting pump.

The valves illustrated as operating in this modification are arranged as two pairs of conical form, each pair being rigidly connected to a common stem, and both said stems rigidly connected with a valve-rod, which latter is provided with a float, and is adapted to operate the valve mechanism in the same manner as the valve-rod in the single-acting pumping-chambers heretofore described, operates its valve mechanism.

If desired, other forms of valve and valve-motion may be employed suitable to the end in view, and a separate valve-chest might be

used with each one of the twin chambers, the same being similar to that which is used with the single-acting pumping-chambers first described.

Having fully described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. A process of pumping, consisting in expanding a suitable gas or vapor, passing it under due regulation into a pumping-chamber, exhausting the same, and, finally, condensing it preparatory to being subjected to a similar repeated process, substantially as set forth.

2. A process of cooling and ventilation for mines and subterranean shafts, consisting in expanding a suitable gas or vapor to a due degree of tension within said shaft or mine, and then passing the same out therefrom under confinement through a draft opening or conduit, substantially as set forth.

3. A combined process of pumping and cooling, consisting in raising a suitable gas or vapor to a due degree of tension, introducing the same into a pumping-chamber, exhausting the gas, and passing said exhaust-gas under confinement through a draft-opening previous to condensing it, substantially as set forth.

4. A process of pumping, consisting in subjecting a liquid piston within a pumping-chamber to the pressure of an expansional gas or vapor, which latter is introduced into said pumping-chamber under due regulation, substantially as set forth.

5. In a system of pumping by means of the expansional power of certain gases or vapors, the combination, with a gas vessel or boiler, intermediate connection, and suitable valve mechanism, of a pumping-chamber which is adapted to be operated by a liquid piston, substantially as set forth.

6. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a suitable vessel or boiler, in which the latter are heated, of one or more pumping-chambers, together with intermediate connections and valve mechanism, substantially as set forth.

7. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a suitable gas vessel or boiler and one or more pumping-chambers connected therewith under valve-controlling communication, of a condenser and exhaust-pipe connection leading from said chamber or chambers thereto, substantially as set forth.

8. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas vessel or boiler, one or more pumping-chambers, a condenser, and suitable intermediate connections, of mechanism adapted to liquefy the gas, substantially as set forth.

9. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas vessel or boiler, one or more pumping-chambers, a condenser, and intermediate connections, of a force-pump and a receiver adapted to liquefy the gas and store the same in said liquid condition, substantially as set forth.

10. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a suitable gas vessel or boiler, located within a mine or subterranean shaft, of a condenser, located above the same, and pipe-connection controlled by valve mechanism between the same, said pipe-connection being placed within a draft opening or conduit, substantially as set forth.

11. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas-boiler, one or more pumping-chambers, a condenser, and intermediate connections, of a receiver and pipe-connection between the same and the gas-boiler, said pipe being provided with suitable valve mechanism, substantially as set forth.

12. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas-boiler, located within a mine or subterranean shaft, of a receiver in which the gas, after being once used, is stored in the form of a liquid or a solution preparatory to being again used, together with a pipe connecting said boiler and receiver, and which is provided with a valve adapted to be moved by valve-rod and float mechanism operating within said boiler, substantially as set forth.

13. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas-boiler, located within a mine or subterranean shaft, and a condenser, located above the same, of pipe connection between the two and suitable safety-valve mechanism, said pipe communicating with the top or upper body of the boiler, substantially as set forth.

14. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas-boiler, located within a mine or subterranean shaft, and a condenser or absorber located above the same, of a pipe-connection and suitable valve mechanism between the two, said pipe communicating with the bottom or lower body of the boiler, substantially as set forth.

15. In apparatus for pumping by means of the expansional power of certain gases or vapors, the combination, with a gas-boiler, one or more pumping-chambers, and intermediate connections, of suitable valve-chests and valve mechanism, the latter being adapted to feed and exhaust gas in alternate succession respectively into and from said chamber or chambers, substantially as set forth.

16. In apparatus for pumping by means of the expansional power of certain gases, the combination, with a gas-boiler, a pumping-chamber, and intermediate connection, of gas-inlet and gas-exhaust valves, said valves be-

ing adapted to be closed and opened in alternate succession, substantially as set forth.

17. In apparatus for pumping by means of the expansional power of certain gases, the combination, with a gas-boiler, intermediate connection, and a pumping-chamber formed with gas inlet and exhaust ports governed by suitable valve mechanism, of respective water-feed and discharge pipes, substantially as set forth.

18. In apparatus for pumping by means of the expansional power of certain gases, the combination, with a gas-boiler, intermediate connection, and a pumping-chamber, of respective gas-inlet and gas-exhaust valves, a valve-rod to which the stems of said valves are secured, and a float adapted to close or open the latter, substantially as set forth.

19. In apparatus for pumping by means of the expansional power of certain gases, the combination, with a pumping-chamber provided with suitable water-feed and water-discharge mechanism, of gas inlet and exhaust valves, whose stems are secured to a common valve-rod, said rod being formed with stops located at suitable points thereon, with which the float is adapted to engage, and thereby respectively close and open said valves, substantially as set forth.

20. In apparatus for pumping by means of the expansional power of certain gases, the combination, with one or more pumping-chambers and gas-exhaust pipes, of a draft pipe or pipes, connecting the same with suitable condensing mechanism, said draft pipe or pipes being located within a draft-opening leading from the surface ground down within a mine or subterranean shaft, substantially as set forth.

In testimony that we claim the foregoing we have hereunto set our hands this 20th day of August, 1878.

EUSEBIUS J. MOLERA.
JOHN C. CEBRIAN.

Witnesses:
F. O. WEGENER,
THOMAS D. GRAHAM.