G. J. MURDOCK.

PUMPING APPARATUS.

APPLICATION FILED MAR. 1, 1906.

Patented Sept. 22, 1908.

2 SHEETS—SHEET 1.

899,458.

Fig. 1,

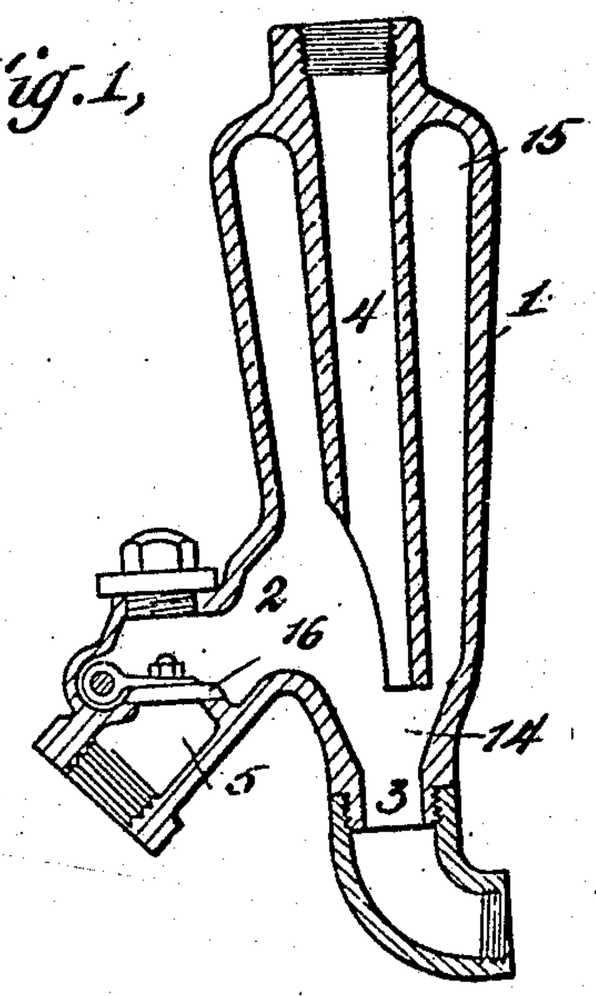


Fig. 2,

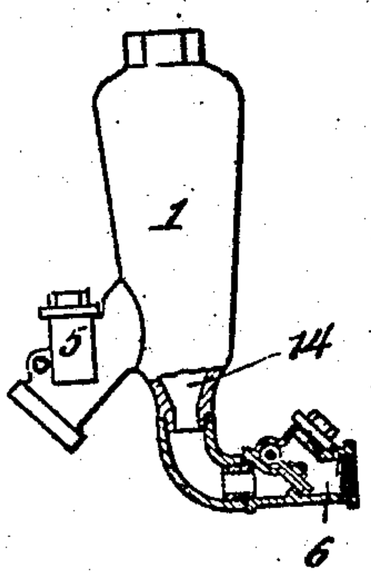


Fig. 4,

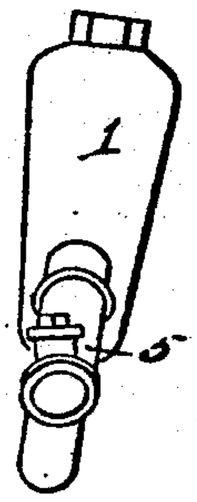


Fig. 4a,

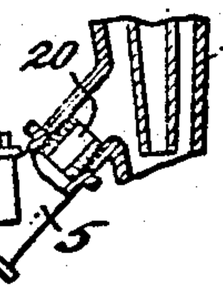
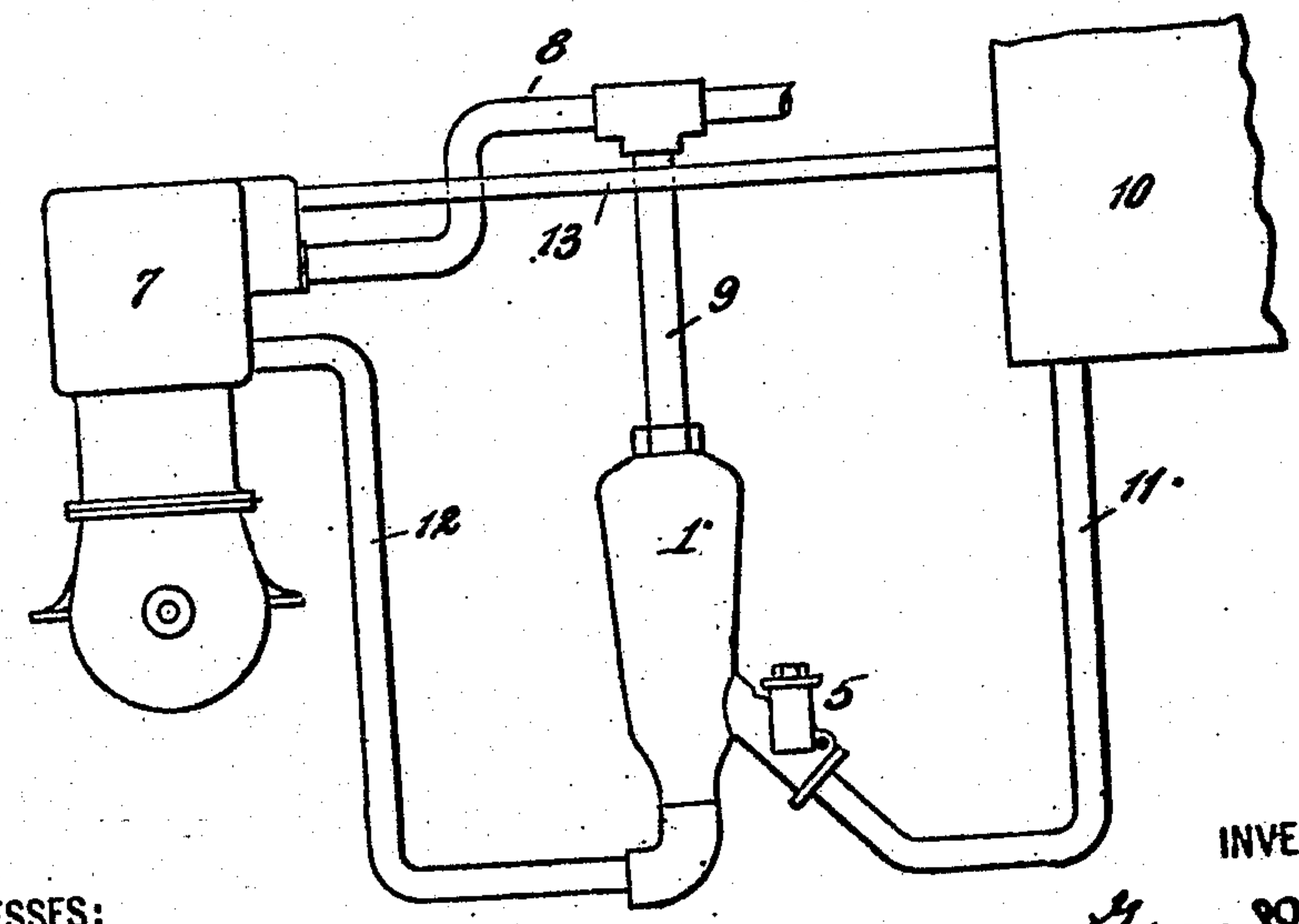


Fig. 3,



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2 SHEETS—SHEET 2

Fig. 5

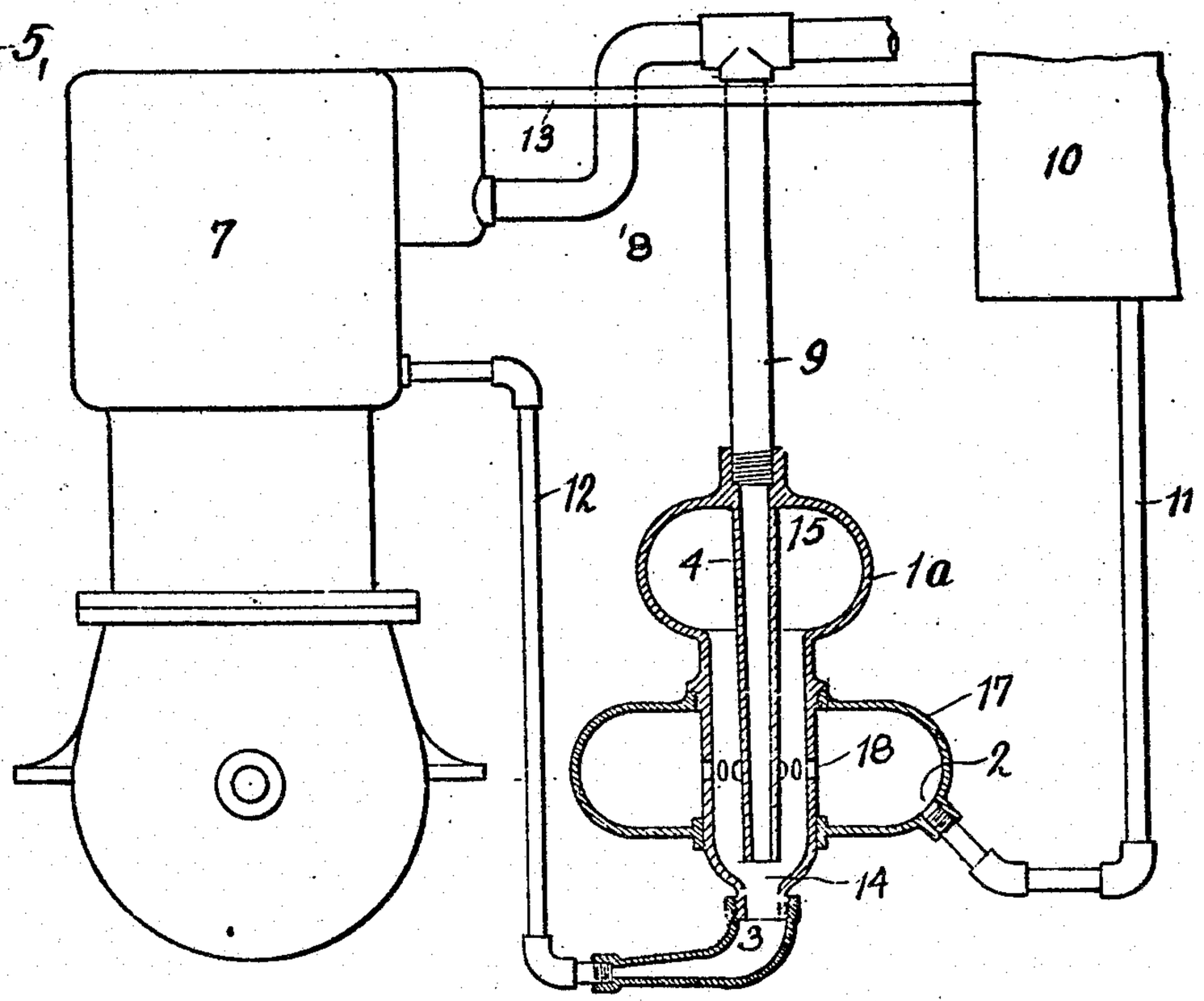
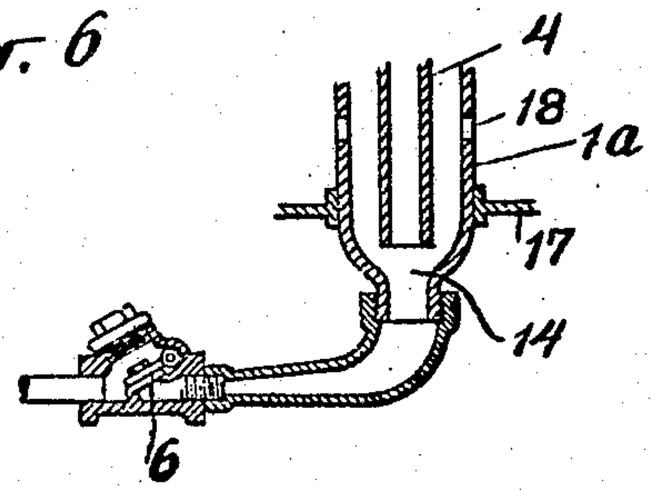


Fig. 6



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PUMPING APPARATUS.

No. 899,458. Specification of Letters Patent. Patented Sept. 22, 1908.

Application filed March 1, 1906. Serial No. 303,598.

To all whom it may concern:

Be it known that I, GEORGE J. MURDOCK, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Pumping Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates generally to pumping apparatus operated by intermittent flow of fluid through a pipe or passage, and particularly to pumping apparatus adapted to be operated by the exhaust from fluid pressure motors such as steam engines or gas or oil explosion engines.

The pumping apparatus herein described is particularly intended for maintaining circulation of cooling fluid through the jackets of internal combustion engines, such as gas engines, but is not limited to such use. It embodies improvements upon the pumping apparatus illustrated and described in my Patent No. 765,438, dated July 19th, 1904.

The objects of my invention are to increase the efficiency of pumping apparatus operated by intermittent pulsatory fluid pressure; to adapt such apparatus for operation by pulsations recurring with extreme frequency; to reduce to a minimum the number of valves required, and even to dispense with valves altogether; to adapt the apparatus for pumping against relatively high heads and for taking water below the level of the pump; to make the apparatus efficient in operation, positive in action; simple, free from liability to derangement, and inexpensive; and to make the apparatus simple and attractive in design and external appearance.

I will now proceed to describe my invention with reference to the accompanying drawings, in which said embodiments of my invention are illustrated, and will then point out the novel features in claims.

In the said drawings, Figure 1 shows a central vertical section of one form of my improved pumping apparatus; Fig. 2 is a similar view of an alternative form of the device having a valve on the discharge side as well as on the admission side; Fig. 3 is a diagram showing the manner of connecting this pump in the circulating system of an engine; Figs. 4 and 4ª are detail views, the former an end view and the latter a longitudinal section, showing the valve 5 separate from the air chamber but connected thereto by a nipple, this being desirable when the air chamber is to be tilted, as when the engine itself is inclined. Fig. 5 shows a central vertical section of a further alternative valveless form of my apparatus; and Fig. 6 shows the use of a discharge check valve in connection with the pump shown in Fig. 5.

Referring now to the drawings and at first to Fig. 1, the pumping apparatus there shown consists of an air chamber 1 provided at one side with an inlet opening 2 and at the bottom with a discharge opening 3. At substantially the center of the air chamber is a downwardly projecting slightly tapered pipe 4 adapted to be connected at the top to the exhaust pipe of an engine or other source of supply of motive fluid. As already stated, this apparatus operates by the action of recurring pulses of fluid under pressure, such as may be obtained from the exhaust pipe of an engine, though of course, they may be obtained from other sources.

5 designates a check valve connected to the admission port 2 and arranged to prevent return flow of water. In many cases where the head to be pumped against is small, this check valve 5 is all that the pump requires. Such is the case usually where the pump is employed for circulating cooling water through the jackets of internal combustion engines, compressors and the like, as the head to be pumped against in such cases is usually small. But when pumping against a considerable head I may provide a second check valve 6 connected to the discharge outlet 3 and arranged to prevent back flow of the water through said outlet, as shown in Fig. 2. By means of this second check valve I have been able to pump water against as much as twenty-five feet of head; the pump being operated by the exhaust of an explosion engine operating under ordinary conditions—*i. e.*, without excessive pressure of the exhaust impulses.

Fig. 3 shows the manner of connecting this pump to be operated by the exhaust of an explosion engine, and to circulate cooling water through the jacket of such engine. 7 designates the cylinder of the said engine, 8 the exhaust pipe thereof, 9 the standpipe

connecting said exhaust pipe with the internal tube 4 of my pump, 10 a reservoir for cooling water such as is commonly provided in connection with such engines, 11 the water supply pipe therefor connected to check valve 5, 12 the pipe leading from my pump to the cylinder jacket of the engine, and 13 the pipe conveying the water from said jacket back to tank 10. While in Fig. 3 I have shown the one-valve type of pump, the two-valve type of pump shown in Fig. 2 may be substituted for the one-valve form, without any change in the connections or piping.

The operation of the pump is as follows: When the engine exhausts, a quick sharp pressure is exerted in the exhaust pipe and is communicated through the standpipe 9 and internal tube 4 of the pump, to the interior of the air chamber 1. Supposing as is normally the case, that the lower portion of said air chamber contains water, such water is forced violently downward through the tapered portion 14 of chamber 1, producing a vacuum in the upper portion 15 of the air chamber 1. Immediately after the pressure has ceased in the exhaust pipe 8 and standpipe 9, a slight vacuum usually exists in this standpipe; and the suction produced by the vacuum in the upper portion 15 of the air chamber 1, aided by the slight vacuum existing in the standpipe 9 (in case such vacuum does exist in said standpipe) causes the water to flow through pipe 11 and check valve 5 into the air chamber 1.

While I have described the operation as occurring with at least a small amount of water in the lower portion of the air chamber 1, as a matter of fact the pump will start dry, even drawing water upward from as much as a foot below the level of the pump. In normal operation, and even after the engine has stopped after once being started, the water usually fills the internal tube 4 of the pump and rises to a considerable height in the standpipe 9. In the one-valve form of the pump shown in Figs. 1 and 3, during the operation of the engine the water will usually rise in the standpipe to the level at which the pump delivers: but this does not in any way interfere with the action of the pump. The upper portion 15 of the air chamber 1 being without outlet at or near the top, said space always remains filled with air or other vapor.

I find that the shape and arrangement of the parts has much to do with the efficient operation of the pump and with its ability to be operated by exceedingly rapidly recurring pulsations of fluid-pressure, such for example as obtain in the exhaust pipe of a high speed multi-cylinder engine. I believe the tapering form of the chamber 1, and particularly the tapered form of the lower portion 14 thereof, adds materially to the efficiency of the pump. So also in my opinion, does the arrangement of the admission passage 2 at an angle of about forty five degrees; and this arrangement of the admission passage has a further advantage that the clapper 16 of the check valve 5 is substantially horizontal when closed, which position I find to be most advantageous. However, I do not limit myself to any particular angle of the admission passage or to any particularly closed position of the clapper of the check valve. Similarly, I believe it expedient to cut away at an angle, the lower portion of the internal tube 4 of the pump, as shown in the drawings. And customarily I taper the discharge passage 3 of the pump in the manner shown, so as to form substantially a continuation of the tapered portion 14 of chamber 1.

I have found swinging check valves to be the best for this type of pump and I prefer to so attach the valve that the clapper thereof, when in the closed position, is substantially horizontal, for the reason that I find that the valve when so arranged permits the pump to be used with higher speed engines than when the clapper is quite oblique in its closed position. I have found the one-valve form of pump to be more efficient as a circulating pump for high speed engines, than the two-valve form, and with this one-valve form of pump it is possible to use the pump on very high speed engines, even those having a number of cylinders connected to the same exhaust pipe. When the speed of the engine is very low, however, I sometimes employ the second valve.

With the one-valve form of pump, the standpipe 9 must be carried up at least to the height at which the pump is to deliver. Where this height is considerable, this is sometimes objectionable, and in such case I employ the second valve, which prevents back flow of water into the standpipe when the engine is not running.

While I do not commit myself to any theory of operation of my pump, I believe that the effect of the communication of the pressure of each exhaust impulse in the exhaust pipe through the standpipe to the chamber 1, forces the water in said chamber violently downward through the contracted portion 14 into the outlet, and that suction is induced by this action, creating a partial vacuum in the upper portion 15 of chamber 1. Observation has shown me that in most cases the passage of an exhaust impulse through the exhaust pipe of an explosion engine, is succeeded by a slight vacuum in such pipe. This vacuum in the exhaust pipe is not constant; it depends for its existence on the length of the exhaust pipe, upon whether a muffler is used or not, upon the diameter of the exhaust pipe, and other conditions. Under certain conditions this partial vacuum in the exhaust pipe following the passage of an exhaust charge therethrough is almost

nothing, but I have found that my pump works as well when connected to such an exhaust pipe as when connected to one in which there is a considerable vacuum following each exhaust impulse. It seems clear to me therefore, that the operation of my pump is not due to the formation of the partial vacuum in the exhaust pipe of the engine, but is due to the formation of a partial vacuum in the annular air space in the upper part of chamber 1, followed quickly by some degree of compression of the air in said chamber as the water rushes in through inlet 2; such compression being due to the inertia of the upward rushing column of water entering the air chamber through inlet 2 at an angle of about forty-five degrees. Such compression together with the weight of the clapper 16 of the valve 5, causes said valve to close quickly, and reaction from the over-compression throws the water downward through the tapered portion 14 of the air chamber. These operations recur rapidly with the recurring exhaust pulses in the exhaust pipe.

I have found that if, while the engine is running, the hand be placed over the intake end of valve 5, a violent suction is felt immediately after the passage of each exhaust charge. This enables the pump to lift water from a level considerably below the pump and even to start dry.

In the valveless form of the pump, shown in Fig. 5, I have found it desirable to vary the proportions of the parts considerably from those of the valved forms of pump shown in the preceding figures, though the general principles of operation are the same. The air chamber, 1^a, is contracted for a considerable distance above the bottom of the internal passage, 4, and then above said contracted portion there is an enlarged air space 15. The water supply pipe, 11, communicates with a belt or annular space, 17, surrounding the chamber 1^a, and a number of relatively small openings 18 are provided to connect the interior of said belt with the interior of chamber 1^a. This pump operates upon the principle that when pressure due to the passage of an exhaust pulse, or the like, is exerted through the standpipe 9 and passage 4, the relatively large discharge outlet 3 offers less resistance to the sudden passage of the water than do the relatively small holes 18, and therefore the greater portion of the water passes out through outlet 3, rather than through openings 18. Immediately after the passage of the exhaust pulse, water flows in again into chamber 1^a, and the operation is repeated. I have found this form of pump to work very efficiently as a circulating pump for explosion engines, and believe it to be especially suitable for very high speed engines; that is to say, I believe it to be capable of working with higher speed engines than any of the valved forms of pump described above, although the single-valve pump is capable of working with practically any of the engines now in use. But the absence of valves or other moving parts is a very great advantage of the pump shown in Fig. 5, insuring absolute reliability. Under special circumstances, as where the pump is to work against considerable head, I provide a discharge check valve, 6, as indicated in Fig. 6; but ordinarily this is not necessary.

It will be understood that the various forms of pumps herein described are not limited in application to use as circulating pumps, or to operation by the exhaust of explosion or steam engines. They may be used for the handling of various fluids, including water or other fluid carrying considerable quantities of sand or sediment. The entire absence of working parts in the pump shown in Fig. 5 makes it particularly suitable for handling strong acids or alkalies, as it may be made of chemically inactive material, or provided with a chemically inactive lining.

The valveless form of pump shown in Fig. 5 is claimed specifically in my Patent No. 857,477, dated June 18, 1907. In said patent I have also claimed a circulating system, whereof a pump such as shown in Figs. 1 and 5 of this case forms a part.

What I claim is:—

1. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, in combination with a source of supply of pulsations of fluid under pressure, and means connecting the same to the interior of said chamber at a point below the top thereof.

2. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, the chamber being contracted between said inlet and outlet, in combination with a source of supply of pulsations of fluid under pressure, and means connecting the same to the interior of said chamber at a point below the top thereof.

3. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, and provided further with a passage adapted for connection with a source of supply of fluid under pressure, said passage directed to deliver its contents past said inlet toward said outlet.

4. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, the chamber being contracted between said inlet and

outlet, and provided further with a passage adapted for connection with a source of supply of fluid under pressure, said passage directed to deliver its contents through the contracted portion of said chamber past the said inlet to the said outlet.

5. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, and with a passage directed to deliver its contents past said inlet toward said outlet, said inlet arranged obliquely with respect to such direction of delivery, there being a closed air space above such inlet and point of delivery.

6. In pumping apparatus such as described, an air chamber provided with an inlet and with an outlet, separate from said inlet, for the fluid to be pumped, and with a passage directed to deliver its contents past said inlet toward said outlet, there being a closed air space above such inlet and point of delivery.

7. In pumping apparatus such as described, an air chamber provided with an outlet, with an internal passage adapted for connection to a source of supply of motive fluid and with an inlet, separate from said outlet, for fluid to be pumped, there being a closed air space above the mouth of said internal passage.

8. In pumping apparatus such as described, an air chamber provided with an outlet, with an internal passage adapted for connection to a source of supply of motive fluid and arranged to direct its contents toward said outlet, and with an inlet, separate from said outlet, for fluid to be pumped, said chamber being tapered between said inlet and outlet, there being a closed air space above the inlet.

9. In pumping apparatus such as described, an air chamber provided at one end with an outlet and provided with an internal passage projecting from the opposite end of said chamber toward said outlet and arranged to discharge its contents in the direction of such outlet, said chamber further provided at one side with an inlet, separate from said outlet, for fluid to be pumped, and having a closed annular air space above said inlet and surrounding said passage.

10. In pumping apparatus such as described, an air chamber provided at one end with an outlet and provided with an internal passage projecting from the opposite end of said chamber and directed to discharge its contents in the direction of such outlet, said chamber further provided at one side with an inlet, separate from said outlet, for fluid to be pumped, and having a closed annular air space above said inlet and surrounding said passage, the chamber being tapered between said inlet and said outlet.

11. In pumping apparatus such as described, an air chamber tapering from one end toward an outlet at the other end and provided with an internal passage projecting from such larger end toward such outlet and directed to discharge its contents in the direction of such outlet, said chamber provided at one side with an inlet, separate from said outlet, for fluid to be pumped, the annular space above said inlet and surrounding said passage constituting a closed air space.

12. In pumping apparatus such as described, an air chamber provided with an inlet passage projecting from one end toward an outlet in the other end and directed to discharge its contents in the direction of such outlet, said chamber further provided at one side with an inlet, separate from said outlet, for fluid to be pumped arranged obliquely with respect to the direction of discharge of contents of said passage, the annular space above said inlet and surrounding said passage constituting a closed air space.

13. In pumping apparatus such as described, an air chamber provided with an outlet and with an internal passage adapted for connection to a source of supply of motive fluid, and directed to discharge its contents toward said outlet, an inlet, separate from said outlet, for liquid to be pumped at the side of said chamber, and an inwardly opening check valve for said inlet.

14. In pumping apparatus such as described, an air chamber provided with an outlet and with an internal passage adapted for connection to a source of supply of motive fluid, and directed to discharge its contents toward said outlet, an inlet, separate from said outlet, for liquid to be pumped at the side of said chamber, and an inwardly opening swinging check valve for said inlet, the clapper of said valve substantially horizontal in the closed position.

15. In pumping apparatus such as described, an air chamber provided with an outlet and with an internal passage adapted for connection to a source of supply of motive fluid and directed to discharge its contents towards said outlet, said chamber provided at one side with an inlet opening, arranged obliquely with respect to such direction of discharge, in combination with an inwardly opening swinging check valve for said inlet, the clapper of said valve being substantially horizontal in its closed position.

16. In pumping apparatus such as described, an air chamber provided with an inlet opening and with an outlet opening, and with an internal passage adapted for connection to a source of supply of motive fluid and directed to discharge its contents toward said outlet and past said inlet, said passage cut away obliquely opposite said inlet.

17. In pumping apparatus such as described, an air chamber having an inlet and an outlet, the portion of said chamber be-

tween said inlet and outlet tapered, said chamber further having an internal passage adapted for connection to a source of supply of motive fluid and projecting into the said contracted portion of said chamber, said passage cut away obliquely opposite inlet opening.

In testimony whereof I affix my signature, in the presence of two witnesses.

GEORGE J. MURDOCK.

Witnesses:
MAY I. TRIMBLE,
H. M. MARBLE.