METHOD AND APPARATUS FOR PUMPING CORROSIVE MEDIUMS

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18 Claims. (Cl. 230—85)

1 This invention relates to a method and apparatus for the compression or pumping of corrosive mediums. More particularly, this invention relates to a liquid piston type of device for pumping and compressing fluorine.

As is well known, fluorine is a very reactive and corrosive medium and hence, presents difficulties of transfer and handling. Fluorine rapidly attacks metals and other materials, and therefore, the use of conventional pumps or compressors is not feasible. Furthermore, because of the reactive nature of fluorine, in the event of contact thereof with lubricating oils such as employed in conventional pumps, there is the probability that the fluorine may react with the oil with extreme violence and heat evolution thereby presenting the problem of fire hazard.

We have discovered a new type of device that may be used for pumping or compressing fluorine gas, or other corrosive mediums, which device overcomes difficulties that have been encountered in prior apparatus and processes heretofore employed in the art.

This invention has for one object to provide an improved method and apparatus for use in the pumping, compressing or transfer of corrosive mediums.

Another object is to provide a device of the class described that is particularly adapted to the pumping or compressing of corrosive gases.

Still another object is to provide a device as aforementioned that is at least partially automatic in operation.

Still another object is to provide a pump or compressing device that is particularly adapted to pumping, compressing, or transferring of fluorine gas or other volatile fluorine containing material, or comparable materials.

Still a further object is to provide a device for obtaining pumping action, as contrasted with the usual mechanical type of pump.

Still another object is to provide a pumping or compressing device that may be used for transferring corrosive gases or vapors from a larger storage reservoir to smaller portable containers.

Another object is to provide a device of the aforementioned type wherein the various parts and constructions are relatively simple and are adapted to withstand the attack of mediums, exemplified by fluorine gas.

Still another object is to provide a liquid piston type of pump adapted to automatic operation for pumping, compressing, or transferring fluorine gas.

2 Still another object is to provide an improved method for pumping and compressing corrosive mediums.

Another object is to provide a method that is particularly applicable to the pumping and compressing of fluorine gas.

Other objects will appear hereinafter.

For a more complete understanding of the invention, reference is made to the attached drawings forming a part of the present application.

Fig. 1 is a semi-diagrammatic side-elevation view of the device. In this figure certain parts are shown in section and some parts are shown in exaggerated scale for clarity.

Fig. 2 is a wiring diagram illustrating one arrangement of electrical connections that may be employed for the operation of the automatic valves.

Figs. 3 and 4 are diagrammatic side-elevation views, similar to Fig. 1, showing modified arrangements of our device.

Referring now particularly to Fig. 1, reference numeral 2 represents a conduit connecting an air pressure tank 3 to a source of air pressure, for example, an air compressor (not shown). As will be described in this species of construction, air pressure may be employed for the motivating medium for our liquid piston type of pump. The air tank 3 is connected by conduit 4 to a chamber 6 of the pumping device. Interposed in the conduit 4 is an automatic valve 7. This valve is similar to several other valves employed in the devices of this invention and will be described in detail hereinafter.

Referring to chamber 6, namely the pumping chamber into which air pressure is admitted, this chamber may be of cylindrical construction more or less similar to an ordinary gas or liquid container. The shape may also be spherical or otherwise, as preferred, and in the apparatus illustrated is provided with a bottom 8, side walls 9, and a top or header portion 11.

To facilitate the introduction of electrodes and various inlet and exhaust conduits, the header portion 11 may be of smaller diameter than the main chamber 6.

Positioned in the top of the header 11 is a member 12 of electrically non-conducting material in which is mounted a pair of electrodes 13 and 14 that extend vertically downward through the header 11 and into the upper portion of the chamber 6 a predetermined distance to a point 15 at which it is desired to limit the upper level of the liquid in the chamber 6. It will be obvious, of course, that the electrodes 13 and 14 need not...
both enter the chamber 6 through the header 11 thereof as described, and one of the electrodes may enter the chamber 6 laterally through the side 9 thereof at the desired level limit, for example, as shown in Fig. 2. Also connected to the header 11 of chamber 6, for example, as indicated at 17 and 20, respectively, are the air inlet conduit 4 and an exhaust conduit 18, the latter having therein an automatic valve 19 of the type previously referred to herein.

The chamber 6 preferably is constructed of metal or other material that is resistant to the particular medium to be contained therein. In the construction shown, since the chamber is to contain air and a fluoride pumping fluid that is relatively less resistant than the fluoride gas to be pumped, the chamber 6 may be constructed of a variety of materials such as, for example, stainless steel, copper, or the more resistant metals such as inhibited steel, nickel, Monel metal, and the like. The electrode support member 12 may be composed of conventional dielectric materials, and preferably materials that are resistant to fluorine are employed.

The bottom of the chamber 6 is connected by means of a U-shaped conduit 21 to the bottom 23 of another chamber 25 of similar construction having, in addition to bottom 23, side walls 24, and a top or header portion 26. This header portion 26 has fitted therein an insulator 27 through which is inserted a pair of electrodes 28 and 29. As indicated, these electrodes protrude into the interior of the chamber 22 to a predetermined point 30 at which it is desired to limit the upper liquid level therein. Likewise, connected into the header portion 26 is a conduit 31 that leads from a source of fluorine (not shown), such as a fluorine generator, storage tank, or the like. There is also connected to the header 26 an exhaust conduit 33 that leads from the chamber 22 to a cylinder 36 or other container into which it is desired to transfer or compress the medium being pumped. The conduits 31 and 33 preferably are each provided with an automatic valve 32 and 34, respectively, of the type previously mentioned herein.

The cylinder 36, shown in Fig. 1, may be a conventional gas cylinder having the usual equipment such as manually operated valves at 37 and 38 and coupling nuts at 39. The latter may comprise lock nuts and associated fittings so that a gas-tight connection may be provided between the outlet conduit 33 and container 36 to be filled with the compressed gas. The valves 37 and 38 may be employed for venting air and for closing the cylinder 36 after it has been filled so that it may then be uncoupled and removed.

As previously stated, the two chambers 6 and 22 are connected by means of the U-shaped conduit 21 and are adapted to contain a suitable liquid that is of a character not materially affected by the gas to be pumped. The liquid should also be an electrolyte so that when it contacts the pairs of electrodes 13, 14 and 28, 29 electric circuits will be completed therethrough.

Since chamber 22 will contain a corrosive medium, such as fluorine gas, during the pumping operation, it should be constructed of a material that is resistant to such corrosive media, and as previously described, Monel metal, inhibited steel, nickel, and other special construction materials may be employed. Thus, a metal surface may be given a preliminary treatment with fluorine, assuming fluorine is the medium to be pumped, to form thereon a skin or film of fluoride that is substantially resistant to the action of this gas. Also the choice of the material of insulator 27, and related parts of the chamber 22 should be made with due care to obtain a gas-tight, fluorine-resistant construction.

The valves 7, 19, 32, and 34 previously referred to herein are preferably automatically functioning valves of the solenoid type. If desired, the valve 34 may be an ordinary check valve since its function, as herein described, is merely to prevent reverse flow from the cylinder 36 into chamber 22. In general, when a check valve is employed, it may be desirable to incline the conduit 33 upwardly from chamber 22 toward chamber 36 to thereby minimize pumping fluid being carried into conduit 33. Likewise the other conduits 17, 18, and 31 may be inclined, if desired, to prevent kickback of pumping liquid. The construction and actuation of the various valves and the functioning of the apparatus will be further apparent from a description of Fig. 2.

Referring now to Fig. 2 of the drawings, the apparatus previously described is shown diagrammatically in conjunction with a suitable electrical circuit for controlling the several valves 1, 19, 32 and 34 to effect operation of the pump 1. In the apparatus, it being kept in mind that the particular arrangement described is merely representative of one circuit that has been employed for causing the solenoid operated valves to operate in the sequence and for the periods described. Other types of circuits, for example, an electronic circuit may be used for accomplishing the desired valve operation. It will also be noted that signal lights and the like may be included in the various circuits.

In respect to the apparatus shown in Fig. 2 of the drawings, it is to be noted that, in lieu of pairs of electrodes 13, 14 and 28, 29 previously described with reference to Fig. 1, there are employed only single electrode elements 13 and 28, respectively, and that the chamber casings 6 and 22 are themselves utilized as the other electrodes. Considering now the electrical circuit, a suitable current, for example, 110 volts alternating current, is supplied at 44 to the conductors 51 and 52, and, assuming that relays B and C are energized, and relay A deenergized, circuits will be complete through contacts 55—X and 56—Y, respectively, causing liquid to flow from conductor 52, through conductor 60, solenoids D and F, conductors 64 and 66 and conductor 51. Solenoids D and F are thus energized with the result that valves 32 and 19 are open. In addition, contacts 66—2 are open and hence no current is flowing in the circuit of 67 and 61 and solenoids E and G, with the result that the latter are deenergized and the valves 34 and 7 closed.

With the valves 7, 19, 32 and 34 positioned as aforesaid, gas enters the chamber 22 through conduit 31 and forces the fluid 41 from the chamber through conduit 21 and into the chamber 6 so that the level of the liquid 42 therein rises to displace air therefrom through conduit 18 to the atmosphere. The apparatus remains in this condition until the pressure in the chamber 6 rises high enough to cause the liquid to rise in the chamber 6, until the liquid comes into contact with the electrode 13, thereby completing
a circuit through conductor 53, casing 22, conduit 21, casing 6, conductor 58 and the relay A causing the relay to be energized and opening contacts 66-X to break the circuit through relay C thereby causing contacts 66-Y to open and contacts 66-Z to close. Opening of contacts 66-X de-energizes the solenoids D and F closing valves 32 and 18, and closing of contacts 66-Y opens the circuit through conductors 62, 65 and 91, solenoids E and G and conductors 68 and 51 thereby energizing said solenoids E and G to open the valves 34 and 7.

In this condition of the valves, the influx of gas through conduit 21 to chamber 22 has ceased and the air exhaust conduit 19 from chamber 6 is closed. Valve 1 having opened, air under pressure is admitted to chamber 6 through conduit 4, and as soon as the pressure in chamber 6 exceeds the back pressure afforded by the gas admitted to chamber 22, the air forces the liquid from cham-

ber 6 through conduit 21 and into chamber 22 thereby forcing the gas from the latter through conduit 33 and into the container 36. As the liquid level in chamber 6 recedes below the elec-

trode 13, the circuit through conductor 59 and relay B is opened, thereby deenergizing the last-

per. Deenergization of relay A, however, does not affect the contacts 66-X that remain open, and air continues to enter chamber 6 forcing liquid therefrom into chamber 22 to pump the gas therefrom until the level of the liquid in chamber 22 recedes sufficiently to close the circuit through conductors 68, 18, and complete a circuit through conductors 62, 65, 51, relay B and conductor 59, thereby energizing relay B and causing switch 64 to close contacts 65-X with the result that relay C is energized causing contacts 66-Z to open and contacts 66-Y to close. Opening of contacts 66-Z breaks the circuit containing the solenoids E and G thereby deenergizing them and closing the valves 34 and 4 to shut off the air supply to chamber 6 and the gas outlet from chamber 22 to tank 32. Simultaneously, closing of the contact 66-Y again completes the circuit containing solenoids D and E thereby energizing them and opening valves 32 and 19 to admit gas through conduit 31 to chamber 22 and to exhaust air from cham-

ber 6 through conduit 18, respectively, to initiate another cycle of operation of the pump.

While the device and method have been de-

scribed in connection with the filling of a con-
tainer, it may be used for other purposes. For example, it may be employed for pumping or transferring fluorine or other gas to a reaction. In this instance, the outlet conduit 33 may be connected, for example, to a catalyst chamber or other apparatus in which a fluorination or other reaction is being carried out. By controlling the pumping speed, the rate of transfer of the gas may be controlled. Other uses will be apparent to those skilled in the art.

It will be further apparent that since the method and apparatus function satisfactorily for pumping corrosive mediums, such as fluorine, they may be utilized to pump, compress, or transfer non-corrosive or non-corrosive gases or vapors. In such instances other pump fluids resistant to these gases or vapors may be employed. As described, the fluids should be electrolytes to per-mit the passage of electrical current upon contact with the conductors and electrolytic pumping liquids other than that named may be used. For example, various molten fluorides obtained in the liquid state at reasonable temperature ranges are satisfactory. A compound such as osmium fluoride may be used. In general, it is preferred that the pumping liquid be saturated with fluoride to prevent reaction of the fluorine being pumped with the pumping fluid. While two chambers have been disclosed, several stages of pumping chambers may be employed. That is, one stage of pumping may be employed for preliminary compressing and a second stage, operating from a higher air pressure or mechanical source, may be employed for further compression. Other ar-

rangements and changes may be arrived at using the principles of our invention.

In order to better illustrate certain modifica-
tions that may be incorporated in the device, reference is made to Fig. 3. In Fig. 3, an ar-

rangement is shown wherein a mechanical pump is incorporated to supplement or replace air pressure as the motivating medium to effect a double pumping operation. In this construction, the mechanical pump does not come in contact with the fluorine gas being pumped, and hence the aforementioned problems relative to corrosion of an ordinary mechanical pump, are avoided.

The modification shown in Fig. 3 comprises a pumping chamber 166 and a fluorine compressing chamber 122. These chambers are connected by a U-shaped conduit 121. Chamber 166 is provided with an inlet conduit 104 and an exhaust conduit 118 each of which is provided with an automatic valve 107 and 119, respectively. Electrodes are provided as indicated at 113 and 114. Inasmuch as all of these various parts correspond to similar parts previously described with refer-

ece to Fig. 1, further description appears unnecessary. In order to double-pump fluorine gas, the conduit 104 may serve as an inlet for fluorine, and conduit 118 may serve as the fluorine outlet. Similarly with respect to chamber 122 a fluorine inlet conduit 131 is provided together with an outlet 133 for connection to the cylinder to be filled. Suitable valves are provided in the inlet 131 and outlet 133 as indicated at 132 and 134, respectively, and electrodes 128 and 129 are associated with the chamber 122 as shown.

Referring now to the U-shaped conduit 121, there is interposed therein a mechanical pump 136 of conventional construction. A plurality of by-pass lines 137 and 138 are connected to the conduit 121 at opposite sides of the pump 136 to permit the use of a unidirectional pump, change of flow being obtained by selectively opening and closing valves 133, 141, 142 and 143 in the by-pass lines. These valves may be intercon-

cnected in a circuit with the valves 107, 110, 132, and 134 already referred to.

The operation of this modified form of appara-
tus is substantially similar to that already de-

scribed. However, in this construction, the pump 136 causes the pumping liquid to flow through the U-shaped conduit 121 in alternate directions from one chamber to the other to produce the alternate compression and pumping cycles, the by-pass lines 137 and 138 and the interconnected automatic valves therein enabling the flow of pumping liquid to be periodically reversed while obtaining the positive pumping action of the mechanical pump 136.

For example, assuming that the pump 136 pumps toward the chamber 106 with valves 141 and 143 open and that valves 139 and 142 closed, the pumping liquid is forced into chamber 106 thus compressing any gas therein and forcing it out through conduit 118. When the pumping liquid rises in 106 sufficiently to make electrical con-

act with electrodes 113 and 114, thereby chang-
ing the valve settings, valves 141 and 142 close and the valves 139 and 143 open. The pumping liquid then flows through conduits 121 and 138 to the pump 136 which forces the liquid through conduit 137 and valve 138 into chamber 128 where it compresses and discharges the gas until the liquid completes the circuit through electrodes 126 and 129 whereupon the operation is reversed and the cycle repeated.

Another modification or species of construction embodying the invention is shown in Fig. 4. In this construction, an arrangement is described whereby greater compactness may be obtained. Referring to Fig. 4, a plurality of chambers of the type already described are provided at 156 and 157. Each of these chambers is equipped with valved inlet and outlet conduits as indicated at 158, 159, 161, and 162, respectively. Likewise these chambers are each provided with a pair of suitable electrodes, 164, 167 and 163, 166, respectively. One of these chambers may function as a pumping chamber and the other as a fluorine compressing chamber. Inasmuch as the foregoing parts are substantially similar to those already described in connection with other embodiments, further description is deemed unnecessary. In the construction shown the two chambers 156 and 157 are connected together at 160 so that the pumping liquid may pass from one chamber to the other during the pumping cycle. The introduction of air pressure into one of the chambers, as in the operation of the apparatus shown in Fig. 1, is employed as the motivating force for the transfer of the pumping liquid.

Also inter-connecting the chambers 156 and 157 are conduits 169 and 170 that lead through a reservoir means 171. A suitable pump 172 is interposed in the conduit 170. However, this pump 172 is not relied upon as the motivating force. In this construction by selectively opening the various valves in the several conduits as previously described, pumping liquid may be withdrawn from the chambers from time to time to the reservoir 171 where its composition may be supplemented or altered by the addition of suitable pumping liquid, and the resultant pumping fluid returned to the chambers. A conduit 173 is provided for removing a sample of the pumping liquid so that it may be analyzed and the amount and composition of the liquid to be added determined. Such a conduit may be advantageously employed in installations where, during extended periods of continuous operation, components of the pumping liquid may become depleted or broken down thereby necessitating a supplement or alteration of the composition of the pumping fluid during operation. In the event of the use of certain compositions, it may be desirable to heat the reservoir 171 and other parts of the apparatus to keep the pumping liquid in a fluid condition.

It is to be understood that all matters contained in the above description and examples are illustrative only and do not limit the scope of this invention, as it is intended to claim the invention as broadly as possible in view of the prior art.

We claim:

1. A gas pump comprising a pair of interconnected chambers defining a working space, a pumping liquid partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, means associated with the other of said chambers operable to effect actuation of said pumping liquid in opposition to the direction and alternately increase and decrease the volume of said liquid in said chambers, and means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid actuating means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

2. A gas pump comprising a pair of interconnected chambers defining a working space, a flowable electrolyte as a pumping liquid partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, means associated with the other of said chambers operable to effect actuation of said pumping liquid in opposite directions and alternately increase and decrease the volume of said liquid in said chambers, and means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid actuating means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

3. A gas pump particularly suitable for pumping fluorine comprising a pair of interconnected chambers defining a working space, a pumping liquid which is substantially non-reactive to fluorine partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, means associated with the other of said chambers operable to effect actuation of said pumping liquid in opposite directions and alternately increase and decrease the volume of said liquid in said chambers, and means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid actuating means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

4. A gas pump particularly suitable for pumping corrosive mediums comprising a pair of interconnected chambers defining a working space, an electrolyte pumping liquid partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, means associated with the other of said chambers operable to effect actuation of said pumping liquid in opposite directions and alternately increase and decrease the volume of said liquid in said chambers, and electrical contact means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid actuating means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

5. A gas pump comprising a pair of interconnected chambers defining a working space, a flowable fluoride material as a pumping liquid partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, means associated with the other of said chambers operable to effect actuation of said pumping liquid in opposite directions and alternately increase and decrease the volume of said liquid in said chambers, and
means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid displacement means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

6. A gas pump comprising a pair of interconnected chambers defining a working space, a pumping liquid partially filling said working space, normally closed intake and discharge valves associated with one of said chambers, means associated with the other of said chambers operable to displace the pumping liquid therefrom into said one chamber, means energized in response to a predetermined pumping liquid level in said other chamber operable to open said discharge valve and actuate said pumping liquid displacement means to cause displacement of said pumping liquid from said one chamber to said other chamber, and interlock means operable to effect deenergization of one of said pumping liquid level responsive means upon energization of the other.

7. A gas pump comprising a pair of interconnected chambers defining a working space, a flowable electrolyte as a pumping liquid partially filling said working space, normally closed intake and discharge valves associated with one of said chambers, means associated with the other of said chambers operable to displace the pumping liquid therefrom into said one chamber, means energized in response to a predetermined pumping liquid level in said one chamber operable to open said intake valve and deactivate said pumping liquid displacement means to effect reverse flow of said pumping liquid from said one chamber to said other chamber, and interlock means operable to effect deenergization of one of said pumping liquid level responsive means upon energization of the other.

8. A gas pump particularly suitable for pumping fluorine comprising a pair of interconnected chambers defining a working space, a pumping liquid which is substantially non-reactive to fluorine partially filling said working space, normally closed intake and discharge valves associated with one of said chambers, means associated with the other of said chambers operable to displace the pumping liquid therefrom into said one chamber, means energized in response to a predetermined pumping liquid level in said other chamber operable to open said discharge valve and actuate said pumping liquid displacement means to cause displacement of said pumping liquid from said one chamber to said other chamber, means energized in response to a predetermined pumping liquid level in said one chamber operable to open said intake valve and deactivate said pumping liquid displacement means to effect reverse flow of said pumping liquid from said one chamber to said other chamber, and interlock means operable to effect deenergization of one of said pumping liquid level responsive means upon energization of the other.

9. A gas pump comprising a pair of interconnected chambers defining a working space, a flowable fluoride material as a pumping liquid partially filling said working space, normally closed intake and discharge valves associated with one of said chambers, means associated with the other of said chambers operable to displace the pumping liquid therefrom into said one chamber, means energized in response to a predetermined pumping liquid level in said other chamber operable to open said discharge valve and actuate said pumping liquid displacement means to cause displacement of said pumping liquid from said one chamber to said other chamber, and interlock means operable to effect deenergization of one of said pumping liquid level responsive means upon energization of the other.

10. A gas pump comprising a pair of interconnected chambers defining a working space, an electrolyte pumping liquid partially filling said working space, normally closed intake and discharge valves associated with one of said chambers, means associated with the other of said chambers operable to displace the pumping liquid therefrom into said one chamber, means energized in response to a predetermined pumping liquid level in said one chamber operable to open said discharge valve and actuate said pumping liquid displacement means to cause displacement of said pumping liquid from said one chamber to said other chamber, and interlock means operable to effect deenergization of one of said pumping liquid level responsive means upon energization of the other.

11. A gas pump comprising a pair of interconnected chambers defining a working space, a pumping liquid partially filling said working space, a source of process gas connected to one of said chambers, an actuating gas source for said pumping liquid connected to the other of said chambers, normally closed intake and discharge valves to control the flow of said process gas to and from said one chamber, normally closed inlet and exhaust valves to control the flow of said actuating gas to and from said other chamber, energizable means associated with each of said valves operable to open the same, an electric circuit including said energizable means, means operable in response to a predetermined pumping liquid level in said other chamber to energize a portion of said electric circuit and open said actuating gas inlet valve and said discharge valve, means operable in response to a predetermined pumping liquid level in said one chamber to energize another portion of said electric circuit and open said process gas intake valve and said actuating gas exhaust valve, and means in said electric circuit operable upon energization of either of said portions of said circuit to deenergize the other portion thereof.

12. A gas pump particularly suitable for pumping corrosive gas comprising a pair of interconnected chambers defining a working space, a pumping liquid partially filling said working space, a source of process gas connected to one of said chambers, an actuating gas source for said pumping liquid connected to the other of said chambers, normally closed intake and discharge valves to control the flow of said process gas to and from said one chamber, normally closed inlet and exhaust valves to control the flow of said actuating gas to and from said other chamber, energizable means associated with each of said valves operable to open the same, an electric circuit including said energizable means, means operable in response to a predetermined pumping liquid level in said other chamber to energize a portion of said electric circuit and open said actuating gas inlet valve and said discharge valve, means operable in response to a predetermined pumping liquid level in said one chamber to energize another portion of said electric circuit and open said process gas intake valve and said actuating gas exhaust valve, and means in said electric circuit operable upon energization of either of said portions of said circuit to deenergize the other portion thereof.
nected chambers defining a working space, a flowable electrolyte as a pumping liquid partially filling said working space, a source of corrosive gas connected to one of said chambers, an actuating gas source for said pumping liquid connected to the other of said chambers, normally closed intake and discharge valves to control the flow of said corrosive gas to and from said one chamber, normally closed inlet and exhaust valves to control the flow of said actuating gas to and from said other chamber, energizable means associated with each of said valves operable to open the same, an electric circuit including said energizable means, means operable in response to a predetermined pumping liquid level in said other chamber to energize a portion of said electric circuit and open said actuating gas inlet valve and said corrosive gas discharge valve, means operable in response to a predetermined pumping liquid level in said one chamber to energize another portion of said electric circuit and open said corrosive gas intake valve and said actuating gas exhaust valve, and means in said electric circuit operable upon energization of either of said portions of said circuit to deenergize the other portion thereof.

12. A gas pump comprising a pair of interconnected chambers defining a working space, a pumping liquid partially filling said working space, gas intake and discharge valves associated with one of said chambers, means operable to selectively open and close said valves, a mechanical pumping means associated therewith operable to effect operation of said pumping liquid in opposite directions and alternately increase and decrease the volume of said liquid in said chambers, and means responsive to a predetermined liquid volume in said chambers to effect operation of said liquid actuating means and said valves in predetermined timed relation with respect to one another so that gas is admitted to and discharged from said one chamber by actuation of said liquid in alternate directions.

17. In a process of compressing fluorine the step of applying pressure to the fluorine through a medium including liquid hydrogen fluoride having a fluoride salt dissolved therein.

18. A process for compressing fluorine which includes the step of applying pressure to the fluorine to be compressed by means of a medium containing a liquid fluoride compound having a fluoride salt dissolved therein and applying mechanical pressure to said medium whereby pressure from the medium is transmitted to the fluorine gas being compressed.

HARRISON S. BROWN.
HENRY H. HUBBLE.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,502,074

HARRISON S. BROWN ET AL.

March 28, 1950

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 6, line 2, for the word "fluoride" read fluorine;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of August, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,

Assistant Commissioner of Patents.