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APPARATUS FOR COMPRESSING HIGHLY REACTIVE GASES

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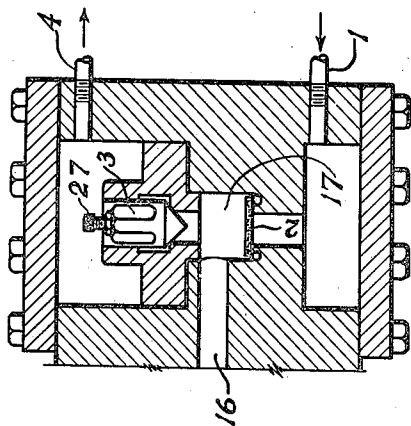


Fig. 2

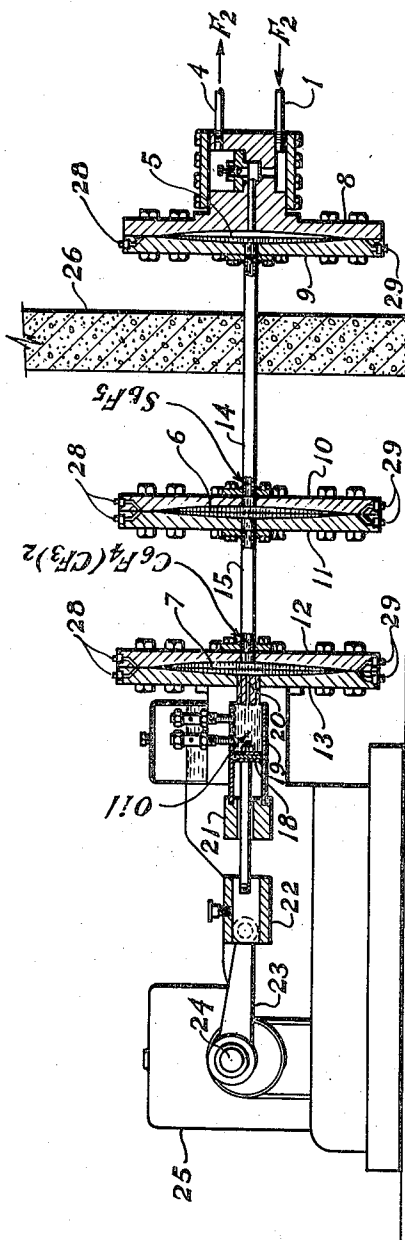


Fig. 1

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APPARATUS FOR COMPRESSING HIGHLY
REACTIVE GASES

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More particularly, my invention resides in an apparatus of the elastic diaphragm type for compressing dangerously reactive gases, especially those that are reactive with lubricating oils. I will describe my apparatus as used for compression of elemental fluorine.

Fluorine is the most reactive of all the chemical elements. In presence of a little moisture or grease, it will attack anything that is not already fully fluorinated. Fortunately, in absence of moisture many metals become coated with a film of fluoride which protects them from further attack. Among these is iron.

Nevertheless, it is not possible to compress fluorine in a compressor of the ordinary piston type, because pistons require lubrication, and lubricating oils set up with fluorine a violent reaction that will eventually consume the iron. Elemental fluorine cannot be compressed as chlorine may be, in apparatus employing a piston of sulphuric acid, because under heat and pressure it reacts with the acid. It is known that gases can be compressed in apparatus employing an elastic diaphragm in place of a piston. However, the diaphragm is subject to fatigue, and rupture of the diaphragm, permitting fluorine to pass through it and come into contact with lubricated mechanism, would be disastrous.

I have now found that certain fully or partially fluorinated or fluorochlorinated reaction products exist which are inert to or of low reactivity with fluorine, liquid at temperatures developed during compression to moderate pressures, and of sufficiently low vapor pressure for use in confined spaces. I have successfully interposed such liquids between an elastic steel diaphragm in contact with fluorine and another in contact with a piston of oil, reciprocally actuated by mechanical means. In this way, I have been able to compress fluorine without serious risk to the operator, even in the event of failure of one or both of the diaphragms. Among such liquids are antimony pentafluoride, perfluorotoluene ($C_6F_5CF_3$), perfluoroxylene ($C_6F_4(CF_3)_2$), perfluormesitylene ($C_6F_3(CF_3)_3$), and certain polymerization products of tetrafluoroethylene and trifluoromonoethylethylene.

Antimony pentafluoride is of course inert to fluorine. The organic compounds are not completely inert to fluorine, as they can under favorable circumstances be fluorinated further to carbon fluorides. However, under ordinary conditions they are of low reactivity with fluorine. Antimony pentafluoride is a powerful fluorinating agent. The above mentioned organic compounds

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are in fact fluorinated in two steps, the second of which may employ antimony pentafluoride.

In my apparatus, the mechanically reciprocated diaphragm is preferably actuated by a liquid piston of lubricating oil which in turn is actuated by a metal piston, in known manner. If the above organic fluorination products were to come into contact with the oil they might, under some circumstances, react therewith, but never with dangerous violence. At moderate pressures, they will not react dangerously with fluorine. They are completely inert to antimony pentafluoride, having already been reacted therewith.

For compressing to moderate pressures, e. g., 40 lbs. per sq. inch gage, therefore, I preferably use one of the above organic fluorine compounds between two diaphragms, one of which is in contact with the fluorine on its opposite side and the other of which is in contact on its opposite side with the oil. For compressing fluorine to pressure above 40 lbs. gage, e. g., 100 lbs. per sq. in. gage, I prefer to use both antimony pentafluoride and one of the organic fluorine compounds, in two compartments separated by an intermediate elastic diaphragm.

Referring to the drawing:

Fig. 1 is an elevation, partly in section, of a typical apparatus for compressing highly reactive gases, employing an intervening column of relatively inert liquid.

Fig. 2 is an enlarged detail in section of the valve mechanism of Fig. 1.

In the figures, 1 is an induction pipe for the gas, 2 an inlet valve, 3 a discharge valve and 4 a discharge pipe for the gas, 5, 6 and 7 are elastic diaphragms clamped between flanges 8 and 9, 10 and 11, and 12 and 13 respectively. Flanges 9 and 10 are connected together by pipe 14 and flanges 11 and 12 by pipe 15, these pipes forming with the space between the diaphragms and their respective flanges pressure tight chambers. Ports 16 and 17 form with the space between diaphragm 5 and flange 8 a chamber closed by valves 2 and 3, the volume of ports 16 and 17 being very small compared with the displacement of diaphragm 5. Diaphragm 5 is therefore in contact on one of its sides with the gas to be compressed. Assuming the gas to be fluorine, the space between diaphragms 5 and 6 is completely filled with a liquid of low reactivity with fluorine, preferably antimony pentafluoride, and the space between diaphragms 6 and 7 with one of the organic fluorine compounds, preferably perfluoroxylene. The other side of diaphragm 7 is in contact with lubri-

cating oil, which fills the space between it and conventional metal piston 18, and communicates with the space between diaphragm 7 and flange 13 through ports 20; piston 18 travels in cylinder 19 and is actuated by conventional mechanism, comprising guides 21 and 22, connecting rod 23, wrist pin 24, and motor 25, which may be electric. 26 is a building wall, interposed between flanges 9 and 10 for greater safety, so that the parts containing fluorine may be completely isolated from the mechanism containing oil.

Referring to Fig. 2, inlet valve 2 is of a simple disc type and discharge valve 3 of the poppet type. Both are gravity closed, as no known spring will withstand fluorine. Valve 3 is provided with adjustable bolt 27, limiting its travel.

Flanges 9, 10, 11, 12 and 13 are provided with ports for introducing the hydraulic fluid into the diaphragm chambers and removing it therefrom. These ports are closed by plugs 28 and 29 respectively.

Diaphragms 5, 6 and 7 are shown as plain sheets. These can have only slight travel in proportion to their diameters, but the permissible travel is nevertheless sufficient for my purpose. The travel can be increased, if desired, by corrugating, in known manner. When pressures in excess of 100 lbs. gage are desired, these can be obtained by using two or more compressors of similar type, in series.

I claim as my invention:

1. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; and mechanical means for causing reciprocal displacement of said second diaphragm; said closed chamber being substantially completely filled with a liquid fluorination product inert with respect to fluorine.

2. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; and mechanical means for causing reciprocal displacement of said second diaphragm; said closed chamber being substan-

tially completely filled with a liquid inorganic fluorination product inert with respect to fluorine.

3. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; and mechanical means for causing reciprocal displacement of said second diaphragm; said closed chamber being substantially completely filled with antimony pentafluoride.

4. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; a second closed chamber, of which second diaphragm constitutes one wall; a third diaphragm, likewise constituting a wall of said second closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragms; and mechanical means for causing reciprocal displacement of said third diaphragm; said first closed chamber being substantially completely filled with antimony pentafluoride and said second closed chamber being substantially completely filled with a liquid organic fluorination product of antimony pentafluoride.

5. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; a second closed chamber, of which second diaphragm constitutes

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one wall; a third diaphragm, likewise constituting a wall of said second closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said before mentioned diaphragms; and mechanical means for causing reciprocal displacement of said third diaphragm; said first closed chamber being substantially completely filled with antimony pentafluoride and said second closed chamber being substantially completely filled with a liquid organic fluorination product of the group consisting of perfluorotoluene, perfluoroxylene, perfluoromesitylene, polymerized tetrafluoroethylene and polymerized trifluoroethylene.

6. An apparatus for compressing anhydrous gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; a second closed chamber, of which said second diaphragm constitutes one wall; a third diaphragm likewise constituting a wall of said second closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said before mentioned diaphragms; and mechanical means for causing reciprocal displacement of said third diaphragm; said first closed chamber being substantially completely filled with antimony pentafluoride and said second closed chamber being substantially completely filled with perfluoroxylene.

7. An apparatus for compressing anhydrous

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gaseous fluorine, comprising a compression chamber; an induction conduit for fluorine communicating therewith; a valve in said conduit adapted to permit inflow to said compression chamber and prevent outflow therefrom; an exit conduit communicating with said compression chamber; a valve in said exit conduit adapted to permit outflow from said compression chamber and prevent inflow thereto; a diaphragm constituting a wall of said compression chamber, capable of elastic displacement of a volumetric magnitude approximating the volume of said compression chamber; a closed chamber, of which said diaphragm constitutes one wall; a second diaphragm, likewise constituting a wall of said closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said first mentioned diaphragm; a second closed chamber, of which said second diaphragm constitutes one wall; a third diaphragm, likewise constituting a wall of said second closed chamber, capable of elastic displacement of a volumetric magnitude at least equal to that of said before mentioned diaphragms; a third closed chamber, of which said third diaphragm constitutes one wall; a reciprocally moveable piston constituting a closure for said third closed chamber, capable of displacement at least equal to that of said before mentioned diaphragms; and mechanical means for causing reciprocal displacement of said piston; said first closed chamber being substantially completely filled with antimony pentafluoride; said second closed chamber being substantially completely filled with perfluoroxylene, and said third closed chamber being substantially completely filled with mineral lubricating oil.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
45 1,101,266	Franklin	June 23, 1914