June 7, 1938. T. WEHRLE 2,119,837

PROCESS AND APPARATUS FOR EXTERMINATING PESTS IN ARTICLES

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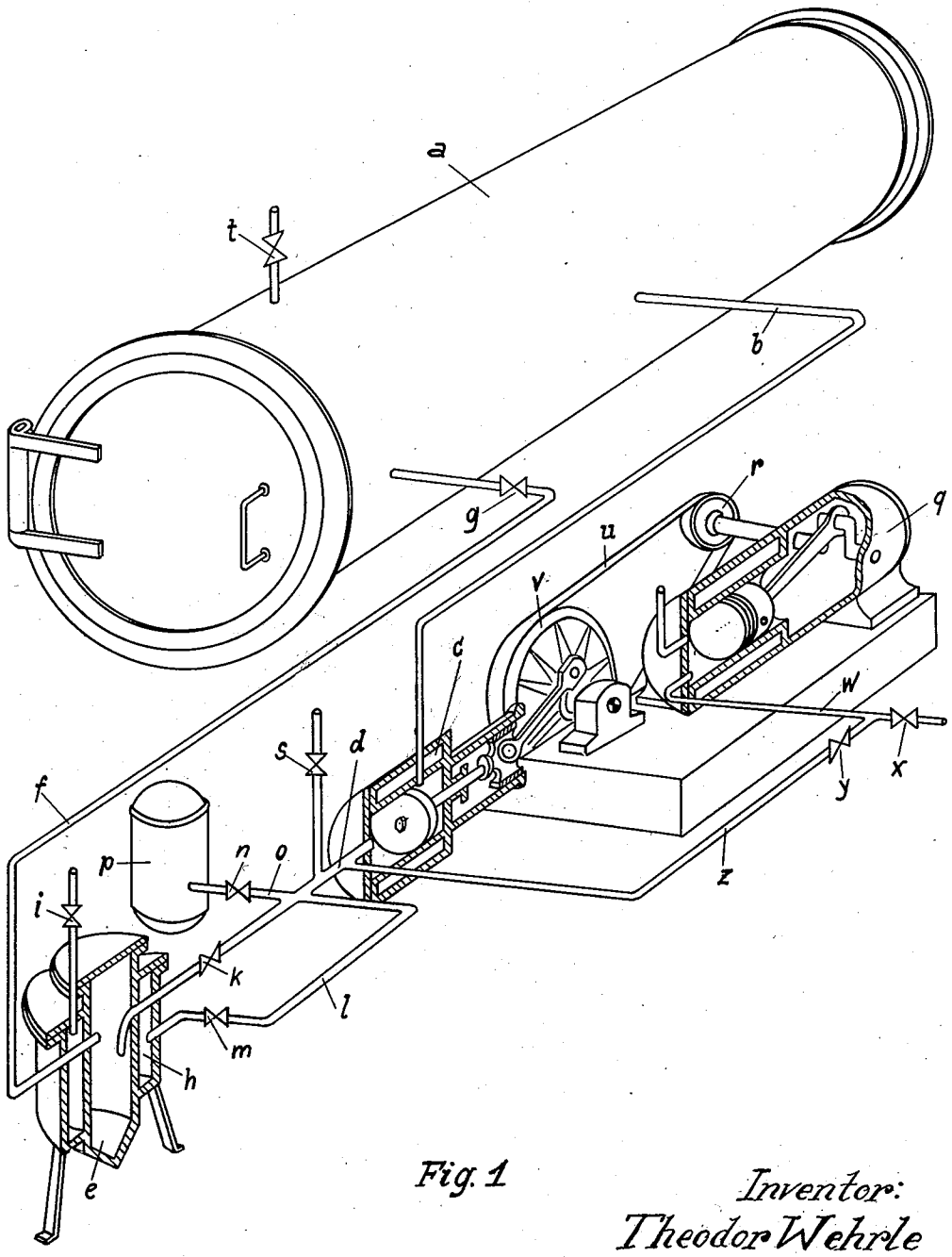


Fig. 1

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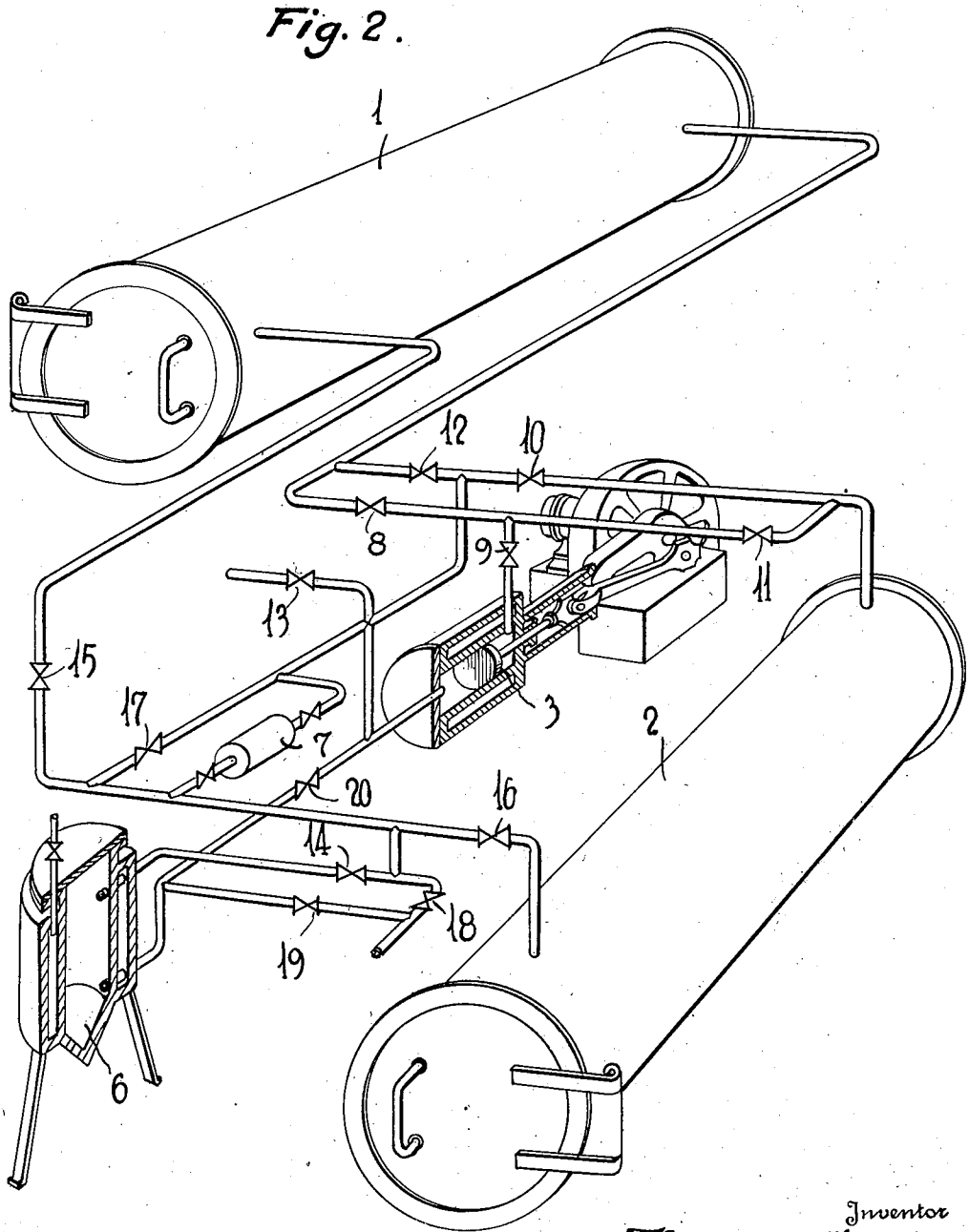
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PROCESS AND APPARATUS FOR EXTERMINATING PESTS IN ARTICLES

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Fig. 2.



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2,119,837

PROCESS AND APPARATUS FOR EXTERMINATING PESTS IN ARTICLES

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14 Claims. (Cl. 21—58)

This invention relates to the extermination of pests with poison gases in chambers, in which the articles, materials etc. containing the pests are subjected, preferably without movement, to the action of toxic substances in gas or vapour form, such as hydrocyanic acid, ethylene oxide, carbon disulphide and the like. The articles to be treated are for example furniture, particularly upholstered furniture, materials of the most varied kind, finished articles of clothing, cereals in sacks, tobacco, dried fruits etc.

The process according to this invention for exterminating pests by circulating a gas, for example air, with the aid of a compression pump through a poison gas generator or space in which the gas is charged with the toxic substances and thence through a fumigating chamber containing the material to be treated, preferably in a state of rest, is characterized by the fact that the fumigating chamber or space stands under considerably reduced pressure and that a constriction is introduced into the passage of the gas prior to its entry into the fumigating space, so that during each cycle the gas is compressed prior to its discharge into the fumigating space and acts in this compressed condition on the toxic substance, which may if desired be associated with a carrier, after which the gas is allowed to expand before its entry into the fumigating space, the gas being compressed to such a considerable extent that the fall of temperature caused by the vaporization of the toxic substance is entirely or substantially equalized by the increase in temperature of the gas produced by the compression.

My invention is illustrated by way of example in the accompanying drawings, in which:

Fig. 1 shows in perspective, partly in section, one form of apparatus suitable for carrying out the process of my invention.

Fig. 2 is a similar view of a modified form.

Referring to Fig. 1 of the drawings, the fumigating chamber *a* is connected by the pipe lead *b* with a pump *c* and the latter by the pipe lead *d*, by way of the valve *k* with the inner chamber of the poison gas generator *e* and the latter by the lead *f* by way of the throttle valve *g* with the fumigating chamber *a*. The waste gas from the pump *c* may be fed by way of the valve *k*, poison gas generator *e* and valve *g* into the chamber *a*, or may discharge through the valve *s* into the atmosphere or may be introduced through the branch lead *l* by way of valve *m* into a heating jacket *h* surrounding the poison gas generator *e* and may thereafter discharge from the jacket through valve *i* into the atmosphere. *t* is a stop valve discharging into the atmosphere.

A combustion engine *q* drives the pump *c* through a driving wheel *r*, a belt *u* and a driven wheel *v*. The exhaust pipe *w* of the engine *q* is provided with a valve *x* permitting direct ejection of the exhaust gases into the air, and a branch pipe *z* which, in turn, is provided with a valve *y* and connected to pipe *d*. If valve *x* is closed and valve *y* opened, the hot exhaust gases of the engine *q* are injected into pipe *d* and therefore into the poison gas cycle for acting therein as a carrier for the poison gas and for heating the contents of the gas generator *e*.

The process is carried out with the aid of the above described apparatus somewhat as follows:

After introducing the article or material to be treated into the chamber *a* the main quantity of the air in the chamber *a* is sucked out with the aid of the pump *c* whilst the valve *g* is closed and the valve *m* opened and is removed from the system for example through the valve *s*. After the desired quantity of air has been removed, the air outlet valve *s* is closed and the valves *g* and *k* are opened, after which the air still remaining in the chamber is circulated through the poison gas generator *e* and the chamber *a*, whereby it becomes charged in the generator *e* with poison gas, for instance hydrocyanic acid, ethylene oxide or the like, after which it is introduced through the lead *f* into the chamber *a* and again passed back to the pump through the lead *b*. The throttle valve *g* disposed in advance of the inlet position of the poison gas mixture into the chamber should be so adjusted that compression of the air in the system *d*, *e*, and *f* takes place to such a degree that the air flowing through the gas generator owing to the heat of compression acquires a marked increase in temperature which promotes the vaporization of the toxic substance in the poison gas generator and is sufficient entirely or at least to a considerable extent to equalize the fall of temperature caused by the vaporization of the toxic substance.

Instead of, or in addition to, a regulable valve *g* or other closing member, such as a slide valve, throttle valve and the like, a non-regulable device for throttling the passage of gas, for example in the form of a nozzle or other constriction may according to my invention be provided in the connecting lead between the pressure side of the pump *c* and the chamber *a*.

It is advisable when evacuating the chamber

a not to let the air discharging from the pump escape directly into the atmosphere but first to pass it with closed valve *s* and opened valve *m* through the jacket *h* surrounding the poison gas generator so that it escapes from the latter into the atmosphere at *i*.

In this way the heat of compression of the air pumped out of the fumigating chamber is also rendered available for the heating of the toxic substance or toxic substance carrier in the generator. This effect may be still further increased by compressing the air by throttling the same after its passage through the heating jacket of the generator, for example with the aid of the air discharge valve *i*.

Heating the circulated gas by compressing the same before its entry into the fumigating space offers various important advantages. In the first place it offers the advantage of an increase in the bactericidal and insecticidal action of the heated gas in the fumigating chamber. Heating the gas has also the further advantage that less of the heated gas is retained in and on the fumigated articles than of the cold gas.

A particularly important advantage of compressing the poison gas mixture before its entry into the fumigating chamber resides in the fact that on passing the gas through the poison gas generator not only is the quantity of toxic substance carried along with the air or other carrier gas in unit of time considerably increased, but also such efficient heating of the toxic substance or toxic substance carrier is effected in the generator that the operation can be carried out at greater speeds than in the known processes without the danger of a liquid toxic substance congealing owing to the fall in temperature produced by evaporation.

It is therefore possible by operating according to my invention to accelerate the fumigating process to an extraordinary degree.

This favourable effect may, as already mentioned, be still further increased by passing the air, which discharges from the pressure side of the pump on evacuating the chamber *a* and has with advantage been compressed by throttling, before its discharge into the atmosphere, through a heating jacket surrounding the poison gas generator or by utilizing this air in another manner for the indirect heating of the contents of the poison gas generator. A further increase in efficiency may also be produced (as shown in Fig. 1) by indirect or even direct heating of the contents of the poison gas generator by the hot exhaust gas of an internal combustion engine *q* serving to drive the pump *c*, by steam or the like, during the separation of the poison gas from the generator, whereby the hot exhaust gas, passed directly through the generator and charged in the generator with poison gas, enters the cycle of the working gas in place of, or in addition to, the air or the like otherwise introduced.

The action of the poison gas mixture or the toxic substance at increased pressure is adapted substantially to accelerate the vaporization of the toxic substance.

The gas charged with toxic substance can be circulated in the manner described continuously or interruptedly through the poison gas generator and the fumigating chamber until, if necessary after repeated circulation, it is charged with the desired quantity of poison gas. The circulation may then for example be interrupted and the poison gas be allowed to react in a state of rest on the articles undergoing fumigation in the chamber until the desired effect is obtained. An alternative procedure is to effect further continuous or intermittent circulation of the air charged with poison gas through the fumigating chamber, with or without compression until the desired effect is obtained, the poison gas generator being if necessary permanently or temporarily cut out of the circuit.

The poison gas may be evolved in the generator, for example from liquids which are capable of being absorbed by porous substances. For the evolution of hydrocyanic acid gas, liquid hydrocyanic acid, if desired absorbed on kieselguhr or the like, may for example be employed. The generator may be charged with quantities of products capable of yielding the poison gas, which have been found by experience to be just sufficient for one fumigating treatment or with greater quantities. Instead of subjecting the toxic substance or the carrier charged with toxic substance in a separate generator to the action of the carrier gas, it may also be introduced into the gas stream at any point of the gas passage between the pump and fumigating chamber, for example by spraying in liquid hydrocyanic acid.

According to one embodiment of the invention the introduction of the toxic substance or the carrier charged with toxic substance into the gas stream in advance of and/or within the fumigating chamber may be effected by producing the desired compression and heating of the gas entirely or partially by the resistance offered to the passage of the gas by the toxic substance or toxic substance carrier introduced into the gas passage for example in granular to finely fragmentary form, if desired in combination with a throttling action exerted at another point of the gas passage.

Thus, for example, the toxic substance or toxic substance carrier may be disposed in the poison gas generator *e* of the drawings in a layer of such length and depth that it offers the requisite resistance to the gas flowing therethrough.

The pressure in the fumigating chamber is maintained considerably below atmospheric pressure during the fumigating process, whilst the pressure in the passage of the gas between the pressure side of the pump and the fumigating chamber or in the poison gas generator is higher than the pressure in the fumigating chamber. The pressure between the pump and the fumigating chamber may be below, at, or in certain cases also above atmospheric pressure. Because of the considerable reduction of pressure in the fumigating chamber, the penetration of the poison gas into the hollow spaces, clefts and pores of the articles or materials undergoing treatment is promoted. The action is further increased and rendered uniform by the circulation. Care must be taken by suitable disposition of the inlet and discharge positions of the gas and suitable charging of the chamber to ensure that the poison gas contacts as simultaneously as possible with all the parts of the articles under treatment.

After the extermination of the pests the poison gas is removed from the fumigating chamber, for example by suction followed if necessary by flushing through with fresh air, after which the chamber is emptied and can be charged afresh.

According to a further feature of this invention, the gas still containing toxic substance on its removal from the chamber *a* can be introduced by way of the lead *o* and whilst valves *s*, *k* and *m* are closed and valve *n* is opened under pressure into a reservoir *p* and be subsequently again

introduced, after charging the chamber with fresh material, back through valve *n* and lead *o* or in another way into the chamber *a* or into a fresh gas cycle. The poison gas generator may also itself be constructed in the form of a reservoir by imparting the requisite dimensions thereto.

It is advantageous after completion of the fumigating process and before evacuating the chamber to allow a little air to enter into the chamber for example through the valve *t*, whereby the gas still left in the chamber and still containing toxic substance is forced into the pores of the fumigated articles and can thereby exert any desired subsequent action.

The aeration of the chamber *a* before removing the fumigated articles therefrom is with advantage effected as follows:

The chamber is first extensively evacuated whereby the greater portion of the poison gas adhering to the previously fumigated articles is removed. Fresh air is then sucked by opening the closing member *t* into the chamber, which air owing to the high vacuum in the chamber penetrates into all the pores of the articles and becomes mixed by diffusion with any residual gas which may be left in the chamber in a concentration still detrimental to health. Gas is then again sucked out of the chamber with the aid of the pump *c* and the sucked out mixture of air and toxic substance in the form of gas or vapour is allowed to escape into the atmosphere either directly through valve *s* or through a device (not illustrated in the drawings) adapted for the recovery of the residual quantities of toxic substance still contained in the gas. This aeration process is with advantage several times repeated, in order to allow the chamber to be entered without danger with a view to emptying the same and introducing a fresh charge. Experiments have shown that with an original content of about 20 gms. of hydrocyanic acid per cubic meter in the working gas, a chamber, after being three times aerated, still contained only 1.5 mgms. of hydrocyanic acid, in any case however less than the smallest quantity capable of being analytically accurately determined (10 mgms. of hydrocyanic acid per cubic meter). Experience has shown it to be possible to endure a quantity of hydrocyanic acid amounting to 50 mgms. per cubic meter of air without danger to health.

Two or more fumigating chambers may also be employed for carrying out my hereinbefore described process. Their employment offers the advantage that the greater portion of the residual poison gas mixture remaining in the fumigating chamber after one fumigation can be utilized in another chamber.

Fig. 2 shows an embodiment of an equipment suitable for alternate operations in two chambers.

In this embodiment **1** and **2** are two alternately operated fumigating chambers; **3** is a vacuum pump, **6** a poison gas generator and **7** a device for ascertaining the toxic substance content of the gas. The aforementioned parts are connected together in the manner shown in the drawings. **8—20** are closing members which are with advantage capable of control.

At the conclusion of a fumigating process in chamber **1**, chamber **2**, which has been previously charged with other articles to be fumigated, is extensively evacuated with the aid of the vacuum pump **3**, for example until a pressure of about 20 mm. of mercury is reached, for which purpose the closing members **9**, **11**, and **13** are opened, whilst the remaining closing members at first remain closed. By closing the closing member **9** and opening the member **8**, the working gas is then allowed to expand from chamber **1** into chamber **2**, until the pressure is equalized. The residual gas still present in the chamber **1** is then conveyed with the aid of the pump **3** with open closing members **8**, **9**, and **10** and closed members **11**, **12**, **13**, **17**, and **20** through the open closing member **10** into the chamber **2** until a high vacuum is produced in chamber **1** for the next fumigating process to be effected therein and an excess pressure for example from 300–400 mms. of mercury is present in chamber **2**.

The gas is then circulated by pump **3** with closed closing member **12** in the above described manner during the whole or a part of the fumigating process through the open closing members **11** and **9** with closed members **8**, **10**, **13**, **15**, **18**, and **20** through the open closing members **17** and **16** and the fumigating chamber **2**, care being with advantage taken to ensure sufficient compression and heating of the gas by throttling the gas passage, for example at the closing member **16**. During this gas circulation or even only during a part thereof, for example until sufficient poison gas concentration in the working gas has been obtained, poison gas or vapour is introduced from the generator **6** through the open member **14** into the stream of working gas. An alternative procedure is entirely to interrupt the circulation after sufficient poison gas concentration has been obtained and to cause the gas to react in a state of rest on the articles introduced into the chamber.

Samples of the streaming gas can be removed at every stage of the operation with the aid of the apparatus **7** branched off from the circuit, a fact which is of importance, particularly during the aeration of the chambers, for the exact determination of the toxic substance still present in the gas. The circulation of the working gas through the chambers and with advantage also the transference of the residual gas of a finished fumigation into another chamber is with particular advantage effected at least during a part of the fumigating process through the poison gas generator and the closing members **20** and **14** with closed members **8**, **10**, **12**, **13**, **17**, **18**, and **19**, whereby particularly abundant quantities of the toxic substance can be taken up by the gas in direct contact with the toxic substance or carrier of the same and the heat produced in the gas by compression for example by the member **16** be utilized directly for the vaporization of the toxic substance in the generator.

After completion of the fumigation in chamber **2** this chamber, after chamber **1** has been charged with fresh material to be fumigated, can be emptied whilst repeating the above described procedure in a reverse direction and a fresh fumigation be carried out in chamber **1**.

In the case of the above described embodiment the poison gas generator may also be provided with a heating jacket for heating, for example with the aid of the exhaust gas of the motor driving the pump, steam or the like or the waste gas discharged whilst aerating one chamber.

The heat of compression produced whilst aerating one chamber may also be transferred into another chamber, for example by transferring the heat of the discharging poison gas mixture by means of a heat exchange apparatus (not

shown in the drawings) indirectly to the poison gas mixture flowing into the other chamber.

When operating with two chambers and also when operating with only one chamber, a reservoir corresponding to the position *p* in Fig. 1 may be provided for storing the working gas under pressure, for example in the event of one chamber being out of action or the necessity at any time of making both chambers simultaneously available.

In place of two chambers several chambers may be connected together in a manner corresponding to the above described procedure, the gas residue of each fumigation being utilized in another previously evacuated chamber.

In order to enable the gas producer 6 to be charged without danger with fresh toxic substance or toxic substance carrier it must be previously aerated. This is with advantage effected during the aeration of one chamber by conveying at least a part of the quantity of fresh air to be introduced into the chamber through the closing members 19, 14 and 15 or 16 through the poison gas generator into the chamber to be aerated.

When employing more than one fumigating chamber each chamber may be allotted a separate poison gas generator with corresponding modification of the circuit.

Example

Through a chamber *a* of 20 cubic meters capacity filled with the articles to be fumigated, after evacuation has been effected with the aid of the suction and pressure pump *c* to a pressure of 160 mm. of mercury, the compressed waste gas of the pump having been passed through the jacket *h* of the poison gas generator *e* in order to pre-heat the contents thereof, consisting of 500 gms. of hydrocyanic acid absorbed in 1000 gms. of kieselguhr or diatomite, the residual gas is circulated for 8–10 minutes through the generator, whereby the gas pressure in the chamber amounted to 140 mm. of mercury and the gas pressure between the pump and the throttling position behind the poison gas generator amounted to 1 atm. After removing the air still charged with hydrocyanic acid present in the chamber *a* after the time indicated with the pump *c* or after passing the residual gas back into another chamber and flushing the evacuated chamber in the manner described, this chamber may be opened and emptied.

If desired before emptying the chamber the gas, first circulated through the poison gas generator and the chamber, can be circulated through the chamber for a further period whilst cutting the poison gas generator out of the circuit and/or without effecting throttling between the pump and the chamber.

In order to increase the final action of the poison gas in the chamber some air may be allowed to flow in from outside before emptying the chamber until the gas pressure in the chamber amounts to about 360 mm. of mercury.

What I claim is:

1. A pest-exterminating process, which consists in circulating gas through a space in which the gas is charged with a volatile toxic substance and thence through a fumigating chamber containing the material to be treated, the fumigating chamber standing under considerably reduced pressure, during each cycle compressing the gas prior to its discharge into the fumigating chamber so that the gas acts in this compressed condition on the toxic substance, and allowing the gas to expand before its entry into the fumigating chamber, the gas being compressed to such a considerable extent that the fall of temperature caused by the vaporization of the toxic substance is at least in a great measure equalized by the increase in temperature of the gas produced by the compression.

2. A process as claimed in claim 1, wherein a part of the air contained in the fumigating chamber is sucked out of the latter after charging the fumigating chamber with the articles to be treated, and then the air remaining in the chamber is circulated through the latter and the space charged with the toxic substance.

3. A process as claimed in claim 1, wherein a part of the air contained in the fumigating chamber is sucked out of the latter after charging the fumigating chamber with the articles to be treated and then the air remaining in the chamber is circulated through the latter and the space charged with the toxic substance, compressing the air first sucked out before its discharge to the atmosphere, and indirectly transferring the resulting heat of compression to the toxic substance to be vaporized.

4. A process as claimed in claim 1 wherein the circulation is effected by means of a compression pump driven by a combustion engine, the hot exhaust gas of the latter being at least partially employed as circulating carrier gas.

5. Apparatus for exterminating pests, which consists of at least one chamber to be charged with the articles containing the pests, a container for a substance giving off a volatile toxic substance inserted in the gas stream, a pump adapted for use both as a suction pump and a pressure pump, connecting leads and closing and reversing members for circulating a gas through the pump, the fumigating chamber and the said container, and means for throttling the flow of gas between the point of discharge from said container and the point of entry into the fumigating chamber, so that the fall of temperature caused by the vaporization of the toxic substance is at least in a great measure equalized by the increase in temperature of the gas produced by the compression.

6. Apparatus as claimed in claim 5, wherein the throttling means are adapted to regulate the resistance to the passage of the gas.

7. A process as claimed in claim 1, wherein air is employed as carrier gas for the toxic substance.

8. A process as claimed in claim 1, wherein the gas is charged with the toxic substance by causing the gas stream at least during a part of its circulating period to contact directly with a solid carrier charged with a volatile toxic substance introduced into the gas cycle so that it becomes charged with volatilized toxic substance.

9. A process as claimed in claim 1, wherein the gas is charged with the toxic substance by causing the gas stream at least during a part of its circulating period to contact directly with a solid carrier charged with a liquid volatile toxic substance and introduced into the gas cycle.

10. A process as claimed in claim 1, wherein, after completion of a fumigating process, the gas still containing toxic substance present in the fumigating chamber is transferred into another chamber which has been previously extensively evacuated and charged with the articles to be treated and is there employed for carrying out a fresh fumigating process.

11. Apparatus as claimed in claim 5, wherein a substance charged with the toxic substance

to be vapourized in granular to fragmentary form is inserted in the gas passage on the pressure side in order to increase the resistance to the passage of the gas, a separate toxic substance container being dispensed with.

12. Apparatus as claimed in claim 5, wherein members for introducing the exhaust gas of the internal combustion engine driving the pump are provided in the gas cycle at a point in front of the point of introduction of the toxic substance into the same.

13. Apparatus as claimed in claim 5, wherein, when employing at least two fumigating chambers, members are provided for transferring the residual gas remaining in one chamber after completion of fumigation into another chamber and for effecting the circulation of gas through this chamber.

14. A process as claimed in claim 1, wherein ethylene oxide is employed as toxic substance to be admixed in vapourized form with the gas.

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