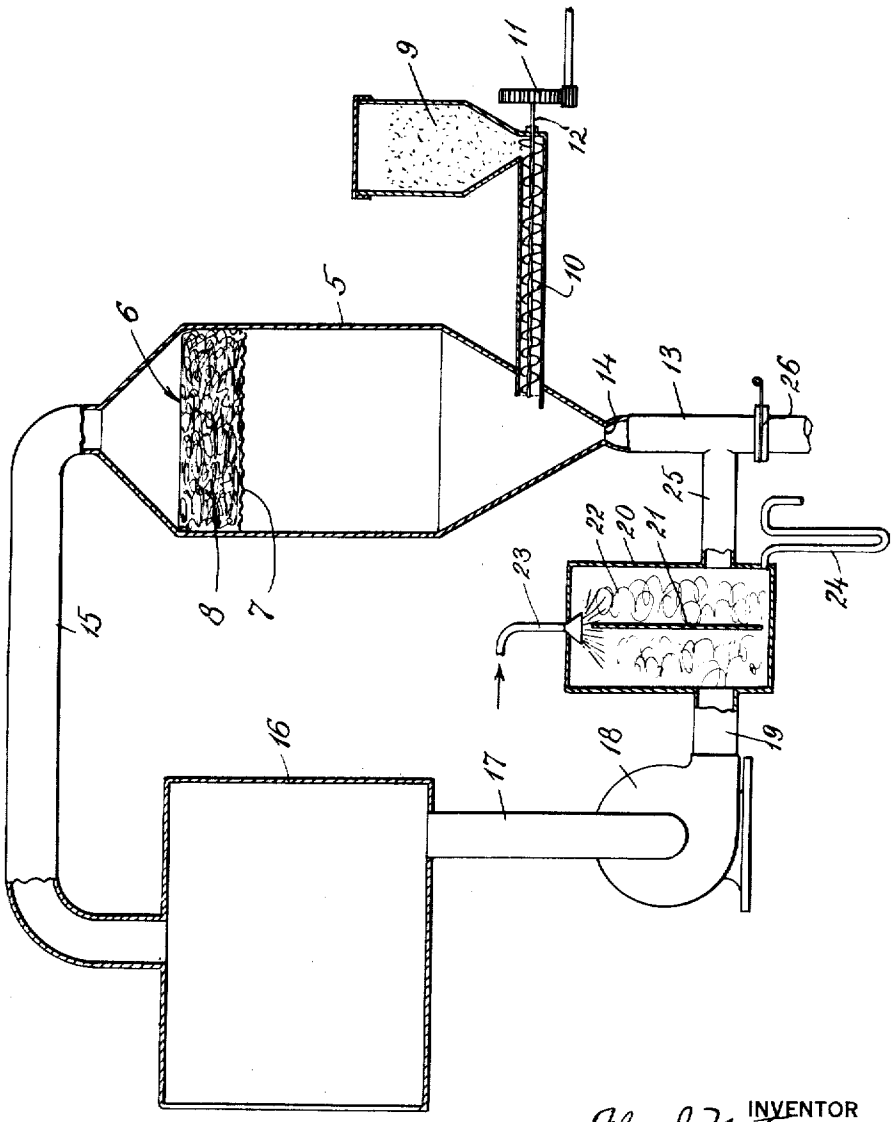
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METHOD OF AND APPARATUS FOR FUMIGATING

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METHOD OF AND APPARATUS FOR FUMIGATING.

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This invention relates to fumigation and particularly to a method of and apparatus for generating and applying hydrocyanic acid gas for the purpose of destroying insects and other pests.

Liquid hydrocyanic acid has been used heretofore as a fumigant and is a very satisfactory medium for that purpose. It may be evaporated within the enclosure which is to be fumigated or converted into the gaseous phase outside the enclosure to which the gaseous hydrocyanic acid may be delivered through a suitable pipe. The use of liquid hydrocyanic acid has certain disadvantages owing to the nature of the material. The liquid must be transported in sealed containers capable of withstanding pressure and it tends to deteriorate and has been known to decompose with explosive force. It is necessary, therefore, to handle the liquid with great care.

Calcium cyanide, on the other hand, is a solid and fairly stable product except when exposed to the atmosphere in the presence of moisture. When so exposed the calcium cyanide decomposes readily and releases practically all of its cyanide content in the form of gaseous hydrocyanic acid. It may, however, be stored indefinitely in ordinary sealed containers and it can be transported and utilized without any particular hazard.

Calcium cyanide can be applied for fumigation purposes by introducing it either as a dust cloud or simply as an exposed layer to the space to be fumigated. The use of calcium cyanide in this manner, while satisfactory in many situations, has the disadvantage that the solid material remaining after the hydrocyanic acid has been released and consisting substantially of calcium hydroxide is not always easily removed from the space and may remain as an unsightly coating upon objects within the space to be fumigated.

It is the object of the present invention to provide a method of and apparatus for generating and applying hydrocyanic acid gas in which solid calcium cyanide is employed.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and the accompanying drawing in which the figure illustrates diagrammatically a suitable type of apparatus for the practice of the invention.

In carrying out the invention the solid calcium cyanide in finely divided form may be placed upon any suitable filter medium which will retain the powder and permit the passage of a gaseous medium such as air. Suitable filter media are crushed rock, steel wool, excelsior and the like. Furthermore, a cloth bag or a diaphragm composed of cloth will retain the dust satisfactorily, permitting the gaseous mixture containing hydracyanic acid to pass therethrough. The gas containing hydrocyanic acid is delivered to the space to be fumigated and after serving its purpose it may be discharged to the atmosphere or returned by a suitable circulating means to the generator to again take up a quantity of hydrocyanic acid for use in the space to be fumigated.

To ensure the proper generation of hydrocyanic acid it is necessary that a small amount of moisture be present in the air or other gas which contacts with the calcium cyanide. At ordinary atmospheric temperatures, particularly those prevailing in summer, together with normally high relative humidity, there is sufficient moisture in the air to decompose calcium cyanide with sufficient rapidity for the purpose of the invention unless for any reason abnormally high hydrocyanic acid concentrations are required or the time permitted for the fumigation is limited. In cold winter weather and under atmospheric conditions of low relative humidity it may be necessary or desirable to artificially humidify the air or other gas employed, and for this purpose a suitable humidifier may be provided to ensure the saturation of the air or other gas which is delivered to the generator.

In the practice of the invention we first determine the cubic contents of the space to be fumigated and from this we ascertain the amount of hydrocyanic acid and consequently the amount of calcium cyanide which must be utilized to complete the fumigation, basing the calculation upon well known standards of the required concentration of

hydrocyanic acid for the purpose of killing the particular pest or pests which exist within the enclosure to be fumigated. The predetermined quantity of calcium cyanide is placed then upon the filter and the air or other gas containing the requisite proportion of moisture is blown through the filter. The resulting gaseous mixture containing hydrocyanic acid is delivered to the enclosure to be fumigated and may, if desired, be returned through a suitable circulating apparatus to the generator. If the gas is circulated, moisture may be added thereto before the gas again comes into contact with the calcium cyanide.

In the preferred form of apparatus for the practice of the invention a generating chamber is employed in which the air or other gas circulates upwardly toward a filter which is disposed near the top of the chamber so that only a portion of the solid calcium cyanide or the residue therefrom reaches the filter. The solid calcium cyanide is fed to the chamber near the bottom thereof and the upward flow of the gas within the chamber causes a suspension of the fine particles of calcium cyanide and a resulting rapid generation of hydrocyanic acid. The filter at the top of the chamber separates the solid material from the gaseous stream which continues through the filter and through a suitable pipe to the enclosure to be fumigated. A return pipe from the enclosure may deliver the gas to a circulating pump and the latter may return it through a humidifier, if the addition of moisture is necessary, and thence to the chamber for the generation of additional quantities of hydrocyanic acid. Preferably, although not necessarily, the solid calcium cyanide is fed gradually to the generating chamber while the generation and fumigation is proceeding. A suitable trap may be provided to facilitate the withdrawal of the spent material from the generating chamber after one or more fumigations have been conducted. The time during which the apparatus may remain in use without dismantling and cleaning of the filter may thus be prolonged.

Referring to the drawing which illustrates the preferred embodiment of the apparatus, 5 indicates a generating chamber at the upper end of which a filter bed 6 is provided. The filter bed may be composed of a diaphragm 7 of cloth or other suitable material and a layer 8 of steel wool, excelsior or the like, disposed thereon. The solid calcium cyanide is placed in a hopper 9 and may be delivered to the generating chamber by a screw 10 or other feeding device actuated mechanically as, for example, through a gear 11 connected to a shaft 12 which supports the screw. The air or other gas enters the bottom of the generating chamber 5 through a pipe 13 and an inlet 14. The latter should be so proportioned with reference to the volume of gas admitted to the generating chamber as to ensure a velocity sufficient to maintain the solid calcium cyanide and the residue therefrom in suspension during the generating period. A pipe 15 is connected to the top of the generating chamber above the filter 6 and conveys the gaseous mixture containing hydrocyanic acid to a chamber or other enclosure 16 which is to be fumigated. The chamber 16 may be a rigid structure to which articles to be fumigated may be introduced or a tent or other enclosure adapted to be placed about the stationary objects.

Since circulation of the gas is desirable a return pipe 17 is connected to the enclosure 16 and to a circulating pump 18 of any suitable kind. The latter delivers the gas through a pipe 19 to a humidifier 20 which may comprise a simple chamber having a partition 21 and a filling 22 of any suitable material designed to ensure maximum contact between the gas and the water which is delivered through a pipe 23 at the top of the humidifier. A sealed overflow 24 is provided at the bottom of the humidifier to facilitate the escape of surplus water. The humidified gas is delivered through a pipe 25 to the pipe 13 and passes thence through the inlet 14 to the generating chamber. A trap 26 in the bottom of the pipe 13 permits the withdrawal of spent material from the generating chamber.

In the use of the apparatus as described water is permitted to enter the humidifier and the circulating pump is started to cause a circulation of air through the system. The feeding device is then permitted to deliver calcium cyanide from the hopper to the generating chamber. The rate of feeding does not affect the generation materially and it is possible to secure satisfactory results by delivering the complete charge of calcium cyanide immediately to the generating chamber. We prefer, however, to feed the calcium cyanide at a reasonably slow rate during the early part of the fumigating period. When all of the solid calcium cyanide has been introduced to the chamber circulation is continued until substantially all of the cyanogen in the solid material has been released in the form of hydrocyanic acid and utilized for its intended purpose.

As an illustration of the application of the invention a box car which required fumigation was placed within a tight compartment built for the purpose which contained 9,426 cubic feet of gross air space. A suitable concentration of hydrocyanic acid for this space was known to be .4% by volume as determined from previous experience. Five pounds of calcium cyanide containing 2.84 pounds of cyanogen were placed

in the feed hopper and the circulating pump was started and was found to be circulating 347 cubic feet of air per minute through the entire apparatus including the compartment enclosing the box car. The calcium cyanide was then fed at an approximately uniform rate during a period of five minutes. After the predetermined amount of calcium cyanide had been fed to the generator the operation of the pump was continued for a further period of fifteen minutes in order to stir up the air within and around the box car and to secure an approximately equal distribution of hydrocyanic acid throughout the chamber enclosing it. At the end of this time the concentration of hydrocyanic acid within the compartment was found by analysis to be .403% by volume.

The residue remaining in the generating chamber was removed and was found to weigh 0.625 pounds. The residue in the filter was found to weigh 2.37 pounds. The total amount of cyanogen in both residues calculated from the analysis of each was .082 pounds. The efficiency of hydrocyanic acid generation, based on the cyanogen in the calcium cyanide employed, was 97.1%.

It is possible, therefore, in carrying out the invention to secure the evolution of more than 90% of the cyanogen content of the calcium cyanide used in the form of hydrocyanic acid. No dust can be perceived in the stream of air or other gas entering the space to be fumigated and consequently the materials undergoing fumigation are protected adequately from injury by contact of the solid material therewith. No. subsequent cleaning of the fumigated space is necessary.

Among the advantages of the invention are the safety and ease with which the highly poisonous hydrocyanic acid may be handled and applied in the manner herein described. The solid calcium cyanide can be delivered from sealed containers directly to the hopper without any substantial escape of hydrocyanic acid. Thereafter the hydrocyanic acid is generated in a closed chamber and is delivered directly to the space to be fumigated and is applied therein without danger to the operators who handle the apparatus.

Various changes may be made in the procedure as described as well as in the apparatus employed without departing from the invention or sacrificing the advantages thereof.

We claim:

1. The method of fumigating, which comprises subjecting a solid cyanide-containing material to the action of a moist gaseous medium capable of causing evolution of hydrocyanic acid from the solid material, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated and returning the gaseous medium for further contact with the solid material.

2. The method of fumigating, which comprises subjecting a solid cyanide-containing material to the action of a moist gaseous medium capable of causing evolution of hydrocyanic acid from the solid material and delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated.

3. The method of fumigating, which comprises subjecting a solid cyanide-containing material to the action of a moist gaseous medium capabe of causing evolution of hydrocyanic acid from the solid material, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated, withdrawing the gaseous medium from the space to be fumigated, adding moisture thereto and returning it for further contact with the solid material.

4. The method of fumigating, which comprises subjecting a solid material containing calcium cyanide to the action of moistened air and delivering the air containing hydrocyanic acid produced by decomposition of the calcium cyanide to the space to be fumigated.

5. The method of fumigating, which comprises subjecting a solid material containing calcium cyanide to the action of moist air, delivering the air containing hydrocyanic acid produced by decomposition of the calcium cyanide to the space to be fumigated, withdrawing and moistening the air and returning it for further contact with the solid material.

6. The method of fumigating, which comprises circulating a moist gaseous medium between a space to be fumigated and a body of solid cyanide-containing material capable of decomposing upon contact with the gaseous medium to produce hydrocyanic acid.

7. The method of fumigating, which comprises circulating a moist gaseous medium between a space to be fumigated and a body of solid cyanide-containing material capable of decomposing upon contact with the gaseous medium to produce hydrocyanic acid and moistening the gaseous medium before contact thereof with the solid material.

8. The method of fumigating, which comprises passing a moist gaseous medium through a body of solid cyanide-containing material capable of decomposing in the presence of the gaseous medium to produce hydrocyanic acid and delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated.

9. The method of fumigating, which comprises passing a moist gaseous medium through a body of solid cyanide-containing material capable of decomposing in the presence of the gaseous medium to produce hy-

drocyanic acid, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated, withdrawing the gaseous medium from the space to be fumigated and returning it for further contact with the solid material.

10. The method of fumigating, which comprises passing a moist gaseous medium through a body of solid cyanide-containing material capable of decomposing in the presence of the gaseous medium to produce hydrocyanic acid, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated, withdrawing the gaseous medium from the space to be fumigated, adding moisture thereto and returning it for further contact with the solid material.

11. The method of fumigating, which comprises passing moist air through a body of solid material containing calcium cyanide and delivering the air containing hydrocyanic acid produced by decomposition of the cyanide to the space to be fumigated.

12. The method of fumigating, which comprises passing moist air through a body of solid material containing calcium cyanide, delivering the air containing hydrocyanic acid produced by decomposition of the cyanide to the space to be fumigated, withdrawing the air from the space to be fumigated and returning it for further contact with the solid material.

13. The method of fumigating, which comprises passing moist air through a body of solid material containing calcium cyanide, delivering the air containing hydrocyanic acid produced by decomposition of the cyanide to the space to be fumigated, withdrawing and moistening the air and returning it for further contact with the solid material.

14. In an apparatus for fumigating, a chamber, means at one end of the chamber to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated and means for delivering the gaseous medium to the enclosure.

15. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for feeding solid material to the chamber, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated and means for delivering the gaseous medium to the enclosure.

16. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure and means for returning the gaseous medium to the chamber.

17. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure and means for returning the gaseous medium to the chamber, including means for maintaining circulation of the gaseous medium.

18. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure, and means for returning the gaseous medium to the chamber, including means for maintaining circulation of the gaseous medium and means for moistening the gaseous medium.

In testimony whereof we affix our signatures.

FLOYD J. METZGER.
GEORGE CARL BAUER.

CERTIFICATE OF CORRECTION.

Patent No. 1,675,123. **Granted June 26, 1928, to**

FLOYD J. METZGER ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 66, for the misspelled word "hydracyanic" read "hydrocyanic"; page 3, line 80, claim 3, for "capabe" read "capable"; page 4, line 44, claim 14, before the word "means" insert the words and comma "means for introducing solid material to the chamber,"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of August, A. D. 1928.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

drocyanic acid, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated, withdrawing the gaseous medium from the space to be fumigated and returning it for further contact with the solid material.

10. The method of fumigating, which comprises passing a moist gaseous medium through a body of solid cyanide-containing material capable of decomposing in the presence of the gaseous medium to produce hydrocyanic acid, delivering the gaseous medium containing the hydrocyanic acid to the space to be fumigated, withdrawing the gaseous medium from the space to be fumigated, adding moisture thereto and returning it for further contact with the solid material.

11. The method of fumigating, which comprises passing moist air through a body of solid material containing calcium cyanide and delivering the air containing hydrocyanic acid produced by decomposition of the cyanide to the space to be fumigated.

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14. In an apparatus for fumigating, a chamber, means at one end of the chamber to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated and means for delivering the gaseous medium to the enclosure.

15. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for feeding solid material to the chamber, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated and means for delivering the gaseous medium to the enclosure.

16. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure and means for returning the gaseous medium to the chamber.

17. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure and means for returning the gaseous medium to the chamber, including means for maintaining circulation of the gaseous medium.

18. In an apparatus for fumigating, a chamber, means therein to permit the passage of a gaseous medium and to retain solid particles, means for delivering a gaseous medium thereto, an enclosure for the space to be fumigated, means for delivering the gaseous medium to the enclosure, and means for returning the gaseous medium to the chamber, including means for maintaining circulation of the gaseous medium and means for moistening the gaseous medium.

In testimony whereof we affix our signatures.

FLOYD J. METZGER.
GEORGE CARL BAUER.

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Signed and sealed this 21st day of August, A. D. 1928.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

DISCLAIMER

1,675,123.—*Floyd J. Metzger*, New York, N. Y., and *George Carl Bauer*, Los Angeles, Calif. METHOD OF AND APPARATUS FOR FUMIGATING. Patent dated June 26, 1928. Disclaimer filed June 14, 1933, by the assignee, *Air Reduction Company, Incorporated.*

Hereby disclaims:

(*a*) From claims 1 to 13, inclusive, of said Letters Patent, any method of fumigating in which solid cyanide-containing material is not fed to the generating chamber and mingled with the moist gaseous medium therein.

(*b*) From claims 16 to 18, inclusive, of said Letters Patent, any apparatus for fumigating which does not include means for feeding solid cyanide-containing material to the generating chamber.

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