169-45. OR 2,543,362 SR

CLAIM 1
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Feb. 27, 1951

C. A. GETZ
METHOD OF INERTING ENCLOSED SPACES TO PREVENT OR EXTINGUISH FIRES

2,543,362

Filed Nov. 7, 1946

2 Sheets-Sheet 1

Fig. 1.

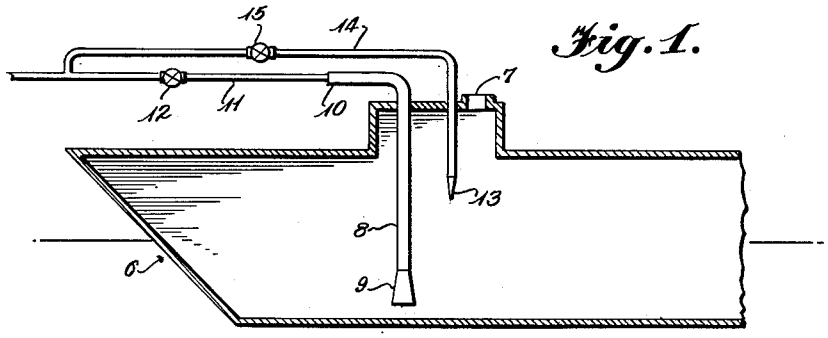


Fig. 2.

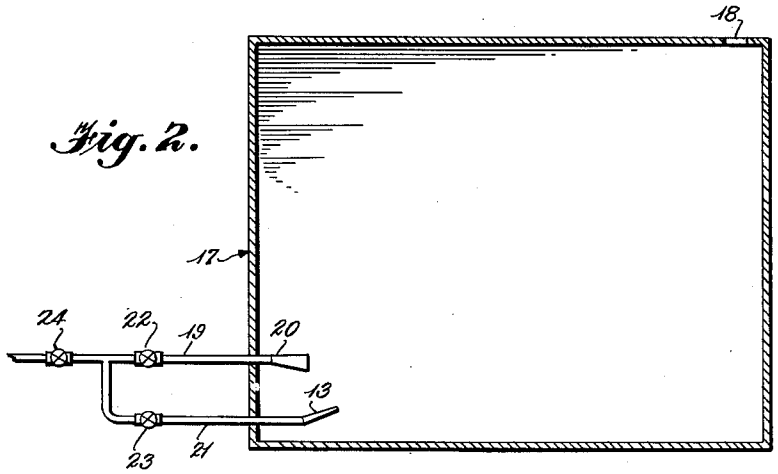


Fig. 3.

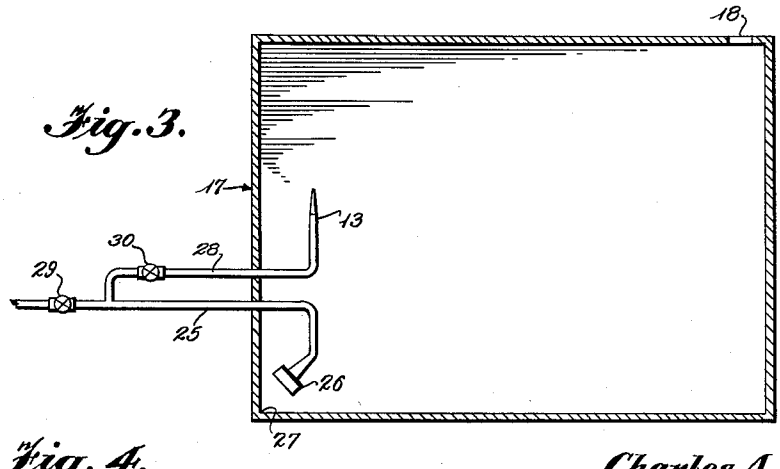
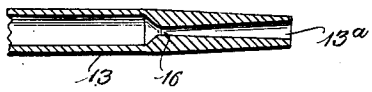


Fig. 4.



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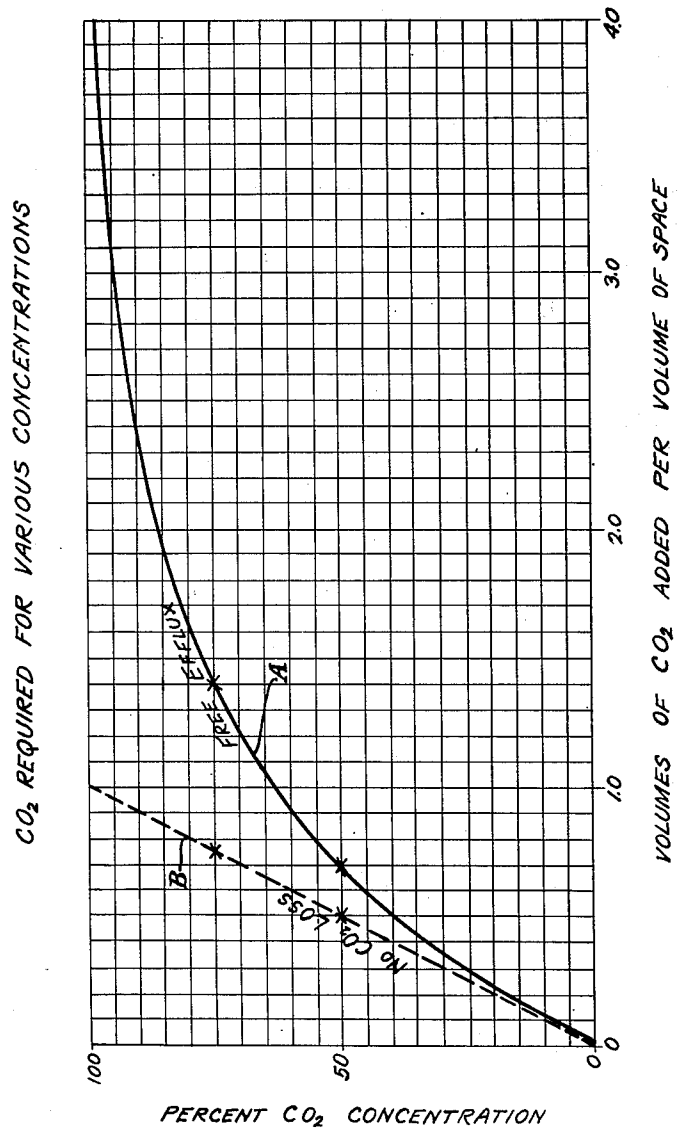
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Feb. 27, 1951 C. A. GETZ 2,543,362

METHOD OF INERTING ENCLOSED SPACES TO PREVENT OR EXTINGUISH FIRES

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Fig. 5.



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METHOD OF INERTING ENCLOSED SPACES TO PREVENT OR EXTINGUISH FIRES

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4 Claims. (Cl. 169—1)

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This invention relates to new and useful improvements in methods of inerting closed spaces to prevent a fire from starting or an explosion from occurring or to extinguish an existing fire.

It is a very old and well-known procedure to "flood" enclosed spaces with an inert gas, such as carbon dioxide vapor, to extinguish fires in class A combustibles and to prevent the ignition of combustible solids and explosive atmospheres. Interest in this old procedure has increased to a considerable extent in recent months because of extensive studies that are being or have been conducted by certain fire prevention and safety organizations, governmental agencies, and the like.

For example, tankers and barges used to transport petroleum or other inflammable liquid present a hazardous problem whenever welding repairs are required. The normal practice has been to steam out the compartments of such vessels until all traces of inflammable vapors have been removed before any attempt is made to effect repairs. Since this has been a costly and time consuming process, extensive studies have been made to determine if savings in time and expense could be effected through the use of an inert atmosphere of carbon dioxide.

Another example is the protection of fur storage vaults. Inerting such vaults with an atmosphere of carbon dioxide has been the accepted procedure because of the non-damaging characteristics of this fire extinguishing medium. Fixed carbon dioxide fire extinguishing systems that have been installed in fur vaults over quite a long period of time have followed a single pattern with reference to the mode or manner of introducing the carbon dioxide and the percentage of carbon dioxide concentration that has been provided. Because several substantial fire losses have been experienced over the last few years in vaults protected by such installations, the insurance groups, fur vault owners, and manufacturers of fire extinguishing equipment have been particularly interested in determining why more adequate fire protection has not been afforded by such systems.

As a result of the studies made in connection with the inerting of tanks and barges, it was determined that carbon dioxide vapor is an exceptionally effective medium for purging the compartments of such vessels to condition the latter for welding repair work. It was ascertained, however, that if the prior known and practiced methods of inerting spaces with carbon dioxide vapor were employed, a uniform concentration throughout the entire interior of the compartments of tanks and barges could not be obtained without delivering to each compartment a substantially larger amount or volume of carbon dioxide vapor than theoretically should be required to produce the percentage of concentration desired. For example, if a final uniform concentration of 50% carbon dioxide were desired (50 volumes of carbon dioxide vapor per 100 volumes of compartment space) it was necessary to deliver 69 volumes of vapor per 100 volumes of compartment space. To obtain a uniform concentration of 75%, it was necessary to deliver 140 volumes of inerting vapor per 100 volumes of compartment space. For a 100% uniform concentration, over 400 volumes of vapor per 100 volumes of space were required. In effecting these inerting operations, the volumes of inerting vapor in excess of the percentage figure desired are lost by being vented from the compartments with the air that is displaced through the vent openings.

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Tests made with prior standard carbon dioxide fire extinguishing systems for fur storage vaults established the facts that higher concentrations of inerting vapors than those accepted or approved as "standard" are required to effect extinguishment of all types of fires encountered in fur vaults—deep-seated smouldering fires require the highest concentration—and that even the inadequate "standard" or approved concentrations of inerting vapor were not being uniformly provided throughout the entire heights of storage vaults and for that reason garments hanging in upper and lower tiers in such vaults were not being uniformly subjected to the same percentage of concentration of fire extinguishing atmosphere.

It is the primary object of this invention to provide a method of uniformly inerting the entire heights of enclosed spaces with carbon dioxide vapor to provide any desired percentage of concentration by delivering to said spaces the same ratios of volumes of vapor per 100 volumes of space as the percentage of concentration desired; i. e., 50 volumes of inerting vapor per 100 volumes of space for a 50% concentration, etc.

A further object of the invention is the provision of a method of uniformly inerting enclosed spaces, having one or more top venting openings, with carbon dioxide vapor to provide any desired percentage of concentration by gently introducing to the bottom portion of the space to be inerted the number of volumes of vapor per 100 volumes of space that corresponds to the per-

centage of concentration desired in such a manner that the inerting vapor will remain as a layer in the said bottom portion of the space while the same number of volumes of air will be exhausted through the top vent opening of the space, and then effecting thorough mixing of the gently introduced vapor and the air remaining in the space to provide the uniform percentage of concentration desired.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a vertical sectional view through one portion of a barge, employed for transporting petroleum products or other inflammable fluids, with equipment associated therewith by means of which the inerting method embodying this invention may be carried out,

Figure 2 is a vertical sectional view through an enclosed space, which may be by way of example a fur storage vault, and with equipment associated therewith for effecting extinguishment of a fire in the said enclosed space,

Figure 3 is a similar view to Fig. 2, but illustrates the use of slightly different equipment,

Figure 4 is a detail enlarged view in longitudinal section of a type of high velocity jet-producing discharge nozzle, and

Figure 5 is a graph showing the amounts of carbon dioxide vapor required for producing various concentrations when two different methods of application are employed.

In the drawings, wherein for the purpose of illustration are shown the preferred embodiments of this invention, and first particularly referring to Fig. 1, the reference character 6 designates in its entirety a barge that has been employed for transporting an inflammable fluid and the interior or compartment of which must be purged of inflammable vapors so that welding repairs may be made to the barge. The barge is illustrated as being formed with a conventional vent opening 7 in its upper portion. Barges of this type normally are provided with one or more pipes of the type designated by the reference character 8 for use in filling and discharging operations. These pipes are provided with flared inner ends 9 which are closely positioned with respect to the bottom of the barge compartment. The outer exposed ends of such pipes are so constructed that fluid delivering or withdrawing pipes readily can be coupled thereto. In Fig. 1, the outer end 10 of the pipe 8 is illustrated as having connected thereto, in any suitable manner, the pipe line 11 that extends to a source of supply of carbon dioxide vapor, not shown. This pipe 11 is provided with a flow control valve 12 that may be either manually or automatically actuated. In other words, the control valve 12 may be of a manually operable type so that it can be opened and closed at the will of an attendant responsible for delivering of carbon dioxide vapor to the interior or compartment of the barge 6. Due to the flared construction of the inner end portion 9 of the pipe 8, the carbon dioxide will be delivered very gently to the barge, or at a low velocity, so that a minimum of turbulence will be created in the barge.

This gentle introduction of carbon dioxide vapor will cause the latter to first spread over the entire bottom surface of the barge compartment or space and to then build up in depth until the introduction of the inerting vapor in this manner is stopped. Because carbon dioxide vapor does not readily diffuse through air, the gently introduced carbon dioxide vapor will remain rather sharply separated from the air in the barge compartment so that the portion of the compartment above the layer of vapor will be filled with air. Of course, the introduction of carbon dioxide vapor in the bottom portion of the barge compartment will cause a like amount of the original air to be expelled from the barge compartment through its top vent opening 7.

After the desired amount of carbon dioxide vapor has been gently introduced to the bottom portion of the barge compartment, the method of this invention contemplates a thorough mixing of the introduced vapor with the air that remains in the compartment of the barge. This is accomplished by discharging an additional amount of carbon dioxide vapor into the barge compartment as a high velocity jet through the discharge nozzle 13 that is suitably connected to the pipe 14 having the flow control valve 15 connected therein. This valve, also, may either be of a manual control type or of an automatically controlled type, the same as the flow control valve 12. Pipe 14 is connected to the previously referred to pipe line 11 which extends from a suitable source of supply of carbon dioxide vapor, not shown. It will be noted that the jet-producing nozzle 13 is vertically arranged so that its discharge will be directed downwardly. It has been determined that the high velocity jet-producing nozzle 13 will function most satisfactorily for thoroughly mixing the air and inerting vapor if its discharge is directed vertically.

Fig. 4 discloses in detail the internal construction of the high velocity jet-producing nozzle 13. This nozzle is so constructed that its bore is of Venturi construction, as at 16, with its outer portion flaring to the extremity 13a of the nozzle.

Fig. 2 discloses an enclosed space 17 that, by way of example, may be considered as representing a fur storage vault. Such vaults conventionally are provided with one or more top vent openings 18.

For the purpose of inerting the interior of the enclosed space 17 to effect extinguishment of a fire burning therein, the space is provided with a pipe line 19 that is intended to extend to a suitable source of supply of carbon dioxide vapor, not shown. The remaining end of this pipe line 19 is provided with a cone-shaped or flared discharge nozzle 20 that extends horizontally into the interior of the enclosure 17 and functions to gently introduce the vapor so that a minimum amount of turbulence will be set up.

A branch pipe 21 is connected to the pipe 19 and extends into the interior of the enclosed space 17. A high velocity jet-producing nozzle 13 is connected to the inner end of the branch pipe 21.

The portion of the pipe line 19 that extends between the points where the branch pipe 21 connects therewith and the flared discharge nozzle 20 is located is provided with a flow control valve 22. The branch pipe 21 is provided with a flow control valve 23. The pipe line 19, upstream of its point of connection with the branch pipe 21, is provided with a flow-control valve 24. It will be seen that the valve 24 is located so that it will control the flow of carbon dioxide vapor to both the down-stream portion of the pipe line 19 and to the branch pipe 21. This valve

24, therefore, may be considered as a master control valve. The valves 22 and 23, on the other hand, only exercise control over the particular pipe lengths in which they are connected. Therefore, the valves 22 and 23 may be considered as selector valves. Either one of these valves may be opened or closed without affecting flow through the pipe length in which the other selector valve is connected.

This arrangement of pipes and nozzles may be employed in the same manner as the pipes and nozzles described in connection with barge 6 of Fig. 1 for producing a layer of carbon dioxide vapor in the bottom portion of the enclosed space and for then thoroughly mixing this introduced inerting vapor with the air remaining in the enclosed space to provide a uniform concentration of carbon dioxide vapor throughout the entire interior of the said space.

Fig. 3, also, discloses an enclosed space 17 which is of the same type as that illustrated in Fig. 2, and which is provided with a top vent opening 18.

This space is provided with a pipe line 25 that extends into the space from a suitable source of supply of carbon dioxide vapor, not shown. The inner end of the pipe line 25 is provided with a discharge nozzle 26 that is not especially designed to introduce the vapor at a low velocity. However, by directing the nozzle 26 into the corner 27 of the enclosed space, impringement of the discharged carbon dioxide vapor against the surfaces of this corner will reduce the velocity of the flowing vapor to such an extent that it will not create any substantial or undesirable amount of turbulence in the remainder of the interior of the said space.

Connected to the pipe line 25 as a branch is the pipe 28 that extends into the interior of the space 17 and has a high velocity jet-producing nozzle 13 connected to its inner end and arranged to discharge vertically.

The pipe line 25 is provided with a valve 29 that is up-stream with respect to its point of connection with the branch pipe 28. Down-stream of this point of connection, the pipe line 25 is not provided with a valve. The branch pipe 28, however, is provided with a valve 30. With this valve arrangement, flow through both the pipe line 25 and the branch pipe 28 is controlled by the valve 29 while the valve 30 only controls the flow of vapor through the branch pipe 28.

This pipe and nozzle arrangement may be employed in the same manner as the pipe and nozzle arrangements of Figs. 1 and 2 for first building up in the bottom portion of the space 17 a layer of carbon dioxide vapor and then thoroughly mixing this gently introduced vapor with the air that remains in the top portion of the enclosed space so that a uniform concentration of carbon dioxide will be provided throughout the entire interior of the said space.

In inerting closed spaces with carbon dioxide vapor in accordance with the prior practice, the inerting vapor has been introduced at a high velocity with the result that a considerable amount of turbulence is created within the space being inerted. This turbulence causes the introduced inerting vapor to be mixed with the air in the space. Consequently, the atmosphere that is expelled through the top vent opening of the space is made up of a mixture of the original air of the space and the introduced inerting vapor. Because of this fact, inerting by this prior method has made it necessary to introduce a substantially larger amount or volume of inerting vapor than the amount that theoretically is required to provide the percentage of concentration desired. For example, if a concentration of 50% is desired in an enclosed space, the theoretical amount of inerting vapor that should be introduced to provide this percentage of concentration would be on a ratio of one to two with reference to the volume of the space. Expressed in another manner, one volume of inerting vapor should be introduced for every two volumes of space to be inerted.

Extensive tests have determined that the heavy scale-line A of Fig. 5 accurately indicates the number of volumes of carbon dioxide inerting vapor that must be introduced to provide a given percentage of concentration when the introduced vapor is thoroughly mixed with the air of the space as it is introduced and the mixed vapor and air are expelled through a top vent opening of the space.

By considering the horizontal lines of the graph of Fig. 5 as representing the percentage of carbon dioxide vapor concentration produced and the vertical lines as representing the number of volumes of carbon dioxide vapor that must be added per volume of space to be noted, it will be seen that .7 volume of carbon dioxide vapor must be introduced for every volume of space to provide a 50% concentration of carbon dioxide in the space. If a 75% concentration is desired, 1.4 volumes of carbon dioxide vapor must be introduced for each volume of space. By inspecting the extreme right-hand end of the solid line A, it will be seen that the introduction of four volumes of carbon dioxide for each volume of space will not even produce a concentration of 100%.

In practicing the method of this invention, in which the inerting vapor is gently built up as a layer at the bottom of the space to be inerted and is then thoroughly mixed with the original air remaining in the space, it has been established that it is only necessary to introduce the amount of inerting vapor that is theoretically required to provide the percentage of concentration desired.

The dash line B of Fig. 5 illustrates the volumes of carbon dioxide vapor that must be introduced per volume of space to provide the percentage of concentration desired when the method of this invention is practiced. By following this line B, it will be seen that .5 volume of carbon dioxide vapor must be added for each volume of space to provide a 50% concentration while .75 volume of vapor must be added per volume of space to provide a 75% concentration. Additionally, the introduction of one volume of carbon dioxide vapor for each volume of space will provide a 100% concentration when the method of this invention is employed.

It will be appreciated that in practicing the method of this invention, the time at which the thorough mixing of the gently introduced vapor with the remaining air may be varied with reference to the time at which the gentle introduction of inerting vapor is stopped. No attempt has been made to define the amount of carbon dioxide vapor that is introduced into the spaces through the high velocity jet-producing nozzles 13 to effect thorough mixing of the air and the inerting vapor because the amount is so inconsequential that it has no appreciable effect on the inerting operation. A very few seconds of discharge through the low volume, high velocity nozzles 13 accomplishes all the mixing that is de-

sired. Three examples of such variations will be given as follows:

A. The gentle or low velocity introduction of inerting vapor may be carried out to the point at which the proper amount of vapor has been introduced and then the gentle introduction of inerting vapor may be stopped and the high velocity mixing jet started. This type of timed relationship between the introduction of inerting vapor and the introduction of the mixing vapor may be carried out with the apparatus illustrated in Fig. 1 and Fig. 2. It cannot be performed with the apparatus of Fig. 3 because the delivery of carbon dioxide at a high velocity through the nozzle 13 cannot be effected unless carbon dioxide is being introduced by the nozzle 26.

B. A second timed relationship can be provided by effecting the gentle introduction of the inerting vapor until almost the desired amount has been introduced; then starting the introduction of the mixing vapor as a high velocity jet through the nozzle 13; then stopping the gentle introduction of the inerting vapor after the desired amount of said vapor has been introduced and while the high velocity mixing discharge continues; and finally stopping the high velocity discharge at any desired time interval after the gentle introduction of inerting vapor has been stopped. This procedure, or discharge relationship, can be provided with the apparatus of Figs. 1 and 2 while it cannot be provided with the apparatus of Fig. 3.

C. A third discharge relationship can consist of carrying on the gentle release of the inerting vapor until the major portion of the desired amount has been introduced; then start the high velocity discharge of the mixing vapor; and simultaneously stopping all introduction of vapor to the space after the desired amount of inerting vapor has been introduced through the first discharge nozzle. This is the only type of discharge that can be accomplished with the apparatus of Fig. 3. However, it readily can be accomplished with the apparatus of Fig. 2 because of the provision of the master control valve 24. It, also, can be carried out with the apparatus of Fig. 1 by proper manipulation of the two valves 12 and 15.

It is to be understood that I do not desire to be limited to the exact order of method steps as they have been disclosed, for variations and modifications of the same, which fall within the scope of the accompanying claims, are contemplated.

Having thus described the invention, I claim:

1. A method of uniformly inerting to a desired percentage of concentration the entire interior of an enclosed space having one or more vent openings in its upper regions, comprising producing a layer of substantially pure inerting vapor at the bottom of said enclosed space by gently introducing an amount of inerting vapor sufficient to provide for the desired percentage of final concentration to the bottom portion of the enclosed space with a minimum of turbulence, the remaining upper portion of the space being filled with the air that has not been displaced by the creation of said layer of the vapor, and after at least the major portion of the layer of inerting vapor has been produced starting a forceful agitation to thoroughly mix all of the remaining air and the layer of vapor to provide a uniform concentration at the percentage desired throughout the entire interior of the space.

2. A method of uniformly inerting to a desired percentage of concentration the entire interior of an enclosed space having one or more vent openings in its upper region, comprising producing a layer of substantially pure inerting vapor at the bottom of said enclosed space by gently introducing an amount of inerting vapor sufficient to provide for the desired percentage of final concentration to the bottom portion of the enclosed space, the remaining upper portion of the space being filled with the air that has not been displaced, and after at least the major portion of the layer of inerting vapor has been produced starting the introduction of additional vapor as a high velocity jet to thoroughly mix all of the remaining air and the layer of vapor to provide a uniform concentration at the percentage desired throughout the entire interior of the space.

3. A method of uniformly inerting to a desired percentage of concentration the entire interior of an enclosed space having one or more vent openings in its upper region, comprising producing a layer of substantially pure inerting vapor at the bottom of said enclosed space by gently introducing an amount of inerting vapor sufficient to provide for the desired percentage of final concentration to the bottom portion of the enclosed space, the remaining upper portion of the space being filled with the air that has not been displaced, and after the major portion of the layer of inerting vapor has been produced starting the introduction of additional vapor as a high velocity jet to thoroughly mix the remaining air and the layer of vapor to provide a uniform concentration at the percentage desired throughout the entire interior of the space, and after the remaining portion of the inerting vapor has been introduced simultaneously stopping the introduction of all vapor to the space.

4. A method of uniformly inerting to a desired percentage of concentration the entire interior of an enclosed space having one or more vent openings in its upper region, comprising producing a layer of substantially pure inerting vapor at the bottom of said enclosed space by gently introducing an amount of inerting vapor sufficient to provide for the desired percentage of final concentration to the bottom portion of the enclosed space, the remaining upper portion of the space being filled with the air that has not been displaced, and after the major portion of the layer of inerting vapor has been produced starting the introduction of additional vapor as a high velocity jet to thoroughly mix the remaining air and the layer of vapor, after the remaining portion of the inerting vapor has been introduced stopping the gentle introduction of the inerting vapor, and continuing the introduction of vapor as a high velocity jet until all of the remaining air and all of the gently introduced vapor have been thoroughly mixed throughout the entire interior of the space to provide a uniform concentration at the percentage desired.

CHARLES A. GETZ.

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