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COMPOSITION OF MATTER COMPRISING A LIQUEFIED GAS.

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To all whom it may concern:

Be it known that I, PIERRE E. HAYNES, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Composition of Matter Comprising a Liquefied Gas, of which the following is a specification.

It has already been proposed to use as an explosive, a mixture of a combustible compound with a highly volatile liquid oxidizing agent, such as liquid oxygen or liquid ozone. Such a mixture is claimed in United States Patent 1,282,229. I have now found that excellent explosives may be made by supplying a part or all of the combustible material in the above combination as a liquid having a volatility of the same order as the liquid oxidizing agents mentioned. Examples of combustible liquids which can be used in this way are the very low-boiling paraffin hydrocarbons, such as methane, ethane, and propane, and the olefine hydrocarbons, such as ethylene and propylene.

A charge of such a mixture may be exploded by merely igniting the gas mixture surrounding it, since both the combustible and oxidizing constituents volatilize and an ignitible mixture is thus formed. If the charge consists solely of these highly volatile liquids, it will usually be necessary to insulate the charge to prevent absorption of heat and premature evaporation of the liquids. By the use of an absorbent for the liquids, evaporation is delayed. The absorbent material may be oxidizing or combustible in nature, or it may be inert, but I prefer to use a highly absorbent carbonaceous material such as that obtained by charring the pithy wood of trees and bushes of the ochroma (balsa) or sola groups. Charcoal from other sources may, of course, be used. Even when an absorbent is used, heat-insulation may be desirable under some conditions. Other explosives or other oxidizing or combustible substances may be added to the volatile liquids mentioned to modify the qualities of the explosives formed and inert materials may of course, be added also. When more than one oxidizing or reducing ingredient is employed, due regard must be given to the proper balance between oxidizing and reducing constituents, and to the effect on this balance of the loss by evaporation of a portion of one or more of the constituents between the time of preparing the charge and the time of firing it.

The combination of liquefied gaseous combustible and oxidizing agents with an absorbent, gives particularly favorable results. If a mixture of oxygen and methane in liquid form and without any absorbent, is employed for blasting or other explosive operations, the oxygen, being considerably more volatile than the methane, will evaporate from the charge much more rapidly than the methane, so that the proportion between the oxidizing and combustible ingredients will undergo a continued and rapid change. For this reason, the ratio of the ingredients which gives an explosion of maximum intensity will only exist for a short period of time. If liquid oxygen is absorbed in a carbonaceous absorbent, methane being omitted and the absorbent material supplying the combustible ingredient of the explosive, a similar variation in the ratio of oxidizer to combustible takes place. The evaporation of the oxygen is delayed by the presence of the absorbent but this advantage is in a measure discounted by the fact that the combustible ingredient of the mixture is non-volatile. If, however, a mixture of oxygen and methane is taken up in an absorbent material, the rates of evaporation of the liquefied gases are very favorably affected. The liquid is then contained in an exceedingly large number of minute bodies of liquid with heat-insulating walls between. Under these conditions, the evaporation of the liquid constituents of the cartridge may take place in such a way that the ratio between the quantities present remains substantially unchanged. Because of the fact that the porous absorbent practically prevents transfer of heat by radiation and convection, evaporation of the liquid contents of the successive superposed layers of cells is progressive rather than simultaneous, and all the methane in a given layer of cells may be volatilized before there is any substantial evaporation of oxygen from the layers of cells just inside the given layer. The effect is, therefore, the same as if the liquefied gases could be made to form a constant boiling mixture of any desired composition. When the absorbent used in the above example is itself a part of the combustible ingredient of the explosive, for example, when it is carbonaceous in composition,

there will obviously be a change in the ratio of oxidizer to combustible brought about by evaporation, in spite of the preservation of the balance between oxygen and methane. Since however, the absorbent constitutes only a portion of the combustible, the ratio of oxidizer to total combustible, will not vary nearly so rapidly as when the absorbent constitutes the entire combustible ingredient, as in a charcoal-oxygen cartridge. From the above it will appear that a cartridge containing liquefied oxidizing and reducing gases and an absorbent will, under suitable conditions, produce an explosion of acceptable intensity over a longer period than would be the case if either the absorbent or the liquefied combustible gas were omitted.

Liquid combustible materials of the kind herein referred to, are in most instances specifically lighter than and immiscible with liquid oxygen and liquid ozone, so that the combustible ingredient of the explosive mixture has a tendency to float on the oxidizing constituents as oil floats on water. By agitating the liquids together, a sufficiently stable emulsion can be formed however, and this emulsion can be used alone as an explosive or can be absorbed in or otherwise mixed with other substances. An emulsion of substantially immiscible liquefied gases with or without a combustible or other absorbent is included in my invention, not only in its specific application to the manufacture of explosives but as a new composition of matter.

I am aware that it is not broadly new to use liquid combustible substances in the preparation of explosive charges. The liquid combustibles contemplated in my invention are substances of great volatility boiling below the centigrade zero under atmospheric pressure. My invention is not limited to any of the specific substances or mixtures recited herein, but is defined by the appended claims.

I claim:

1. An explosive mixture comprising an oxidizing agent, and a combustible liquid boiling below the centigrade zero.

2. An explosive mixture comprising an oxidizing agent, and a liquid hydrocarbon having a boiling point below the centigrade zero.

3. An explosive mixture comprising an oxidizing agent, and liquid methane.

4. An explosive mixture comprising an oxidizing liquid, and a liquid hydrocarbon, both of said liquids boiling below the centigrade zero.

5. An explosive mixture comprising liquid methane and an oxidizing liquid boiling below the centigrade zero.

6. An explosive mixture comprising liquid methane and liquid ozone.

7. A composition of matter comprising an emulsion of substantially immiscible liquefied gases.

8. A composition of matter comprising a liquefied gaseous hydrocarbon, emulsified with another substantially immiscible liquefied gas.

9. A composition of matter comprising an emulsion of substantially immiscible liquefied gases and an absorbent.

10. A composition of matter comprising an emulsion of substantially immiscible liquefied gases and a combustible absorbent.

11. An explosive mixture comprising a combustible liquid boiling below the centigrade zero, an absorbent therefor, and an oxidizing agent.

12. An explosive mixture comprising a liquid hydrocarbon boiling below the centigrade zero, an absorbent therefor, and an oxidizing agent.

13. An explosive mixture comprising liquid methane, an absorbent therefor, and an oxidizing agent.

14. An explosive mixture comprising a liquid hydrocarbon boiling below the centigrade zero, a carbonaceous absorbent therefor, and an oxidizing agent.

15. An explosive mixture comprising a liquid hydrocarbon boiling below the centigrade zero, charcoal, and an oxidizing agent.

16. An explosive mixture comprising a liquid hydrocarbon and a liquid oxidizing agent, both boiling below the centigrade zero, and an absorbent.

17. An explosive mixture comprising a liquid hydrocarbon and a liquid oxidizing agent, both boiling below the centigrade zero, and charcoal.

18. An explosive mixture comprising an emulsion of a combustible liquid and a liquid oxidizing agent.

19. An explosive mixture comprising a liquid hydrocarbon and liquid ozone.

20. An explosive mixture comprising a liquid hydrocarbon, liquid ozone, and an absorbent.

21. An explosive mixture comprising a liquid hydrocarbon, liquid ozone, and charcoal.

In testimony whereof, I affix my signature.

PIERRE E. HAYNES.