

Oct. 6, 1942.

N. M. HOPKINS

2,298,255

LIQUID EXPLOSIVE

Filed May 8, 1939

2 Sheets-Sheet 1

Fig. 1

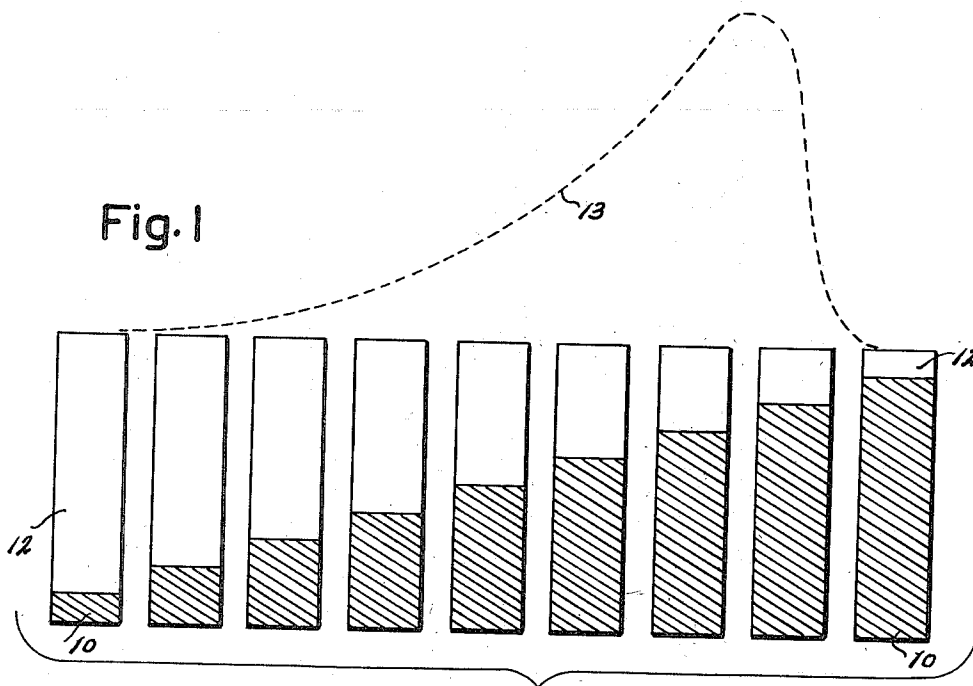


Fig. 4

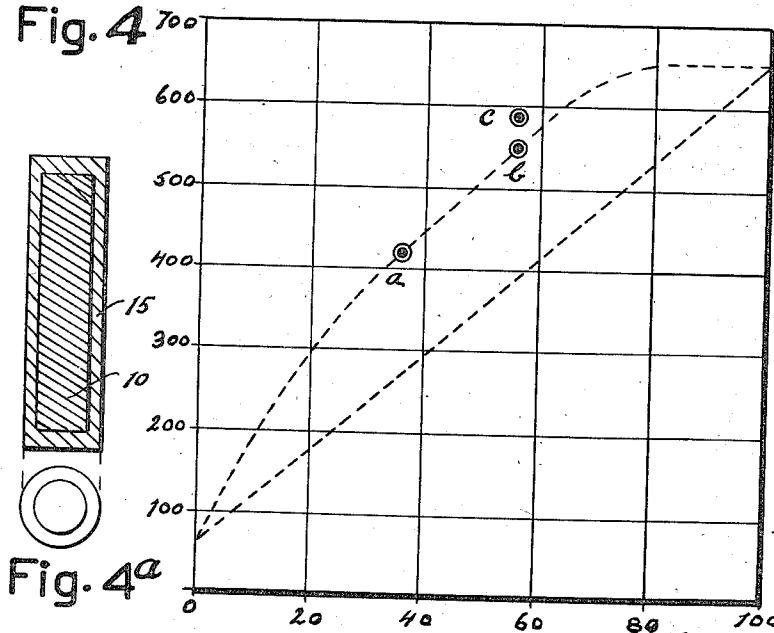


Fig. 3

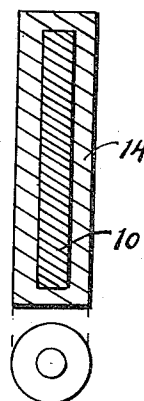


Fig. 3a

Fig. 2

Nevil Monro Hopkins
INVENTOR

Oct. 6, 1942.

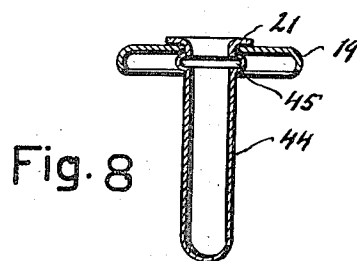
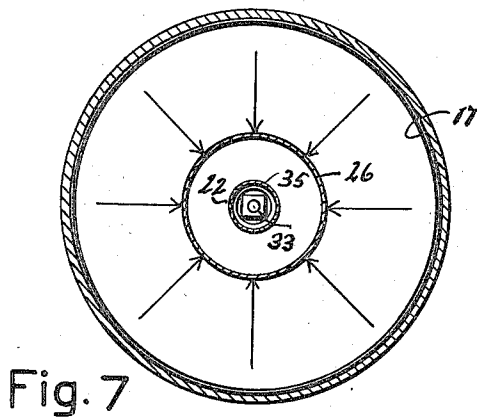
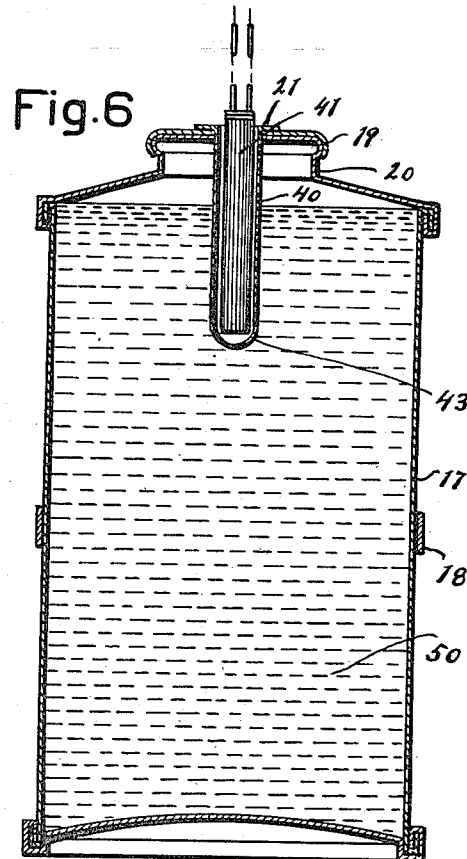
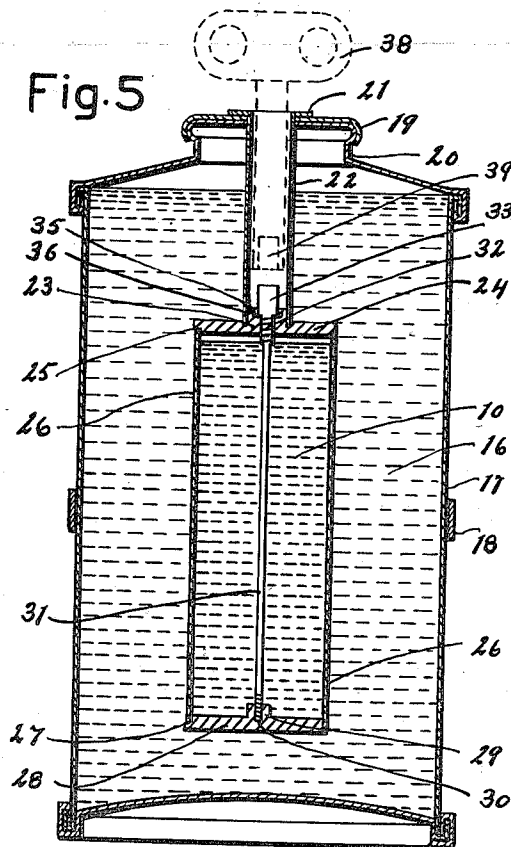
N. M. HOPKINS

2,298,255

LIQUID EXPLOSIVE

Filed May 8, 1939

2 Sheets-Sheet 2



INVENTOR

David Monroe Hopkins

UNITED STATES PATENT OFFICE

2,298,255

LIQUID EXPLOSIVE

Nevil Monroe Hopkins, New York, N. Y.

Application May 8, 1939, Serial No. 272,434

5 Claims. (Cl. 52—1)

This invention relates to new developments in liquid explosives, comprising mixtures of certain liquids, or the solutions of certain liquids in liquids, and in ways, means and methods of producing, storing the liquid explosives or their component parts, and in using them safely and economically in industry and war.

It is an object of this invention to produce new liquid explosive mixtures, or mutual solutions of liquids in liquids which can be made according to my new teachings, more or less sensitive to shock, or more or less powerful in the release of energy, with a greater or less rate of detonation, when struck a suitable blow.

It is an object of this invention therefore to produce new graded liquid explosives, each grade depending upon the character of the liquids in the mixture or mutual solution of the liquids, and each being especially adapted by virtue of its sensitivity to shock and rough handling, detonation velocity and release of energy, to any particular purpose.

It is a particular object of this invention to mix with or mutually dissolve with a liquid gas, as a common source of oxygen, such as liquid nitrogen peroxide, of one or more combustible bodies, such as benzene, certain controllable grades of gasoline, mono-nitrobenzene, mono-nitrobenzene in which some di-nitrobenzene has been dissolved, or carbon di-sulphide, or carbon di-sulphide in which some white phosphorus has been dissolved, for example.

It is also an important object of this invention to mix or mutually dissolve the component parts of the liquid explosive, or the component parts of a comparatively low-powered liquid explosive with an isolated component part, adapted and adjusted to make the comparatively low-powered explosive a comparatively high powered explosive.

It is also an object of this invention in certain classes of work, to mix at the proper time, with a common liquid source of oxygen, liquid nitrogen peroxide, for example, one or more suitable solid and preferably finely divided solid combustible bodies, carbon or sulphur, for example.

It is a particular object of this invention, to provide ways, means and method for using the several grades and types of the new liquid explosives outlined, in containers for industrial blasting operations, for military demolition work, as well as in artillery shells, not only for general use, when properly heat treated in view of the fragmentation requirements and the faster rate of detonation of some grades of my explosive, but for such specific duty as anti-aircraft and armor piercing shells, respectively, drop-bombs, naval depth-bombs, submarine mines, and war heads of torpedoes.

It is also a particular object of this invention

to produce new liquid explosives and containers therefor, capable of meeting the requirements of a service, where the solid explosives developed, are too expensive or which regardless of cost, fail upon one or more counts.

In order to adequately introduce this subject, setting forth thereby the need for the new products proposed, a brief résumé of the characteristics of one liquid and nine solid explosives is given, and applicant's reasons wherein they all fail in connection with industrial and military use.

Nitroglycerine is too sensitive to shock and therefore too dangerous, and moreover it has too great a shattering power for some purposes, and freezes at 13.1° C. or the comparatively high temperature of 55.5° F.

Dynamite is also too sensitive to shock and likewise too dangerous for most industrial purposes, and is not favored for any military purposes, including bombs for demolition work, not only because it is easily frozen, because of the nitroglycerine content, but is readily detonated by the impact of a rifle bullet, and moreover the safe storage period for dynamite is limited.

Ammonium nitrate dynamite, which is manufactured under a number of formulas and trade names, contains usually from 20 to 30 per cent nitroglycerine. It is quite hygroscopic, and is too dangerous for most purposes, especially military demolition work, as it is also detonated by the impact of a rifle bullet or flying shell fragment.

Ammonal is another ammonium nitrate explosive, very hygroscopic and lacks proper shattering power for many purposes.

Ammonium picrate is far too insensitive for blasting and military demolition work, requiring expensive high shock booster detonation to set it off.

Blasting gelatin is made according to a variety of formulas. It occasions very severe headaches when it comes into contact with the hands of the human body, and is again too sensitive to shock for many purposes.

Picric acid is an ill and uncertain explosive. It becomes wet and is set off when in this condition with great difficulty. It is crumbly and porous, and not only stains the skin and clothing, but it forms dangerously sensitive salts when in contact with certain metals.

Gun cotton has to be kept wet to prevent it from undergoing chemical change and in becoming too sensitive. When it is wet it requires dry gun cotton, or an equivalent high power booster to cause its detonation.

Nitrostarch, recently developed for demolition purposes, by the military engineers, is not very stable and accelerated stability tests as well as long periods of storage have not shown it to be wholly reliable. It is quite hygroscopic and not very effective in producing induced detonation.

T.N.T. is far too expensive for industrial blasting and in addition requires a high power booster detonator to set it off. It has been standardized practically the world over for military and naval purposes, but is dependent upon toluene, a commodity which may become very difficult to procure in large enough quantities during a prolonged major war.

It is an object of this invention, therefore, to produce a liquid explosive, one either completely mixed, or scientifically blended, to be completely mixed, to meet and fully satisfy conditions where all of the foregoing explosives fail.

It is now specifically desired to point out and particularly emphasize the important new fact that whereas all of the foregoing explosives are mere mechanical mixtures, more or less interspaced, of solid complete explosive bodies, or of solid complete explosive bodies with a complete liquid explosive body, as in the case of nitroglycerine mixtures, on the one hand, and that all of the applicant's mixtures of liquids are not only mutual solutions which are perfectly interspersed, but mutual solutions of substances which in themselves are not explosive bodies.

Referring to the accompanying diagrams forming a part of this specification in which like numerals designate like parts in all the views.

Figure 1 represents a series of nine mixtures, or mutual solutions of liquid nitrogen peroxide and benzene, with sensitivity and substantial power curve, for these particular substances.

Figure 2 is a diagram showing the vapor pressures of mixtures or the mutual solutions of liquid nitrogen peroxide and benzene.

Figures 3 and 3a show a certain theoretical or practical distribution of volumes of liquid nitrogen peroxide and benzene.

Figures 4 and 4a show a different quantitative distribution of these substances.

Figure 5 is a sectional view through one design of one of my high explosive producing canisters for industrial blasting.

Figure 6 is a sectional view through one design of one of my comparatively insensitive and comparatively low power explosive canisters and filler therefor.

Figure 7 is a transverse view in partial section of Figure 5, showing vapor pressure of adjusted explosive mixture.

Figure 8 is a detail of one design of detonator well and cap for cannister.

Figure 1 illustrates nine volumes, of nine different mixtures, or mutual solutions of liquid nitrogen peroxide and benzene, where 10 is the liquid nitrogen peroxide and 12 is the benzene. These nine volumes, as illustrated diagrammatically, may be practically nine glass vials, equipped with ground-in glass stoppers and set in position either through the agency of collodion cement, or a solution of sodium hydroxide.

In the case of actual practical mixtures or mutual solutions of the liquid nitrogen peroxide and benzene, we have at laboratory temperature, a series of amber colored liquids, ranging in color from a light yellow to a deep yellow, the depth of the color increasing as the percentage of the liquid nitrogen peroxide increases. In this illustration, which is taken from one of my elaborate series of experiments, the dotted line 13 shows substantially the practical experimental results obtained with my new combined impact and friction tests to prove my theory in relative sensitivity of such graded mixtures or mutual solution of mixtures as I am dealing with.

Here it may be clearly seen that the most sensitive combination of the substances in this particular test, comprising combined impact and friction, is between 70 and 80 per cent. of the liquid nitrogen peroxide to the benzene.

These combined impact and friction tests comprising the hermetic sealing of liquid explosive mixtures will be fully described later, herein.

Figure 2 is a diagram, also based upon applicant's experimental work, wherein the small figures at the left ranging from 100 to 700 are millimeters of mercury, and the small figures below are percentages of liquid nitrogen peroxide to benzene, and *a*, *b* and *c* are the respective vapor pressures of these percentages of liquid nitrogen peroxide and benzene at a temperature of 80° F.

Thus it may be seen that the vapor pressure of a mixture, or mutual solution of liquid nitrogen peroxide and benzene, consisting of substantially 30 per cent. liquid nitrogen peroxide, exerts a vapor pressure of substantially 400 millimeters of mercury at 80° F., and that a mixture, or mutual solution of these liquids consisting of substantially 50 per cent. liquid nitrogen peroxide exerts a vapor pressure of substantially 550 millimeters of mercury at 80° F. Here *c* is the result of another experimental determination, where a vapor pressure of 590 was secured with these substances, and represents merely the margin of experimental error.

In general, however, it will be observed that mixtures or mutual solutions of liquid nitrogen peroxide and benzene, in the matter of their vapor pressures, are comparatively low and follow approximately a straight line.

In Figure 3, 10 represents, as in Figure 1, a volume of liquid nitrogen peroxide and 14 may be first considered to be an isolated mixture of liquid nitrogen peroxide and benzene, said isolated mixture being less sensitive to shock or impact than after the addition of the volume of liquid nitrogen peroxide. This diagram would represent therefore a design of bi-compartment container, fashioned to add the liquid 10 to the liquid 14 at a time it was desired to detonate.

In Figure 4, 10 represents a volume of liquid nitrogen peroxide, and 15 an isolated mixture of liquid nitrogen peroxide and benzene, the said isolated mixture being far less sensitive to shock or impact, than after the addition of the volume of the liquid nitrogen peroxide 10.

In other words the liquid explosive mixture 15 would stand unusual rough usage, as compared with that suggested in Figure 3.

Figures 2 and 3 are given to illustrate that I may elect to make what I have termed "complete" mixtures from "incomplete" mixtures prior to use.

I have learned in my more recent work, that I can still theoretically and in some cases practically improve my system of making "complete" mixtures from "incomplete" mixtures, by having the mutual solution of liquid nitrogen peroxide and benzene well freed of moisture, and of allowing a certain moisture content to the volume of liquid nitrogen peroxide to be added to complete the explosive. The moisture thus acts as an added catalyser when needed. In this connection I also propose to isolate with the liquid gas, as catalyzing agents such substances as aniline, iodine, iron carbonyl or tetraethyl lead, for example.

Figure 5 illustrates in some detail one design of one of my metal canisters for practically

taking full advantage of my system of using one or more explosive mixtures in connection with liquid nitrogen peroxide or liquid nitrogen peroxide containing a catalyzing agent or a freezing point depressant.

Here 10 is the liquid nitrogen peroxide and 16 a mixture or mutual solution of pure liquid nitrogen peroxide and benzene, one that will withstand ordinary rough usage without detonation. In this illustration 17 is a sheet metal can, of iron, tinned iron or aluminum, for example, designed and constructed to withstand internal pressures of my graded explosive mixtures at all temperatures likely to be met with in storage, and 18 is a suitable reinforcing band. 19 is a crown cap, or a screw cap, likewise of iron, tinned iron or aluminum, fashioned to be applied to the neck member 20 of the can with a liquid and gas tight fit, and 21 is an end of a tubular member 22, passing through an opening in the cap member 19 and made a liquid and gas tight combination therewith by soldering, for example. 23 is a boss member of the cover member 24, said boss member fitting snugly into an end of the tubular member 22 and attached by screw threads, (not shown), or by soldering, for example. 25 is a flange fashioned to receive with a ground liquid and gas tight fit, an end of the tubular member 26, and 27 is a like flange member, in the closure member 28, also fashioned to receive with a ground, liquid and gas tight fit, an end of the tubular member 26, the closure member 28 comprising the boss member 29, bored and threaded with a right hand thread to receive the threaded end 30 of the tension rod 31, and threaded with a left hand thread at the enlarged end of the tension rod 32 terminating in the square shank member 33, free to revolve in a countersink 35, but with a shoulder 36 ground into the recess and adapted to make a liquid and gas tight fit with the interior of the boss member 25. Thus it will be seen that the tubular member 26 may be filled with the liquid nitrogen peroxide 10, and through the agency of the closure members 24 and 28, and the right and left hand threads, respectively, upon the rod member 31, be locked hermetically within the interior of the tubular member 26.

A key 38 shown in dotted lines has a square recess 39 for the reception of the square end 33 of the rod member 31, and it will be seen that a few turns of this key will not only assist the liquid nitrogen peroxide 10 in forcing open the chamber enclosing it, but lift the square end 32 from its gland seat and if the key is turned a sufficient number of times, the ejection of the end closure member 28 is effected and admixture of the liquid nitrogen peroxide 10 with the mixture or mutual solution of the liquid nitrogen peroxide and benzene 16 takes place, and if the key is still further turned, the rod member 31 will be removable through the tubular member 22 and in consequence there will be a vent therein for the vapor of the liquid nitrogen peroxide to escape in due time, and thereby render the entire contents of the cannister harmless.

With the removal of the key therefor, after repeated turning, the cannister and high explosive filler must be used promptly in warm weather, or else the liquid gas will distill away. In cold weather it will also become a "dud" but naturally only after a longer period of time.

Applicant's combined impact and friction tests

As previously stated, the curve or dotted line of

Figure 1 is based upon new experimental technique, made necessary in testing liquid explosives, where the component liquids have different boiling points.

The conventional weight drop, or impact machine, universally employed in testing the sensitivity of solid explosives upon an anvil, and under the plunger member of which a small quantity of the solid explosive is placed, was not deemed at all suitable for the new mutual solutions of liquids, liquid nitrogen peroxide and benzene, for example, because in such minutely small quantities used unprotected upon the anvil, a slight delay in making the test of any liquid sample, would allow time for evaporation to take place, and since the boiling point of liquid nitrogen peroxide is much lower than the boiling point of benzene, the mixture or mutual solution of these consolute liquids would be undergoing continuously a percentage change in composition.

Likewise, the standard pendulum friction test machine would be unsuitable, and since applicant visualized possible new and valuable achievements in scientifically measuring sensitivity and basing liquid explosive factors thereon, he devised new ways, means and methods of not only combining the desired impact and friction tests, but in preventing the differential evaporation factor, and also in working with larger quantities of explosives than heretofore possible with the standard design of impact machine.

For the purpose of laying the important foundation of a new system of grading liquid explosive mixtures in general, a mixture or mutual solution of liquid nitrogen peroxide and benzene were first taken.

For this purpose, liquid nitrogen peroxide was prepared, using the method of acting upon arsenous oxide with strong nitric acid. The nitrogen peroxide was not dried over phosphorous pentoxide and therefore contained traces of moisture.

The benzol was of tested purity and dehydrated.

To insure high accuracy, the various percentage mixtures or mutual solutions of the liquid nitrogen peroxide and benzene ranging from 10% to 90% of the liquid gas by volume to the benzene, were made up in large and consequently easily measured quantities at low temperature to reduce to a minimum differential evaporative errors, and samples were taken and transferred by chilled pipette to chilled $\frac{1}{16}$ c. c. glass stoppered vials, and the stoppers were put in place and attached with collodion cement to prevent blowing when the tubes and contents were allowed to come to laboratory temperature.

The character and the hardness of the particular glass, of which the little vials were made, is a matter of standardization and of record.

Each sealed sample was laid upon its side upon a steel anvil consisting of a stack of five steel plates, each $\frac{5}{8}$ inch thick and 9 inches square, all resting upon a cast Portland cement block 15 inches thick and 16 inches square. A ten pound steel weight made of cold rolled steel shafting, 10 $\frac{1}{8}$ inches long and 2 inches in diameter, was fitted with a suspension eye and used as the impact weight. There was no plunger member used between steel weight and steel anvil, as in the case of the standard design of machine.

A galvanized iron pipe 8 feet 7 $\frac{1}{2}$ inches long and 2 $\frac{1}{2}$ inches in diameter, was employed in a true vertical position to serve as a guideway for

the freely falling 10 pound weight. A steel drum was placed around the anvil and lower end of the galvanized iron pipe as a protective screen and all tests were made at a temperature of 78° F.

Applicant is tabulating below the remarkably clear-cut results obtained in full support of his previously advanced conception, making for the first time, in what is believed to be in a reliable manner, new graded liquid explosives using a liquid gas and capable of supplying oxygen, as a common oxidant to one or more combustible bodies.

Tabulation

1. 7½ foot drop, 10% N₂O₄— No detonation
2. 7½ foot drop, 20% N₂O₄— No detonation
3. 7½ foot drop, 30% N₂O₄— No detonation
4. 7½ foot drop, 40% N₂O₄— No detonation
5. 7½ foot drop, 50% N₂O₄— No detonation
6. 7½ foot drop, 60% N₂O₄— No detonation
7. 7½ foot drop, 65% N₂O₄— Sharp detonation
8. 7½ foot drop, 70% N₂O₄— Sharp detonation
9. 7½ foot drop, 80% N₂O₄— Sharp detonation
10. 7½ foot drop, 90% N₂O₄— No detonation

Thus it will be seen that from 65% to 80% by volume of N₂O₄ when mixed with benzene, produces detonation, and that 65% by volume is very close to the lower critical limit, and that 80% by volume is very close to the upper critical limit.

Lower and upper critical limit

With the proven existence in a soundly practical manner, that there exists not only a clearly defined lower critical limit, but an equally clearly defined upper critical limit, applicant is enabled to extend the practical field of usefulness of his liquid explosives, because of the following vitally important point.

In a number of my containers, or high explosive producing devices and liquid component parts therefor, such as the blasting canister herein described, I add to a mixture of liquid nitrogen peroxide and one or more combustible bodies adjusted to remain fluid at low temperatures, a volume of liquid nitrogen peroxide prior to actual use.

Now liquid nitrogen peroxide has a freezing point of -10° C. or 14° F. (water freezing at 32° F.) and therefore the freezing of the liquid nitrogen peroxide, under certain conditions of use where the temperature falls to the above, would result.

Since with my upper critical limit, I have a safe margin or insensibility to combined impact and friction, I may elect to add a liquid hydrocarbon, some pentane for example, or a mass of soluble solid, naphthalene for example, to the liquid nitrogen peroxide, and thereby depress the freezing point to a marked degree.

When this is done, I naturally elect to remove a comparable value of liquid or solid combustible substance from the cooperative high explosive forming mixture.

This design is based also upon the experimental fact, that every soluble substance, solid or liquid lowers the freezing point of the liquid in which it is dissolved. The substances chosen for addition to the liquid nitrogen peroxide, are selected with a view of maximum freezing point depression, a matter which is a factor of molecular weight.

Graded liquid explosives

Whereas applicant has emphasized combinations of liquid nitrogen peroxide and benzene and

nitro-benzene, respectively, in connection with his commercial blasting and/or military demolition canisters herein illustrated and described, he considers that he has but indicated within the range of a naturally limited patent specification wider possibilities, using such substances also as heavy oils, turpentine, greases and fats, with or without admixture with light hydrocarbons.

An explosive which may be ideal for one class of work may be lacking in characteristics for another class of work. For example, in metal mining for iron, copper, zinc, gold and silver, applicant can adjust to a nicety in a manner heretofore impossible, to supply the proper safety, rate and power of the release of energy, for any particular climate, and in a water-proof package.

For faster rates of detonation, for rock and boulder blasting, oil-well "shooting" and the like, where the greatest shattering force is desired, applicant can meet with equal safety every requirement, by using the canister, illustrated in Figure 5, as well as for the slower rates of detonation and release of energy for agricultural purposes, stumping, ditching, swamp and soil blasting, where naturally lower velocities of energy release are desired.

For this purpose, such a canister as illustrated in Figure 6 is recommended. In either case, the hermetically sealed liquid explosive or the component parts for the liquid explosive are within a water-proof container, a most important point.

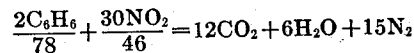
In military demolition work, applicant adjusts always for sensitivity below metal jacketed, high velocity bullet impact, because of the ever-present danger from stray shots from rifles, machine guns and artillery in time of war.

In practice applicant finds that substantially 2.18 volumes of the liquid gas to 1 volume of benzene give the most effective high shattering results, using standard Trauzl lead blocks, and substantially 70% liquid gas to benzene according to applicant's combined impact and friction test.

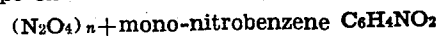
In one series of standard Trauzl lead blocks, the expanded cavities therein measured for 7 grams of the mixture 468, 479, 481, 477 cubic centimeters, averaging 476 cubic centimeters, which is about 55% better than 10 grams of T. N. T.

Theoretical thermodynamical calculations call for a larger volume of the liquid gas in its relationship to benzene than practical results indicate.

Upon detonation, the products of this admixture are N + CO₂ + H₂O probably according to the following equation:



The next simplest case is probably liquid nitrogen peroxide with mono-nitrobenzene

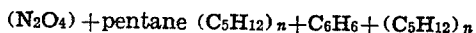


Since the mono-nitrobenzene already carries a NO₂ radical, manifestly it will require less of the liquid nitrogen peroxide to complete the reaction

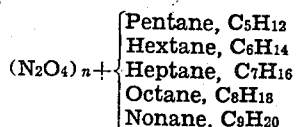
Where I have an "incomplete" mixture such as contained for example in the outer shell 11 of the canister illustrated in Figure 5 and desire to make it "complete" by the addition of an extra volume of liquid nitrogen peroxide, such as contained in the inner chamber 26 of this canister, I add to this isolated liquid gas to prevent it from freezing a small volume of pentane, for example.

This it will now be appreciated, is possible up to 10% in view of the "upper critical limit" of sensitivity without producing an explosive. With a suitable volume of pentane therefore, added to both liquid components of the liquid explosive, I am enabled to produce a low temperature non-freezing system.

In my practical formulas therefore for cold weather use, I may write the formulas thus:



For graded power in release of energy applicant is working very successfully with mixtures of hydrocarbons, the plan being indicated by the following:



The higher the carbon content in the molecule, the more powerful the explosive, when properly supplied with the requisite quantity of the liquid nitrogen peroxide.

Using a mixture of one or more of these hydrocarbons with carbon disulphide, a still wider range of possibilities for adjusting sensitivity rate of detonation and release of energy are possible.

It will be observed in the opening page of this specification that applicant mentions the possible solution of some white phosphorus in carbon di-sulphide as one of the combustible constituents of an explosive mixture where liquid nitrogen peroxide serves as the common donor of oxygen. When this combustible body, namely white phosphorus, is used in one of the mixtures in an explosive for an anti-aircraft artillery shell for example, its white phosphoric oxide enables the gunners to observe the location of the burst. In addition to the foregoing combustible bodies, applicant is also working with certain heavy oils, turpentine, greases and fats, with or without the admixture of a light hydro-carbon. These bodies give us a wide choice for modifying liquid explosive mixtures in all of their characteristics, namely detonation velocity, release of energy, and sensitiveness.

Whereas the applicant has illustrated by diagram and formula, and has described his novel methods, as well as novel ways and means of producing, testing and using certain liquid explosives, complete and incomplete, respectively, it is possible that those skilled in the arts and sciences involved, may further vary the methods, ways and means, as well as to develop new applications, possibly in the line of propellants, without departing from the spirit of this invention, and it is therefore not desired to be limited to the foregoing disclosure and teachings except as may be called for in the claims.

Having described my invention, I claim:

1. A hermetically sealed bi-compartment high explosive producing device, comprising one closed chamber containing a mixture of ingredients comprising a liquid combustible body and nitrogen peroxide, said ingredients being in such proportions to each other as to produce a relatively insensitive and low powered explosive; a second closed chamber containing the requisite amount of one of said ingredients which, when added to said mixture, will change the said proportions to produce a relatively sensitive and high powered

explosive mixture; and chamber opening means for causing the liquid of one chamber to mix with the liquid of the other chamber to obtain such change of proportions.

2. A hermetically sealed bi-compartment high explosive producing device, comprising one closed chamber containing a mixture of ingredients comprising a liquid combustible body and nitrogen peroxide, said ingredients being in such proportions to each other as to produce a relatively insensitive and low powered explosive; a second closed chamber containing the requisite amount of one of said ingredients which, when added to said mixture, will change the said proportions to 65-80% of nitrogen peroxide to 35-20% of the combustion body to produce a relatively sensitive and high powered explosive mixture; and chamber opening means for causing the liquid of one chamber to mix with the liquid of the other chamber to obtain such change of proportions.

3. A hermetically sealed bi-compartment high explosive producing device comprising one closed chamber containing a mixture of ingredients comprising a liquid combustible body and nitrogen peroxide, said ingredients being in such proportions to each other as to produce a relatively insensitive and low powered explosive; a second closed chamber containing the requisite amount of one of said ingredients which, when added to said mixture, will change the said proportions to substantially 2.18 volumes of nitrogen peroxide to 1.0 volume of the combustible body to produce a relatively sensitive and high powered explosive mixture; and chamber opening means for causing the liquid of one chamber to mix with the liquid of the other chamber to obtain such change of proportions.

4. A hermetically sealed bi-compartment high explosive producing device, comprising one closed chamber containing a mixture of ingredients comprising a liquid combustible body and nitrogen peroxide, said ingredients being in such proportions to each other as to produce a relatively insensitive and low powered explosive; a second closed chamber containing the requisite amount of one of said ingredients which, when added to said mixture, will change the said proportions to substantially 70% of nitrogen peroxide to 30% of the combustible body to produce a relatively sensitive and high powered explosive mixture; and chamber opening means for causing the liquid of one chamber to mix with the liquid of the other chamber to obtain such change of proportions.

5. A hermetically sealed bi-compartment high explosive producing device, comprising one closed chamber containing a mixture of ingredients comprising a liquid combustible body and nitrogen peroxide, said ingredients being in such proportions to each other as to produce a relatively insensitive and low powered explosive; a second closed chamber within and completely surrounded by said mixture, said second chamber containing the requisite amount of one of said ingredients which, when added to said mixture, will change the said proportions to substantially 2.18 volumes of nitrogen peroxide to 1.0 volume of the combustible body to produce a relatively sensitive and high powered explosive mixture; and chamber opening means for causing the liquid of the inner chamber to mix with the liquid of the outer chamber to obtain such change of proportions.

NEVIL MONROE HOPKINS.