Dec. 18, 1945. R. C. HURREY 2,391,242

THERMIT BOMB

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Fig. 2.

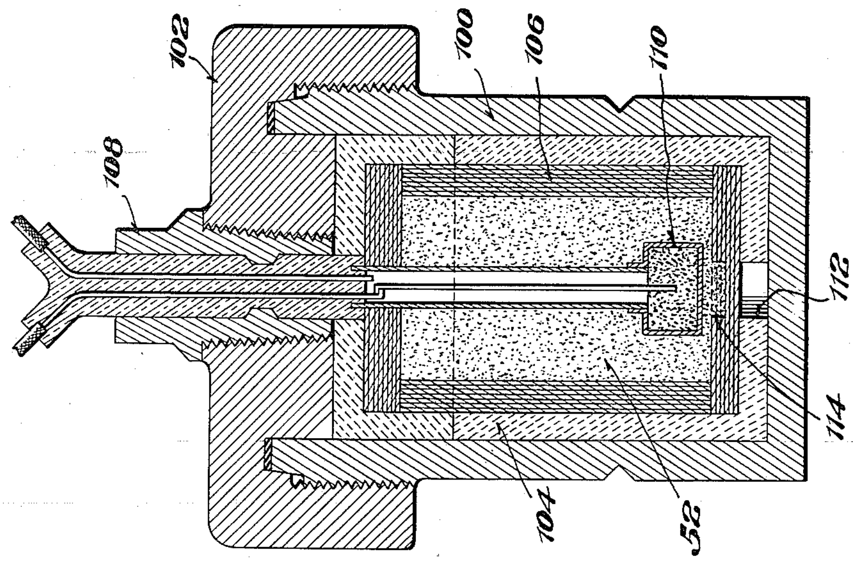
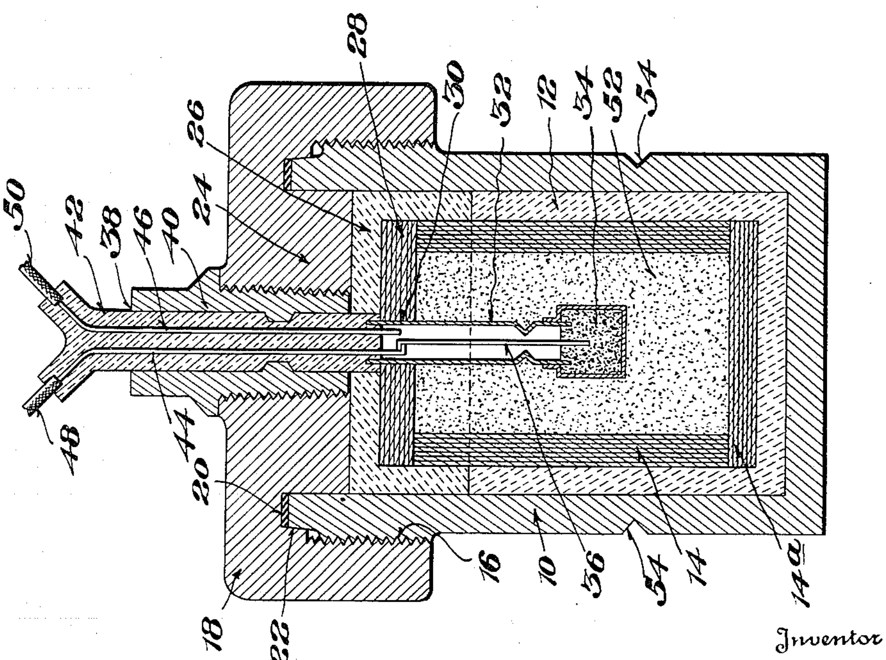


Fig. 1.



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2,391,242

THERMIT BOMB

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8 Claims. (Cl. 102—90)

It is an object of this invention to produce an explosive which may be manufactured by unskilled labor with ordinary factory equipment; which has complete chemical stability; and which may be manufactured, shipped, stored and handled as safely as any ordinary commodity such as wood, paper, steel, or cement.

Heretofore explosives have almost without exception been based on the use of some form of nitrate, with the result that the end product is chemically unstable and therefore dangerous. The major efforts along this line have involved nitration of cellulose (guncotton), phenol (picric acid), glycerol (nitroglycerine) and toluol (TNT). The addition of the NO_3 radical has two effects: it first produces a chemical unstability which favors instantaneous decomposition or detonation, and secondly it provides an excellent source of oxygen which, upon detonation, is free to combine with excess carbon and/or hydrogen in the material nitrated.

Both of the aforementioned effects of nitration are present in ordinary gun powder. The primary difference between gun powder as an explosive and the above mentioned "high explosives" lies in the character of the products of decomposition. When gun powder decomposes, the products are all gaseous, and the gases consist mostly of SO_2, CO_2, and N_2. With the high explosives, on the other hand, there is, in addition to the same gaseous products, a large measure of water which, due to the heat of the reaction, is in the form of steam, and it is this steam which gives the explosion its power.

I have found that at high temperatures (in the region of 2000° F.) either wood or cellulose undergoes an exceedingly rapid decomposition with the formation of a volume of gas which is enormous relative to the original volume of the cellulose or wood. This reaction is not combustion in the ordinary sense since it takes place substantially in the absence of oxygen.

Cellulose has the empirical formula:

$$(C_6H_{10}O_5)_x \quad \text{or} \quad (C_9H_{10}O_5)_y$$

from which it may be seen that a decomposition in the absence of air would produce a quantity of free carbon plus at least five molecules of water per molecule of cellulose. If the decomposition occurs at high temperature, the five molecules of water will produce a great volume of steam, and this will be sufficient to produce an explosive effect whether or not the carbon of the cellulose be oxidized to CO_2.

When the reaction takes place on wood as distinguished from pure cellulose, many additional factors occur due to the presence of lignon, sugar, pitch, etc., which upon ordinary destructive distillation tend to form acetone, methyl alcohol and other compounds. I have not identified the products of decomposition under high temperature of either wood or cellulose. If the gases are released slowly, apparently considerable gas of a combustible nature is evolved. If the gases are confined and released with explosive force, I do not attempt to say what the composition of the gases may be.

I propose to carry out my explosive process by exposing either wood or cellulose or a mixture of wood and cellulose to the effects of a "Thermit reaction." For the purpose of this discussion, I define a Thermit reaction to be any exothermic reaction between an oxide and a reducing agent such as, for example—

Fe_2O_3+2Al
$KClO_3+2Al$
$KClO_4+2Al$
Fe_2O_3+2Mg
$KClO_3+2Mg$
$KClO_4+2Mg$

Obviously, the oxidizer can be any of a variety of compounds in addition to those set forth such, for example, as barium peroxide, potassium permanganate, or manganese dioxide. The selection of any particular oxidizer in conjunction with any particular reducing agent will be governed by the type of reaction desired and by the exigencies of the class of work to which the explosive is to be directed. For example, a reaction between magnesium and potassium chlorate or perchlorate would be very much faster than the reaction between aluminum and iron oxide. On the other hand, a mixture of comminuted magnesium with potassium chlorate or perchlorate would be dangerously unstable, whereas a mixture of aluminum and iron oxide is almost perfectly stable, requiring an ignition temperature in excess of 2000° F. Again, the selection of cellulose or ground wood, or a mixture of cellulose and ground wood, will depend upon the exigencies of the job. Generally speaking, cellulose would decompose more rapidly than wood. On the other hand, ground wood is a cheaper material than cellulose, and under some circumstances the cost factor might be controlling. Wood is, however, unpredictable in its precise chemical characteristics, whereas cellulose can be refined to a point where it will enjoy a high degree of chemical uniformity, and this particular characteristic probably favors the use of refined cellulose rather than ground wood.

The reaction of any appreciable quantity of a Thermit mixture requires a measurable period of time. If the Thermit mixture is surrounded by cellulose there will be a progressive decomposition of the cellulose and this too will require a substantial period of time. Accordingly, if any real efficiency is to be attained, the reaction must take place in a closed chamber having sufficient strength to withstand a considerable building up of pressure so as to allow time for completion or approximate completion of the several reactions.

I propose to utilize my explosive in the form of a charge or bomb comprising a sealed steel vessel of substantial strength and wall thickness, lined with a sufficient thickness of cellulose to provide a substantial thermal insulating effect, and thus to prevent, for a measurable period of time, any attack on the walls of the vessel by the Thermit reaction. This interval of time will be sufficient to permit substantial completion of the Thermit reaction with consequent substantial completion of the decomposition of the cellulose.

The cellulose can of course be in the form of cotton, but both from the standpoint of cost and the standpoint of ease of manufacture, it will probably be best to supply the cellulose in the form of paper. This may be laminated to a substantial thickness and will thereby contribute not only a considerable insulating value but also a considerable element of strength. It may be well in some cases to provide, between the steel shell and the charge of cellulose, a refractory lining to restrain the action of the Thermit should any portion of the molten mass penetrate through the cellulose before an explosive pressure has been developed. It is intended that ultimately the internal pressure developed by the Thermit and the decomposition of the cellulose will be sufficient to rupture the steel shell with shattering force.

The use of a charge of the above-described sort makes possible a large degree of flexibility of "design" of the type of explosion to be produced. For example, the initial explosive force will be a direct function of the bursting strength of the steel shell, and this may be proportioned to the quantity of Thermit and cellulose involved, so as to produce any particular desired effect under any particular circumstances. Moreover, the steel shell may be locally weakened and locally strengthened so as to direct the force of the explosion upon ultimate rupture. This may be carried to a point at which only a single opening in the shell will take place under the force of the gases and/or the effect of the heat and temperature involved in the reaction, so that the remaining portion of the shell will operate as a nozzle for directing a stream of the molten contents at great velocity. The incendiary possibilities of such an organization will be at once apparent.

I have directed most of my statements herein toward the decomposition of cellulose since that material has many properties which are particularly fitted for this type of work. It is apparent, however, that other organic compounds may be utilized, especially (but not necessarily exclusively) those in which the hydrogen and oxygen atoms of each molecule are so balanced as to form water. This embraces most carbohydrates having the general formula CmH2nOn including sucrose ($C_{12}H_{22}O_{11}$); glucose ($C_6H_{12}O_6$), starch $(C_6H_{10}O_5)_z$. Probably glycerol ($C_3H_8O_3$) and phenol (C_6H_6O) could also be used, though in such case, there should be present sufficient oxidizer to combine at least with the total hydrogen. If an oxidizer be added, then toluol (C_7H_8) becomes a possibility. Any of these compounds, however, lack the mechanical properties which make cellulose so effective for this service, and while I consider such compounds, with or without the presence of an oxidizer, to be within the scope of my invention, I prefer to use cellulose.

Whatever compound be chosen to be decomposed, the question of adding an oxidizer is one to be determined by a consideration of all the factors involved. These are:

1. How many atoms of free carbon will remain on decomposition of each molecule of the compound?

2. How many atoms of free hydrogen will remain after decomposition of the compound?

3. What type of oxidizer can best be incorporated in the compound? (i. e.: Can the oxidizer be placed in solution together with the compound? Is the oxidizer soluble in the compound? Is it capable of mechanical mixture with the compound? Can the compound be impregnated with a solution of the oxidizer? etc.)

4. How many mols of oxidizer will be required per mol of the compound, (*a*) to oxidize excess hydrogen and (*b*) to oxidize excess carbon?

5. What will be the cost?

6. To what extent will the safety of manufacture, shipment, etc., be decreased?

The above are the primary factors which must be taken into account. Consideration of these factors in the light of the job to be done will determine the advisability of using an oxidizer.

One or two ways of practicing my invention are illustrated in the annexed drawing in which:

Fig. 1 is a cross-sectitonal view of a bomb embodying the principles of my invention, and

Fig. 2 is a cross-sectional view of a different form of bomb designed for an incendiary effect.

Referring now to Fig. 1, I provide a strong steel shell **10** in which is a refractory liner **12**. Inside the refractory liner **12** is a liner **14** of organic material. This may be any of the carbohydrates or hydro-carbons, either in solid form or impregnated into a suitable vehicle. It is desirable, though not indispensable, (in the presence of the refractory liner **12**) that the organic liner **14** be so formed as to have substantial thermal insulating properties.

I have illustrated the organic inner liner **14** as being composed of laminated sheets of paper. This paper can be formed of pure cellulose (e. g. refined sulphite pulp) or it may be formed of a mixture of such pulp and ordinary ground wood pulp. In any cylindrical shell the body portion of the liner would be formed by winding a continuous web of paper into a thick tube. It will be apparent that the paper can be impregnated with a solution of an oxidizer such as potassium chlorate or perchlorate before winding, and that additional oxidizing material can be incorporated between the several laminations.

I have shown the bottom portion of the inner liner **14** as a laminated disc **14*a*** underlying the entire cross-section of the cylindrical portion of the liner **14**. Bear in mind that the cylindrical form illustrated, while simple to manufacture, is not the only form. By resort to pulp moulding operations, the organic liner can be given any form desired.

At the upper end of the shell **10** I provide a threaded portion **16** for engagement with a steel cap **18**. The cap **18** is grooved as at **20** to receive the edge **22** of the shell **10**. The portion **24** of the cap **18** surrounded by the groove **20** bears against a disc 26 of refractory material. The disc 26 is of a size to fit snugly within the refractory liner 12, and bears in turn on a disc 28 of laminated paper. The paper disc 28 is also sized to fit the refractory liner 12 and to bear upon the whole cross-section of the paper liner 14.

The paper disc 28 has a central aperture 30 through which passes a paper tube 32. The upper end of the tube 32 is flush with the upper surface of the paper disc 28, and its lower end is embedded in an ignition cartridge 34 of any desired type. A mixture of powdered magnesium and barium peroxide is recommended. Through the tube 32 runs a strip 36 of magnesium, the strip likewise terminating in the ignition cartridge 34.

Threaded into the cap 18 is a member 38 designed like an ordinary spark plug with a metal section 40 in engagement with the cap 18 and a porcelain core 42 which contains wires 44 and 46. The wires terminate, at the outer end of the core 42 in binding posts 48 and 50. The lower end of the core 42 is cylindrical. It snugly fits the opening in the refractory disc and bears upon the paper disc so as to surround the tube 32. The wires 44 and 46 emerge from the lower end of the core 42 to form a spark gap in which is secured the magnesium strip 34.

The space 52 inside the lined shell 10 is filled with a Thermit mixture of any desired type, the quantity of Thermit being of course calculated with reference to the quantity of organic material in the liner 14.

When the binding posts 48 and 50 are wired to a source of electrical current and are energized, a spark jumps the gap between wires 44 and 46, igniting the magnesium strip 36 which in turn starts sets off the igniting charge 34 which in turn starts the Thermit reaction. This results in building up in the highly insulated chamber a temperature probably well in excess of 5500° F. which is ample to bring about an extremely rapid decomposition of the organic material. When this decomposition proceeds sufficiently, the internal pressure developed will burst the steel shell 10 with explosive effect. It should be noted that by proportioning the Thermit mixture so as to provide an excess of oxidizer over that required to react with the metallic reducing agent, a source of oxygen may readily be provided to take part in the decomposition of the organic material and to oxidize all or a part at least of the free carbon of the carbohydrate, thus increasing the volume of gas developed, and this is probably the simplest method of securing a supply of free oxygen. The question of costs will, of course, largely determine whether and to what extent any oxidizer will be supplied.

In Fig. 1 I have indicated a deep score-line 54 running circumferentially around the shell 10. This score-line is intended to predetermine the line on which the shell will ultimately rupture and thus in a measure to direct the force of the explosion. Naturally the location and proportions of any such weakening will depend on the job to be done and the shape of the shell.

In Fig. 2 I have illustrated a bomb generally similar to that shown in Fig. 1, but designed particularly for an incendiary effect. This incendiary bomb consists of a steel shell 100 threaded to a steel cap 102, the shell containing a refractory liner 104 and an organic liner 106. An igniting device 108 consists of the same elements as the igniting device illustrated in Fig. 1, except that the igniting charge 110 is placed near the lower end of the shell instead of approximately centrally as is the case in Fig. 1. The refractory liner 104 is cut away over an area 112 which is approximately central of the bottom of the shell 100, and the organic liner is similarly reduced in thickness over an area 114 which registers with the cut-out portion 112 on the refractory liner.

The purpose of this construction is to restrain the Thermit mixture only long enough to permit an initial building up of pressure which is nevertheless insufficient to rupture the shell 100. By the time this pressure is reached, the Thermit will have passed through the reduced portion 114 of the organic liner and will have attacked the metal of the shell in the area exposed by the opening 112 in the refractory liner. When the Thermit penetrates the shell, an orifice will be provided and by this time there will be a considerable gas pressure and a considerable body of molten metal within the shell. The gas pressure will force the molten metal through the orifice at great velocity and should have an incendiary effect over a considerable adjacent area.

In designing a bomb as shown in Fig. 2, emphasis will be placed on the provision of a large quantity of Thermit mixture rather than on the development of the maximum amount of gas, since the gas in this case is intended to act merely as a propellor for the molten metal resulting from the Thermit reaction.

Obviously, the Thermit need not be relied on to form an opening in the shell. Lines of weakness may be used to outline the desired opening and the pressure developed in the shell may be used to force the opening. The opening may also be preformed and filled with a meltable or frangible plug.

No attempt is here made to reduce the showings of either Fig. 1 or Fig. 2 to a military form. The structures which will adapt bombs of the type illustrated to military purposes are plentiful in the art and form no part of this invention.

While I have shown electrical ignition, it is obvious that other igniting devices can be used, the only requisite being that the passage of the igniting device through the shell must be accomplished in such a way as not to destroy the sealing or heat-insulating effects, though obviously in the case of an incendiary bomb as illustrated in Fig. 2 these requirements are not so important as in the case of an explosive bomb as illustrated in Fig. 1.

What is claimed is:

1. An incendiary device comprising a sealed metal shell of substantial strength, a refractory lining for said shell, an inner lining of cellulosic material within said refractory lining, a charge of Thermit mixture within said inner lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said cellulosic material under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

2. An incendiary device comprising a sealed metal shell of substantial strength, a refractory lining for said shell, an inner lining, formed of a carbohydrate, within said refractory lining, a charge of Thermit mixture within said inner lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell

whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said carbohydrate under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

3. An incendiary device comprising a sealed metal shell of substantial strength, a refractory lining for said shell, an inner lining of laminated paper within said refractory lining, a charge of Thermit mixture within said inner lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said paper under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

4. An incendiary device comprising a sealed metal shell of substantial strength and wall thickness, a refractory lining for said shell, an inner lining of laminated paper composed chiefly of ground-wood within said refractory lining, a charge of Thermit mixture within said inner lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said paper under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

5. An incendiary device comprising a sealed metal shell of substantial strength, a lining of cellulosic material within said shell, a charge of Thermit mixture within said lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said cellulosic material under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

6. An incendiary device comprising a sealed metal shell of substantial strength and wall thickness, a lining formed of a carbohydrate within said shell, a charge of Thermit mixture within said lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said carbohydrate under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

7. An incendiary device comprising a sealed metal shell of substantial strength and wall thickness, a lining of laminated paper within said shell, a charge of Thermit mixture within said lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said paper under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

8. An incendiary device comprising a sealed metal shell of substantial strength and wall thickness, a lining of laminated paper composed chiefly of ground-wood within said shell, a charge of Thermit mixture within said lining, means for igniting said Thermit mixture, and means forming a weakened portion in said shell whereby said Thermit mixture, when ignited, will rupture said shell so that gases developed by decomposition of said paper under the influence of the Thermit reaction may expel the Thermit mixture forcibly through the localized opening thus created.

ROSS C. HURREY.