

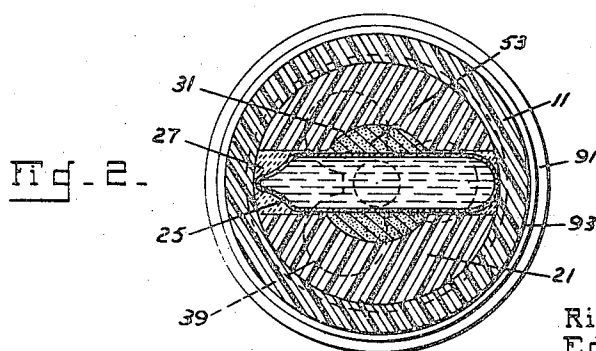
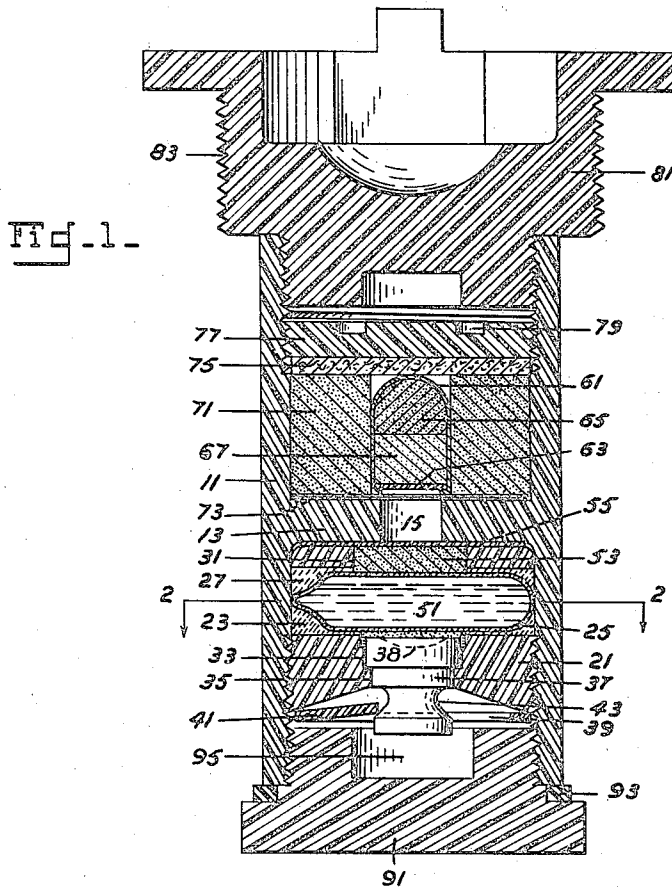
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This invention relates to a chemical fuze for setting off or igniting explosives.

An object of the invention is the provision of a generally improved and more satisfactory fuze in which the detonating action is initiated by the chemical reaction of two or more substances upon each other.

Another object is the provision of a fuze of the pressure-operated type, so constructed that pressures of less magnitude than the predetermined operating pressure will not damage nor distort the fuze, and especially will not decrease the magnitude of pressure required to operate the fuze when it is again subjected to pressure.

Still another object is the provision of a fuze so designed and constructed that no metal is contained therein, with the result that the presence of the fuze cannot be detected by magnetic or electrical detecting means.

A further object is the provision of a simple and reliable fuze of a chemical nature, adapted to a wide variety of uses, both military and civilian.

A still further object is to provide a fuze which is perfectly safe against rough handling to any reasonable extent, and in which the operating pressure required to set off the fuze may be closely controlled within reasonable limits.

Other objects of the invention will be apparent from the detailed description which follows, which description and the accompanying drawings are merely exemplary and are not intended to limit the invention to the specific construction described.

In the drawings:

Fig. 1 is a central section taken longitudinally through a preferred embodiment of fuze in accordance with this invention, and

Fig. 2 is a transverse section thereof taken substantially on the line 2—2 of Fig. 1.

The same reference numerals throughout the drawings indicate the same parts.

Referring now to the drawings and to the reference numerals marked thereon, a preferred embodiment of the invention comprises a tubular fuze body 11 of molded plastic material having intermediate its ends a transverse partition 13 provided with a central hole or aperture 15. Both ends of the tubular body 11 are internally threaded as shown.

Seated in the lower end of the body 11, below the partition 13, is an ampule housing 21 in the form of a plug of molded plastic material externally threaded and screwed into the internal threads in the lower end of the body 11. This

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ampule housing has, near the upper end, a transverse bore 23 extending approximately diametrically, and in this bore 23 is seated a tubular glass ampule 25 sealed at both ends and held in place at both ends by suitable cement 27, such as plaster of Paris, preferably mixed with a suitable indicator (such as Congo red, for example) sensitive to the liquid within the ampule so that if any liquid leaks from the ampule due to improper sealing, the plaster of Paris will change color and give a visual indication of the leak.

A longitudinal bore also extends centrally through the ampule housing 21. The upper portion 31 of this bore is of fairly large diameter, substantially larger than the diameter of the ampule bore 23, and forms the primer cavity. The lower portion of the longitudinal bore is of stepped formation, including a portion 33 of smaller diameter than the upper portion 31, and another portion 35 of still smaller diameter. A piston 37, also preferably of molded plastic material, is seated in and capable of limited longitudinal movement in the portions 33 and 35 of the longitudinal bore, the piston being stepped so as to prevent withdrawal from the bore in a downward direction. The upper surface of the piston head is centrally depressed or recessed as shown at 38 so that upon upward movement of the piston, contact with the glass ampule 25 will occur only at approximately the outer edges of the piston. A piston retainer 39 in the form of a disc of somewhat flexible resilient material such as a thin sheet of laminated phenolic material, is cut away centrally and has inwardly extending spokes, one of which is shown at 41, which enter an annular groove 43 in the lower portion of the piston 37. The outer portion of the retainer 39 bears against the bottom of the ampule housing 21, and the spokes 41, being deflected somewhat upwardly to enter the groove 43, tend resiliently to hold the piston 37 in its downward position, nevertheless permitting it to rise when upward pressure is applied. The sides of the piston are preferably lubricated with low-viscosity grease to insure easy longitudinal movement of the piston and to assist in excluding moisture from the primer cavity.

The glass ampule 25 has relatively thin walls easily broken by substantial pressure produced by upward movement of the piston 37. Sealed within this glass ampule is a quantity of activating agent 51 for the primer mixture, this activating agent preferably being a solution capable of igniting the primer mixture upon more contact therewith when the glass ampule is broken. For the particular primer mixture hereinafter

disclosed, excellent results are obtained by using, as the activating agent, a solution of approximately 75% by volume of concentrated sulphuric acid, chemically pure, specific gravity 1.835 at 20° C., and approximately 25% by volume of orthonitrotoluene. Preferably the glass ampule 25 is only about 60% filled with this solution, so that a small air space is left. This facilitates the sealing of the ampule after the liquid is inserted.

The primer mixture is packed loosely all around the ampule 25 in the primer cavity 31, as shown at 53, and is retained in this primer cavity by a pressure disc 55 of thin plastic sheeting, cemented to the upper end of the ampule housing 21 around the edges of the cavity 31, and further held in place by the partition 13 when the ampule housing 21 has been screwed into and firmly seated within the body 11. The bottom of the primer cavity is formed mainly by the top surface of the piston 37. The primer mixture consists of one or more substances which will ignite immediately on contact with the solution in the glass ampule. For use with the particular activating solution hereinabove disclosed, excellent results are obtained by using a primer mixture of potassium chlorate and lead sulphocyanate, preferably in the proportions of approximately 55% by weight of potassium chlorate and 45% by weight of lead sulphocyanate. Both of these substances are finely ground in a ball mill so as to pass 325-mesh, and are thoroughly blended with each other.

On the other side of the partition 13 from the primer mixture and activating agent, there is a detonator comprising an inverted cup 61 of plastic composition, the bottom end of which is closed by a suitable closure 63 also of plastic composition. In this cup 61 there is an upper detonator charge 65 and a lower detonator charge 67 of any suitable detonating material. For example, the lower detonator charge may consist conveniently of lead azide compressed at a pressure of approximately 4,000 pounds per square inch, and the upper detonator charge may consist of pentaerythrite tetranitrate (commonly known as PETN) likewise compressed at a pressure of approximately 4,000 pounds per square inch.

Surrounding the detonator 61 is a booster pellet 71 of annular form, the detonator being mounted in the central opening or cavity of the booster pellet. This booster pellet may be of any convenient material, such as, for example, tetryl pressed to a specific gravity throughout of 1.40 to 1.55.

Overlying the partition 13, beneath the booster pellet 71 and the detonator 61, is a booster disc 73 of thin material such as paraffin paper. Overlying the booster pellet and the detonator is a pad 75 of somewhat compressible resilient material, such as felt, held in place by a closure disc 77 preferably of molded plastic material, screwed into the internal threads at the upper end of the body 11 with enough pressure to compress the pad 75 slightly and thus hold the booster pellet and the detonator firmly in place. Recesses 79 formed in the upper surface of the closure disc 77 may be engaged by means of a spanner wrench or special tool to screw the disc in place. The upper end of the body 11, above the closure disc 77, is preferably provided with a cap 81 of any suitable design, preferably of molded plastic material, having for example a lower portion of reduced diameter, screwed into the internal

threads at the top of the body 11 above the disc 77, and an upper portion of larger diameter provided with external threads 83 which may be screwed into a suitable threaded opening in any article with which this fuze is to be used, such for example as an explosive mine, torpedo, shell, rocket, blasting equipment, or the like.

After the ampule housing 21, with its contained activating solution 51 and primer mixture 53, has been screwed into place in the lower portion of the housing 11, if the fuze is not to be used at once it may be protected from accidental discharge by means of a safety cap 91 screwed into the bottom end of the body 11 against an interposed gasket 93 of rubber or cork or both, to form a tight seal and prevent entrance of moisture. The safety cap has a central recess 95 providing ample clearance around the lower end of the piston 37, so that no pressure will be exerted on the piston.

The fuze in its preferred embodiment above described is made entirely of non-metallic material so that it cannot be detected by magnetic or electrical detecting means. If protection against such detection is not important, however, metal may be used for various structural parts such as the main body 11, the ampule housing 21, the piston 37, the disc 77, and the caps 81 and 91.

The operation of the fuze is as follows:

In order to prepare the fuze assembly for use, the safety cap 91 is unscrewed and discarded. The fuze assembly is then placed in appropriate operating position with respect to any suitable form of actuating mechanism, as for example by screwing the screw threads 83 into a threaded opening of a mine or torpedo in such position that, upon the happening of a predetermined event or movement, upward pressure will be exerted on the piston 37. This upward pressure on the piston causes upward movement of the piston and, if the pressure is great enough, breaks the fragile glass ampule 25, allowing the liquid solution 51 therein to escape and come into contact with the primer mixture 53, which immediately ignites. The presence of the disc 55 at the top of the primer cavity enables pressure in this cavity to build up when ignition takes place, and this pressure results in faster and more violent combustion, which quickly consumes or breaks through the discs 55 and 73 and passes through the flame hole 15 and causes immediate detonation of the detonating charges 65 and 67 in the detonator 61, and this causes immediate and more violent explosion of the booster pellet 71. This explosion of the booster pellet shatters the entire body 11 and transmits the explosion pressure to the main charge of explosive, surrounding or immediately adjacent to the body 11 of the fuze assembly, thus causing the main charge of explosive to explode.

Some of the advantages of the preferred construction, in addition to those already mentioned, may be summarized as follows: The use of a glass container 25 of tubular form is found to give results much superior to those obtained with a container of spherical form, for example. An ampule made from glass tubing can readily be made of closely controlled wall thickness, since glass tubing of controlled wall thickness is available. Consequently, since the wall thicknesses of different ampules can be kept substantially the same, the magnitude of pressure required to break the ampule is reasonably constant for various ampules of the same design and dimensions. Con-

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stant breaking pressure (within reasonable limits) is, of course, a prerequisite to a fuze which is intended to be set off by pressures of a given magnitude but is not to be set off by pressures of a lesser magnitude. As distinguished from the present very satisfactory construction a container of globular or spherical glass is unreliable and unsatisfactory because of the fact that there is not sufficient control over the wall thickness of glass in this shape, with the result that different glass containers intended to break under the same magnitude of pressure actually are very erratic and require widely varying pressures to break them. Moreover, a globular or spherical container is difficult to seal properly after the liquid is inserted therein. The tubular form of ampule is very easy to seal at the open end after the liquid is inserted therein, the liquid preferably filling only about 60% of the volume of the ampule.

The safety of the present construction is noteworthy. The glass ampule, after being seated in the ampule housing 21 and sealed therein by the plaster of Paris 27, is protected on all sides by the housing 21 from any accidental jar or blow which might fracture it during assembly of the fuze parts. In case there is a leak in the ampule due to improper sealing, the escape of acid will turn the Congo red in the plaster of Paris 27 to a blue color, so that when the ampule housing 21 is picked up by the person assembling the fuze parts, to be screwed into the main body 11, any change in color of the plaster of Paris can immediately be seen and thus a leaky ampule can be detected. Moreover, with this construction, there is no substantial danger of premature firing even if there is a leak in the ampule, because the plaster of Paris itself forms a seal preventing any liquid which may leak out of the sealed end of the ampule from coming into contact with the primer mixture 53.

Another important feature of this construction is that subjecting the fuze to any pressure less than that required to break the ampule does not lower the magnitude of the pressure required later to break the ampule and set off the fuze. When a pressure-sensitive fuze is provided with a shear pin to determine the extent of pressure required to set off the fuze, as has been proposed in the past, it may happen that a pressure almost, but not quite, great enough to shear the pin completely, may cause deformation and partial shearing of the pin, without setting off the fuze. Then, when pressure is again applied to the fuze at a later time, it may require only a very slight pressure, much less than the intended critical magnitude, to complete the shearing of the pin and to set off the fuze. The serious dangers in any such construction are apparent. With the present construction, however, if the pressure is not sufficient to break the glass ampule, it does not affect the ampule at all, and when the fuze is again subjected to pressure at a later time, it still requires the full predetermined magnitude of pressure to break the ampule and set off the fuze.

The recessed shape of the head of the piston 37 results in applying to the glass ampule a shear load just inside the ampule holding ring, formed by the upper part of the housing 21. This results in quicker breaking and quicker escape of the contents of the ampule, when broken, and thus in quicker igniting action, than would be the case if the piston pressure were applied near the center of the unsupported portion of the ampule.

Another factor which aids in securing the de-

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sired fast action of the fuze, is the inclusion of the orthonitrotoluene along with the sulphuric acid in the ampule. The addition of the orthonitrotoluene lowers the freezing point of the sulphuric acid, enabling the mixture to run rapidly out of the broken ampule at temperatures even as low as minus 40° F., whereas sulphuric acid alone will freeze at considerably higher temperatures, which would make the fuze inoperative. The orthonitrotoluene also acts somewhat as a catalyst, greatly speeding up the ignition action of the acid. Although other acids may be used as igniting agents, sulphuric acid gives consistently faster ignition than other common acids, such as hydrochloric acid and nitric acid, and is the only one of these acids which is miscible with orthonitrotoluene. The combination of sulphuric acid and orthonitrotoluene remains fast in action and stable at all temperatures from minus 40° F. to plus 170° F., and thus provides an activating agent which is very satisfactory over a wide range of temperatures.

Another feature to be noted is the composition of the primer mixture, preferably potassium chlorate and lead sulphocyanate, as above stated. Broadly, it is possible to use a mixture of (a) any substance which will ignite spontaneously upon contact with the activating agent, and (b) any oxidizing compound, to furnish the necessary oxygen to support rapid combustion. Good results can be obtained by using, as the ignitable substance, lactose or sucrose or hexamethylenetetramine or guncotton or benzoic acid or pentaerythrite, for example, and by using, as the oxidizing compound, MnO_2 or $NaClO_3$ or NH_4ClO_4 , for example. However, some of these substances are highly hygroscopic, which undesirably delays the fuze action when used in a humid atmosphere. The best results, from the over-all standpoint of rapid action throughout the desired wide temperature range and stability against deterioration at extreme temperatures, have been obtained by using the preferred mixture above disclosed, namely, lead sulphocyanate as the ignitable substance and potassium chlorate as the oxidizing compound. This mixture is substantially non-hygroscopic. Small amounts of other substances may be added to the mixture (e. g. charcoal or guncotton or benzoic acid or red phosphorous) but no consistent improvement is thereby obtained except in the case of red phosphorous, and this material is far too friction-sensitive to be safely used.

Still another feature aiding in the quick action of the fuze is the above-described fine grinding of the ingredients of the primer mixture 53. When these ingredients are ground to a fineness of the order of magnitude above described, it is found that there is consistently faster ignition of the primer mixture and faster flame propagation in the mixture, than if the ingredients are not so finely ground. The grinding of the ingredients so as to pass a 200-mesh screen is considered reasonably satisfactory, as distinguished from coarser mixtures, but the preferred grinding so as to pass a 325-mesh gives even better results.

Each of the factors above mentioned in connection with the speed of the fuze may in itself give only a slight increase in speed, amounting to only a small fraction of a second, but when all of these factors are used conjointly in the preferred form, there is a substantial and noteworthy increase in speed, the fuze ordinarily operating to cause ignition of the detonator charges 65 and 67

within about one-tenth of a second or less after the necessary pressure is applied to break the ampule. The importance of having a fuze capable of such fast action is seen when it is realized that a vehicle traveling at, say, fifty miles an hour is only over a given point on the road for a small fraction of a second. If it is intended to have the weight of the vehicle actuate the fuze and blow up a mine planted in the road, a delay of one second or even half of a second in operation of a fuze may result in the mine explosion taking place after the vehicle has safely passed over the mine. The effectiveness of the mine is greatly increased by using an extremely quick-acting fuze constructed in accordance with the preferred embodiment of the present invention.

While one embodiment of the invention has been disclosed, it should be understood that the invention may be carried out in a number of ways. This invention is not to be limited to the precise details disclosed, but is intended to include all variations and modifications thereof falling within the scope of the appended claims.

What is claimed is:

1. In a fuze for explosives, the combination of a member having therein two openings intersecting each other, one of said openings being of larger diameter than the other in the region of intersection, a frangible liquid-tight container of generally elongated tubular shape having its intermediate portion extending across said region of intersection and its ends mounted in one of said openings, a liquid activating agent including acid in said container, said region of intersection of said openings being adapted to hold a combustible primer substance sensitive to said acid to be ignited thereby when said container is broken, and cement holding the ends of said container in said openings, said cement including an acid-sensitive color-changing substance to provide a visual indication of leakage of acid from an end of said container.

2. A fuze for explosives comprising a frangible liquid-tight receptacle containing sulphuric acid and orthonitrotoluene, and a primer mixture adjacent said receptacle in position to come into contact with the contents of said receptacle when the receptacle is broken, said primer mixture including a combustible substance capable of being ignited by contact with the contents of said receptacle, and an oxidizing agent.

3. A fuze for explosives comprising a frangible liquid-tight glass receptacle of generally tubular shape containing a mixture of sulphuric acid and orthonitrotoluene in the proportions of approximately 75% sulphuric acid and approximately 25% of orthonitrotoluene, and a primer mixture adjacent said receptacle in position to come into contact with the contents of said receptacle when the receptacle is broken, said primer mixture including lead sulphocyanate and potassium chlorate.

4. A fuze for explosive comprising a frangible liquid-tight receptacle containing sulphuric acid

and orthonitrotoluene, and a primer mixture adjacent said receptacle in position to come into contact with the contents of said receptacle when the receptacle is broken, said primer mixture including lead sulphocyanate and potassium chlorate both in the form of finely ground powders intimately blended with each other.

5. The combination claimed in claim 4, in which said powders are of a fineness capable of passing a 325-mesh screen.

6. A non-metallic fuze comprising in combination a cylindrical body, a frangible liquid-tight container containing a liquid activating agent mounted within the body, the axes of said body and said container being at substantially right angles with each other, a piston disposed within said body adapted to slide axially relative to said body and to contact said frangible container, a primer substance adjacent to said frangible container, an annular recess on said piston and a perforated disc of resilient material, the inner portion of said disc fitting into the recess and the outer portion of said disc being retained by the body, said disc tending to keep the piston from contacting the frangible container.

7. The fuze of claim 6 in which the disc comprises a thin sheet of laminated phenolic material.

8. The fuze of claim 6 in which the disc is perforated so that inwardly directed spokes are formed, the inner ends of said spokes fitting into the annular recess on the piston.

9. A fuze for explosives comprising a frangible liquid-tight container of generally tubular form, means for supporting said container at two spaced points, a liquid activating agent within said container, a combustible primer substance sensitive to said activating agent closely adjacent said container, and a member mounted for movement toward said container in the space between said points of support, to break said container to release said activating agent for contact with said primer substance to ignite the same, said activating agent including sulphuric acid and orthonitrotoluene, and said primer substance including lead sulphocyanate and potassium chlorate.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
42,185	Ganster	Apr. 5, 1864
2,133,119	Smith	Oct. 11, 1938
2,328,276	Hunt	Aug. 31, 1943

FOREIGN PATENTS

Number	Country	Date
18,659	Great Britain	Apr. 14, 1912
62,857	Switzerland	Apr. 17, 1913