

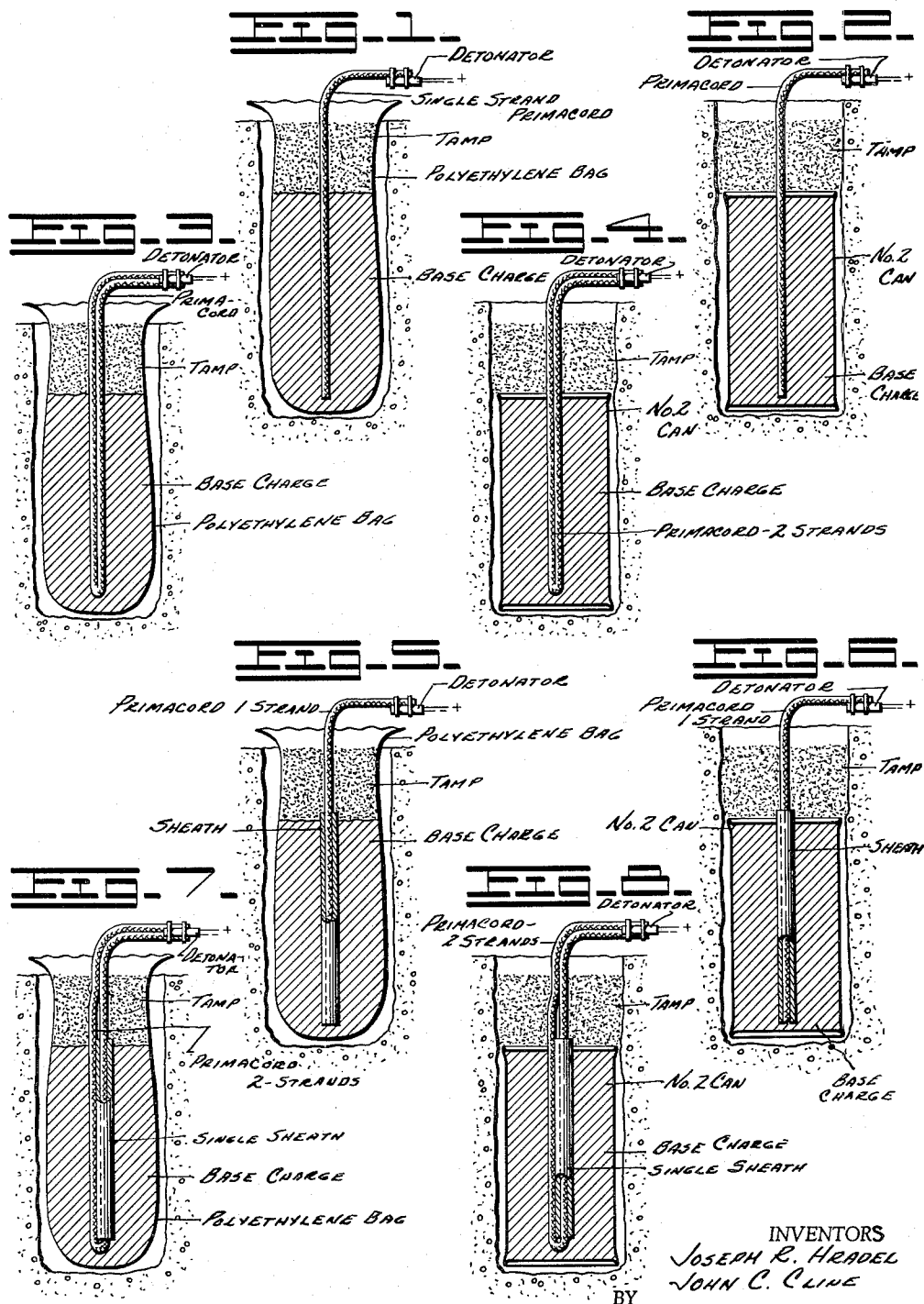
Feb. 20, 1962

J. R. HRADEL ET AL
COUNTERFORCE INITIATION

3,021,785

Filed May 4, 1959

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

FIG. 9.

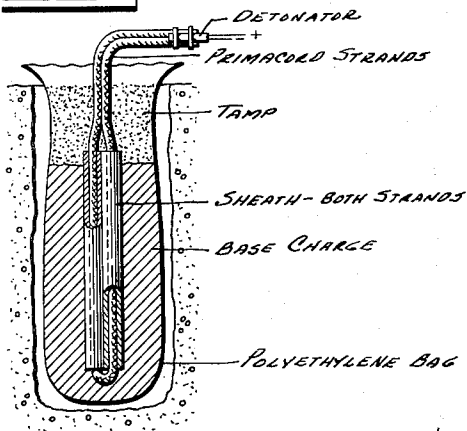


FIG. 10.

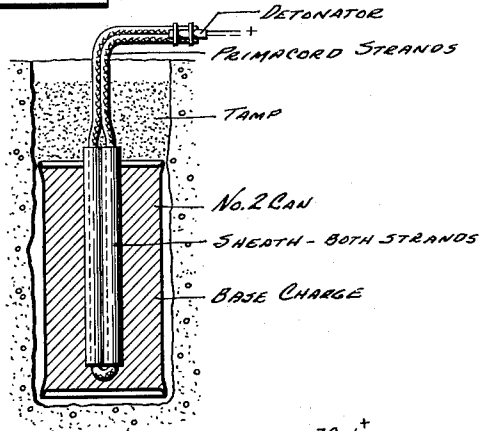


FIG. 11.

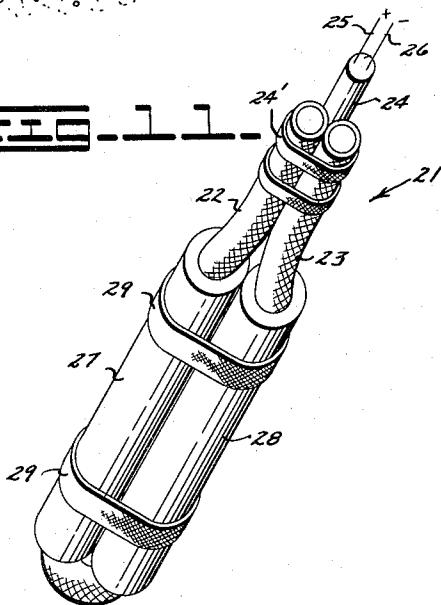


FIG. 12.

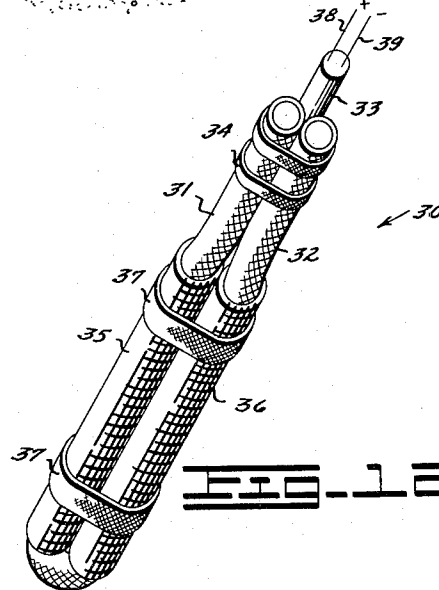
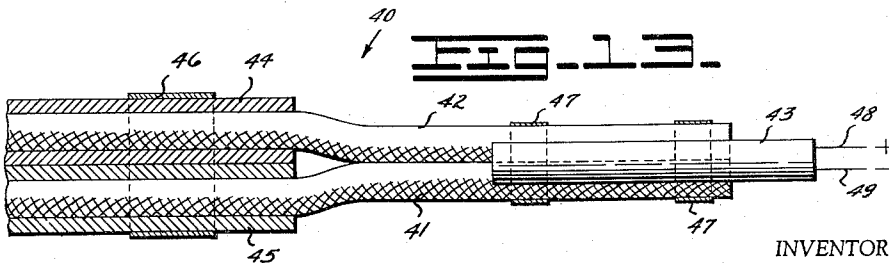


FIG. 13.



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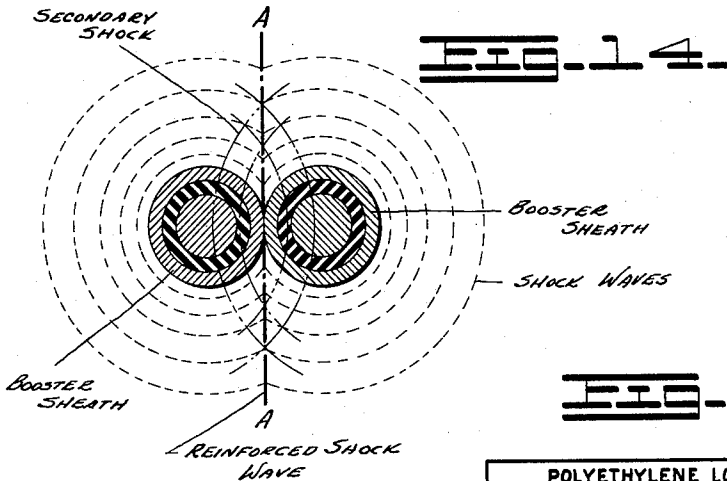


FIG-15-

POLYETHYLENE LOAD CONTAINER			
INITIATION SYSTEM	PRIMACORD STRENGTH GRAINS/FOOT	FAILURES	DETONATIONS
FIG. 1	50	5	NONE
FIG. 3	50	5	NONE
FIG. 5	50	5	NONE
FIG. 7	50	5	NONE
FIG. 9	50	3	2
FIG. 1	100	5	NONE
FIG. 3	100	3	2
FIG. 5	100	NONE	5
FIG. 7	100	NONE	5
FIG. 9	100	NONE	5

FIG-16-

METAL CAN CONTAINS BASE CHARGE			
INITIATION SYSTEM	PRIMACORD STRENGTH GRAINS/FOOT	FAILURES	DETONATIONS
FIG. 2	50	5	NONE
FIG. 4	50	4	1
FIG. 6	50	2	3
FIG. 8	50	1	4
FIG. 10	50	NONE	5
FIG. 2	100	5	NONE
FIG. 4	100	1	4
FIG. 6	100	NONE	5
FIG. 8	100	NONE	5
FIG. 10	100	NONE	5

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3,021,785

COUNTERFORCE INITIATION

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Filed May 4, 1959, Ser. No. 810,649

5 Claims. (Cl. 102-24)

The present invention relates to devices for accomplishing the initiation of an explosion. More specifically, the invention is directed to a form of initiator in which two generally parallel strings of encased or jacketed Primacord are fired simultaneously while in controlled adjacent spacing each with the other. Still more specifically the present invention relates to initiating devices wherein the Primacord strands are encased in a boosting sheath, where the selected sheath upgrades the initiating shock.

The initiation of explosive materials involves the provision of an initiating shock of sufficient magnitude to start the complex chemical reactions in the base load of explosives so as to create a liberation of gases and heat to do work. Upon initiation the shock propagates through the contiguous mass of the base charge. Historically, gun powder was and is initiated by the use of fulminate primers and the like where simple mechanical shock on the sensitive primer load causes an initiating explosion communicating itself to the base load. Similarly fused caps or primers have been used where the heat of the fuse initiates the detonation of the primer, with the primer, imbedded, for example in a base charge of explosive material such as dynamite. Similar results have been obtained in primers exploded by an electrical potential. Then Primacord or detonating fuse was developed which is essentially a continuous train of high explosive material such as trinitrotoluene encased in a protecting outer layer of reinforcing and waterproofing material. The Primacord was then detonated by one of the primers set forth and the explosion of the Primacord is extended by very rapid propagation to the entire length of the Primacord and if the Primacord is imbedded in a matrix of base load explosives, those explosives may be detonated. More usually, the Primacord or detonating fuze is imbedded in a primer charge of relatively sensitive material, the latter being imbedded in an explosive mass. Detonation of the base charge presumes that the heat and shock of the Primacord is of sufficient intensity to serve the initiating function in the base charge or where the action of the Primacord is insufficient to cause detonation, either the sensitivity of the base charge must be upgraded or the magnitude of the initiating shock must be increased, the latter within reasonable limits imposed by the available strengths of Primacord.

Thus, in the shooting of relatively insensitive base loads, such as ammonium nitrate, for example, the problem of successful initiation is somewhat difficult and in the minds of some "shooting" experts well nigh impossible with any degree of uniform results. One successful shooting system developed is detonation employing a Munroe type Jet, or shaped charge, the principal axis of which is oriented to penetrate the base charge. Sensitization is sometimes employed but is extremely dangerous inasmuch

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as the sensitizing or priming materials themselves may commence an initiating reaction impossible or impractical to control so as to endanger lives and property. Where sensitization of the base load is employed close control over the loads and sensitizers must be observed for reasonable safety. Frequently combinations of upgrading or sensitizing of the base load and the upgrading of the initiating shock are utilized.

The present invention, however, has as its object the provision of a very simply fabricated initiator which is cheaper than shaped charges while obtaining excellent detonation action over relatively insensitive base charges. It goes without saying that its utility therefore extends through the entire range of conventional base loads, for example TNT, RDX, dynamites, composition C, oil primed ammonium nitrate, water primed ammonium nitrate, metal sensitized explosive compositions, and the like. Collaterally, and quite unexpectedly, the invention utilizes simple means to upgrade the initiator shock so that field use is greatly expedited and uniformly good detonating results are obtained.

Thus, one object of the present invention is to provide a cheaply constructed initiator.

Another object is to provide an initiator using readily available components in simple combination.

Another object is to provide parallel lines of adjacent jacketed Primacord to upgrade the shock potential of initiation devices beyond normal expectations.

Still another object is to provide an initiating explosive structure which is capable of accomplishing uniformly good detonation in relatively insensitive explosive compositions and which can be assembled in the place where such materials are fired and thus avoid handling explosive material altogether. Here even the base explosive is not necessarily active while the above is being carried out.

Other objects of the present invention will become obvious to those experienced in explosives and explosive detonating techniques as the description proceeds.

General description

It is relatively well known in work with explosives that when two charges having substantially equal power factors are placed a distance from each other and are detonated simultaneously, that shock waves emanate radially and concentrically from the situs of each of the charges and that upon collision of the two shock waves a resultant interference shock is observable of a magnitude greater than either one of the shock waves at the point of collision. The present invention makes use of this observation by providing at least a pair of adjacent strands of explosive material and securing them in adjacent spaced apart relation. In practice it has been found convenient to do this by using tubes of a suitable electrically conducting material such as metal although sheaths comprised of boron compounds and celluloid have proved satisfactory. Peculiarly, excellent results are also obtained with tubular sheaths wherein openings or holes are provided therethrough so that the tubular encasing member may even comprise a metal mesh or screen. Simply encasing the explosive train is observed to upgrade the available initiating shock. When two encased spaced apart strands are detonated simultaneously, a shock result of unpredictable magnitude is available for initiation. The explosive shock which results is greatly upgraded

beyond the predictable cumulative increase assuming the added strength of an additional strand. This makes this simple arrangement an excellent initiator in relatively insensitive materials thus avoiding dangerous initiators. This effect of excellent initiation was observed inadvertently in attempts to "wad" or "ball" Primacord material so as to upgrade initiation. In such instances, the Primacord served as priming material. Random "balling" or "wadding" failed to accomplish detonation without supplemental sensitizing in ammonium nitrate explosive compounds, for example. Neither did parallel strands standing in adjacent spaced relationship consistently accomplish an initiating shock in such base loads. However, when the strands of Primacord were encased in metal tubes and were taped at least along part of their length, or otherwise held in abutting relationship the required initiating shock wave was available and shot failures due to inadequate initiation force ceased. The success obtained is believed to result principally from the encasement of the Primacord charge in the boosting sheath. The sheath may be made of conducting material or it may be made of a higher energy fuel such as magnesium, aluminum, boron compounds or even of celluloid. Experimental and actual field usage indicates enhancement of initiation with simple encasement, improvement is indicated using parallel strands of Primacord with a single strand encased, and superior performance was observed where encasement of each of parallel spaced apart Primacord strands was employed. Experiments with non-conducting encasements showed less desirable results. The result also is in part attributed to minimizing of the space gap as between the two or more parallel strands of Primacord. Tubular sheaths of light metal i.e. aluminum and magnesium, boron compounds, and celluloid were tested satisfactorily. Rubber, poly-vinyl chloride, tar, paper and other non-conducting materials did not show well in testing. Aluminum and magnesium encasements seemed best. As will be obvious to persons skilled in the art of initiating explosive materials, such an initiating device is simple to prepare, easy to use, and productive of uniform shooting in avoidance of initiating failure. Shot propagation is greatly enhanced by reason of the fact that the initiators as herein disclosed may be made up as long or as short as necessary.

In the drawings:

FIGURE 1 is a schematic cross section view of a hole having a polyethylene liner, containing a base charge, a sand tamp, and using a single strand of Primacord for attempted initiation. Consistent initiating failure occurred using this system of initiation with relatively insensitive base charges.

FIGURE 2 is a schematic cross section view showing the initiation system set out in FIGURE 1 but where the base charge is confined in a metal can. Consistent failure occurred in using this system of initiation with a relatively insensitive base charge.

FIGURE 3 is a schematic cross section view of the use of an initiation system wherein two parallel strands of Primacord are used in abutting adjacent relationship with both strands fired simultaneously in a base charge substantially as in FIGURE 1 in a polyethylene bag. Occasional detonation was accomplished using this system where Primacord in the strength of about 100 grains per foot was used.

FIGURE 4 shows a schematic cross section of an initiating system as shown in FIGURE 3, except that the base charge is contained in a metal container. Occasional detonation was observed.

FIGURE 5 shows a schematic cross section view of a charge loaded hole wherein the base charge is in a polyethylene bag, the initiating system comprises a single strand of Primacord encased in a metal tube and imbedded in the base charge. Results in terms of detonation was unsatisfactory except when Primacord of relatively high strength (100 grains per foot) was used.

FIGURE 6 is a schematic cross section view showing the initiation system set forth in FIGURE 5 but where the relatively insensitive base charge was contained in a metal container and the tubular metal cased Primacord was imbedded in the charge container. In both 50 and 100 grain per foot Primacord strengths, detonation occurred although with better consistency in the 100 grain strength.

FIGURE 7 illustrates in schematic cross section an initiator prepared from two parallel strands of Primacord fired simultaneously and in abutting adjacent relationship wherein one of the strands is encased in a tube sheath of electrically conducting material. The thus prepared initiator was imbedded in a base charge of relatively insensitive explosive material in a polyethylene bag and upon firing the initiator structure uniform failure of detonation was observed in the 50 grain per foot strengths of Primacord and uniform success of detonation was observed when the 100 grain per foot strength of Primacord was used.

FIGURE 8 is a cross section view showing employment of the initiating system shown in FIGURE 7 except that a metal container is used to hold the base charge. Upon firing the initiator fairly good detonation results were obtained using lower strength Primacord (50 grains per foot) and detonation was indicated in each instance where the 100 grain per foot Primacord was used.

FIGURE 9 is a schematic cross section view showing an initiator prepared from two parallel strands of Primacord, each contained in a tubular electrically conductive case and the cases positioned in abutting relationship to each other and arranged for simultaneous detonation. Using 50 grains per foot strength Primacord occasional detonation was observed where the relatively insensitive base charge material was in a polyethylene bag. Using 100 grains per foot strength of Primacord uniform detonation of the base charge was observed.

FIGURE 10 is a schematic cross section view showing an initiator as set forth in FIGURE 9 inserted in a base charge contained in a metal container. No failures of detonation were observed using this system in either the 50 or 100 grain per foot strengths of Primacord, where the base charge comprised relatively insensitive explosive material.

FIGURE 11 is a perspective view of an initiator structure as shown in FIGURES 9 and 10 and indicating the arrangement of the tubular electrically conductive sheath enclosing each of the looped Primacord strands and both strands having an attached blasting cap attached to the ends thereof for simultaneous firing. The conducting tubular members are secured in adjacent parallel contact with each other.

FIGURE 12 is a perspective view of an initiator structure wherein the conducting tubular member is of mesh or open-work construction. Results using this form of the initiator have indicated excellent detonation properties in relatively insensitive base charges, generally showing a consistent result as in the initiator shown in FIGURE 11.

FIGURE 13 is a partial cross section elevation through a structure similar to that shown in FIGURE 11 indicating the means for securing the conducting tubular members in abutting parallel relationship and the attachment of a blasting cap to the Primacord lines for simultaneous firing. It will be noticed, however, that the two strands of Primacord are not looped as previously illustrated.

FIGURE 14 is a schematic end cross sectional elevation showing a pair of columnar explosive strands encased in electrically conducting and abutting tubes. In this illustration the concentric lines about the explosive train indicate the propagation of primary shock waves. The arcuate lines indicate secondary or rebounding shock waves and their intersection on the line tangential to both tubular cases represents a trace of a plane running the length of the tubes and representing a zone of shock wave

amplification. The possible mechanics of this amplification are suggested.

FIGURE 15 is a chart tabulating the results of a complete shot series in polyethylene bags as set forth in FIGURES 1, 3, 5, 7 and 9 using 50 grain per foot Primacord and 100 grain per foot Primacord.

FIGURE 16 is a chart tabulating the results of a complete shot series in metal cans or containers as set forth in FIGURES 2, 4, 6, 8 and 10 using 50 grains per foot Primacord and 100 grains per foot Primacord.

Specific description

While ammonium nitrate as a base explosive charge has increased in volume employed in detonation work, a uniformly successful means of accomplishing initiation of such base charges has defied engineers and others called upon to accomplish detonation. To date, the shaped charge initiation has given the best uniform results without priming or sensitizing the base charges beyond reasonable safe limits. In general, the relatively insensitive and economical nature of ammonium nitrate explosives is well recognized and has a marked safety advantage in use over more conventional organic explosives. As will be appreciated failure to accomplish initiation and consequent detonation is extremely serious in mining, quarrying and shooting operations. The use of shaped charges for initiation is often times expensive and not fully amenable to field conditions. Shooters employing ammonium nitrate explosive compositions (using oil, water and metal additives) have explored various conventional initiating means without uniform success. The applicants have repeatedly attempted initiation by "balling" or "wadding" Primacord in random orientation in an attempt to accomplish satisfactory initiation. Satisfactory detonation was not obtained using these methods and means. However, occasional detonation indicated that some particular orientation of the detonating means might prove promising. Primacord was selected as the medium because it is universally available and is relatively easy to work with. As will be appreciated by persons familiar in the explosives art the term "Primacord" has reference to a columnar contiguous train of high explosive material confined in a protective plastic or insulating sheath and is available from a variety of explosives supply sources. Conventionally, it is used as a fuse or an initiator. The Primacord is conventionally inserted in a base charge and the explosive train itself is initiated at a selected distance from the base charge as by means of a blasting cap and the shock of explosion propagates from the point of initiating the Primacord to the end of that explosive train. While this system of initiating is quite effective with dynamites, nitro-gels, nitroglycerine and the like, it is uniformly unsuccessful in initiating ammonium nitrate compositions and like materials having equally low responsiveness to initiating shock. With reference to FIGURES 1 and 2, and tabulated shot results as shown in FIGURES 15 and 16, using a 5 shot series for control, no detonation was accomplished with the selected base charge comprising a 72 percent ammonium nitrate load with 14 percent magnesium and 14 percent aluminum metallization. This was true where the base charge was contained in a polyethylene bag (FIGURE 1) and where the base charge was confined in a metal container. These failures were again repeated even through the strength of the Primacord was doubled.

Improved results were observed using the initiator shown in FIGURES 3 and 5 comprising parallel and abutting strands of Primacord using simultaneous initiation. The selected length of Primacord was looped, taped together and initiated with a conventional blasting cap so that firing of both strands was simultaneous. With reference to tabulated results in FIGURES 15 and 16 failures persisted in the 50 grains per foot strength of Primacord but improved at the higher strength of 100 grains per foot and improvement was also observed where

the base loads were contained in the metal container as set forth in FIGURE 4. It was then decided that the results might be enhanced if the Primacord strand was jacketed. Polyethylene sleeves were employed over the Primacord along with vinyl coverings and other tubular organic and substantially electrically non-conducting coverings with no improvement in result. Then an electrically conductive sleeve comprising a tubular thin-walled metal encasement was utilized to jacket a single strand of Primacord. Such an arrangement is illustrated in FIGURES 5 and 6. The former was inserted in an ammonium nitrate base charge as above indicated and the latter was inserted in a metal container filled with the same base charge. No failures were observed in the shot series using the 100 grain per foot Primacord strength with the base charge of FIGURE 5. However, detonation failure was observed in the lower strength Primacord set out in the polyethylene contained base charge although some increase in initiating power was observed. Using the metal base charge container of FIGURE 6 occasional failure of detonation was observed at the lower level strength of Primacord and uniform success was obtained when the higher strength Primacord was used (FIGURES 15 and 16). The shot series of FIGURES 5 and 6 clearly showed an unpredictable increase in detonation efficiency. Tubes of various metals, copper, steel, aluminum, magnesium, and tinned steel wire were used successfully. A celluloid encasement also tested satisfactorily. The so called "light metals" of aluminum and magnesium were preferred.

The shot series as shown in FIGURES 7 and 8 and tabulated in FIGURES 15 and 16 show a further progression in the use of a double strand of Primacord, one of the strands being encased in an electrically conducting tube and the other of the strands in parallel abutting relation thereto. In FIGURE 7, this initiator was inserted in a base charge of ammonium nitrate as employed in the others of the shot series. In FIGURE 8 the initiator was inserted in the mass of the same base charge contained in a metal container. In the FIGURE 7 arrangement no initiating success was observed at the lower strength of Primacord but at the 100 grain per foot strength initiation and detonation was uniformly good. From 5 shots no failures were observed. In the FIGURE 8 arrangement, one failure in 5 attempts was noted at the lower strength level of Primacord and no failures occurred where the 100 grain strength of Primacord was employed. Clearly the results were better employing the higher strength of Primacord and best when the arrangement of FIGURE 8 was used wherein the base charge was in the metal container.

Finally, the shot series illustrated in FIGURES 9 and 10 were attempted wherein two strands of Primacord (actually comprising a loop of a single strand), each encased in thin walled electrically conducting tubing were taped into abutting parallel relationship and fired simultaneously. In FIGURE 9 this was done where the base charge of metallized ammonium nitrate was contained in a polyethylene liner. In FIGURE 10 the same base charge was placed in a metal container. Excellent detonation results were obtained. In obtaining the tabulated data metallized ammonium nitrate was used as the base charge.

The significance of this work is to show an improved initiator comprising at least a pair of adjacent lines of explosive material arranged for simultaneous detonation. Optimum performance is obtained where the strands of explosive material are each encased, or at least one of the strands is encased, in boosting material such as aluminum. In the shot series set forth in FIGURES 1-10, inclusive, and tabulated in FIGURES 15 and 16, the initiator was made up from Primacord in the two strengths indicated, and the explosive base charge comprised a liquid solution of ammonium nitrate with 14 percent magnesium and 14 percent aluminum metallization in fairly large chip form. The ammonium nitrate solution comprised 72 percent by

weight of the base load. One pound of base charge was employed in each test hole in sand and 2 feet of sand tamp was applied over each of the loads. In each shot wherein the base charge was contained in the polyethylene sack, the polyethylene was uniformly used and of stock origin. The metal contrainers used in the test shots illustrated in FIGURES 2, 4, 6, 8, and 10 were number 2 tin plated cans of conventional design perforated axially to receive the initiator structure.

With reference to FIGURE 11, the initiator 21 is shown comprising two parallel strands of Primacord 22 and 23 and being attached to a blasting cap 24 for simultaneous initiation. The two strands 22 and 23 are made up by bending a single strand of Primacord. The blasting cap 24 is taped or clipped by means of 24' to the Primacord strands 22 and 23 adjacent the terminal ends thereof in such a manner that each of the strands 22 and 23 are substantially equal in length measuring from the position of the blasting cap 24. The ends of the Primacord are water-proofed as by wax or other means to avoid the possible dampening out by possible water intrusion. The blasting cap 24 is supplied with electrical leads 25 and 26 for conventional initiation by battery or generator. Each of the strands 22 and 23 are encased in a tubular sheath 27 and 28 held in adjacent parallel and abutting relationship as by tape 29 or other suitable holding means such as wire, metal clips or the like.

FIGURE 12 illustrates a modification of the optimum form shown in FIGURE 11. The initiator 30 comprises parallel adjacent strands 31 and 32 of Primacord. These strands 31 and 32 are arranged so as to explode simultaneously. Initiation of the strands 31 and 32 is accomplished by a blasting cap 33 adjacent to the upper ends of the initiator 30 and each of the strands 31 and 32 being of substantially equal length from the location of the cap 33. The terminal ends of the Primacord are water-proofed against dampening out by possible water intrusion. Tape 34 securely binds the cap 33 in position. Each of the strands 31 and 32 are encased in a wire or open work electrically conducting mesh 35 and 36, and these are secured in longitudinal abutting relationship as by tape 37 or other suitable holding means such as wire, metal clips, or the like. Amazingly, this form of the initiating structure is as effective as the form shown in FIGURE 11, and is as easy to manufacture and the mesh stock is cheaper to obtain. Leads 38 and 39 serve to initiate the cap 33.

FIGURE 13 shows a form of initiator 40 wherein parallel strands of Primacord 41 and 42 are in parallel adjacent relationship for simultaneous detonation by blasting cap 43. However, in initiator 40, both ends of the strands 41 and 42 are clipped and not looped as previously observed in FIGURES 11 and 12. Tubular electrically conducting jackets 44 and 45 are employed over the strands 41 and 42 and the jackets 44 and 45 are held in adjacent abutting relationship by tape 46 or other suitable means. The blasting cap 43 is secured an equal distance from the conducting jackets 44 and 45 as by tape 47. All ends of the strands 41 and 42 are water-proofed to avoid dampening out of the explosive train by the intrusion of moisture or water. Equally good results are obtained using the initiator 40 or the initiators illustrated in FIGURES 11 and 12, the primary difference being that the forms shown in FIGURES 11 and 12 using the looped piece of Primacord are somewhat simpler to construct and less troublesome to waterproof. Electric detonating leads 48 and 49 are connected to the cap 43. While the blasting caps illustrated in FIGURES 11, 12 and 13 are electric caps it is also contemplated that fused caps, percussion caps and the like may be used in specific blasting situations.

FIGURE 14 best illustrates what is believed to occur as a consequence of utilizing parallel adjacent strands of material such as Primacord for initiators, where the

parallel strands are initiated simultaneously. The explosive train (Primacord) is encased in tubular metal sheaths and the sheaths are held in abutting parallel relationship. Upon simultaneous initiation the two parallel explosive trains send out shock waves which travel outwardly from the explosive situs in circumferential form. The principal shock waves intersect in a plane A—A which is tangential through the point of contact between the tubular bodies or sheaths. This is believed to give rise to a reinforced shock wave substantially on the plane A—A, which is further enhanced by secondary shock waves or rebound to provide a planal zone of shock amplification as shown. Usage bears out the fact that the resultant initiating shock is in a higher order than predictable on the basis of total initiating charge. The theory can be proved, for example, by placing two blocks of composition C (an explosive material) a measured distance away from each other, say three inches. If both blocks are detonated simultaneously a shock reinforcement zone in a plane midway between the two blocks is observed and is measurable. In the instance of encasing the trains of Primacord in a tubular boosting sheath an additional quantum of initiating energy is obtained clearly beyond the initiation value of adjacent unjacketed Primacord strands without the use of additional explosive. The initiators herein described are believed to make initiating use of both of these findings. For example, comparing the results of initiation under the conditions of FIGURE 1 loading (single strand) at 50 and 100 grains strength, uniform failure of detonation is observed as against the double strand jacketed system of FIGURE 9 wherein marked improvement in initiating characteristic is shown using identical amounts of Primacord strength in the 50 grain per foot strength. Beyond the results of FIGURE 1 no improvement was found in random orientation of Primacord in equal strength, until, of course, an economic limit in Primacord strength was reached at which point it became questionable as to whether the base charge was the ammonium nitrate composition or the explosive material of the Primacord. FIGURE 11 devices have been twisted longitudinally without diminution of initiating force.

In actual detonation of large loads elongate initiators in accord with the present invention have been used successfully with base charges in excess of several hundred pounds.

While Primacord has been described throughout the specification as the material employed in preparation of the initiators herein described, the invention also encompasses the loading of metal tubes, for example, with material having the explosive strength of the Primacord core and placing such tubes in parallel abutting relationship for simultaneous firing. So also, the plural tubes may be integrally formed in parallel adjacent relationship wherein a thin wall separates the two parallel affixed openings.

Other modifications within the skill of the art will be apparent upon a complete digestion of the specification and such modifications are intended to be included herein limited only by the scope of the hereinafter appended claims.

We claim:

1. In an initiator for base charges of explosive material the combination comprising: a pair of electrically conducting encasements; a strand of Primacord explosive looped and each end passed through the length of each of said conducting encasements; means securing said conducting encasements in adjoining abutting parallel relationship; a blasting cap secured to the ends of said Primacord an equal distance from each of said encasements so as to simultaneously detonate said strand along its entire length.

2. In an initiator for base charges of explosive material

as set forth in claim 1 wherein said encasements are tubular in form and made from a mesh-like metal material.

3. In an initiator for base charges of explosive materials as set forth in claim 1 wherein said encasements are made of aluminum metal in integral form.

4. In an initiator for base charges of explosive materials as set forth in claim 1 wherein said encasements are made of aluminum metal in integral form.

5. In an initiator for base charges of explosive materials as set forth in claim 1 wherein said encasements are spiral windings of wire of light metal.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,021,785

February 20, 1962

Joseph R. Hradel et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 27, strike out "wire"; column 9, line 5, for "made of aluminum metal in integral form" read -- thin walled open-work tubular structures --.

Signed and sealed this 3rd day of July 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents