Sept. 24, 1946. H. J. ROLFES 2,408,125

MEANS FOR SAFEGUARDING ELECTRIC IGNITERS OF BLASTING DETONATORS AGAINST ACCIDENTAL FIRING

Filed Aug. 18, 1942 2 Sheets-Sheet 1

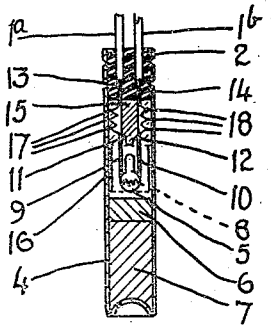


Fig. 1.

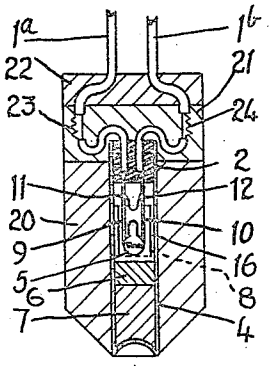


Fig. 2.

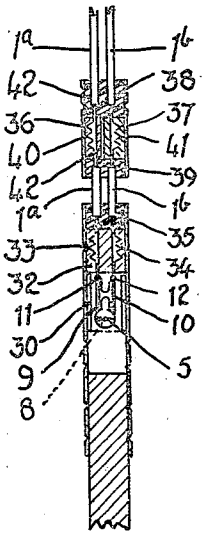


Fig. 3.

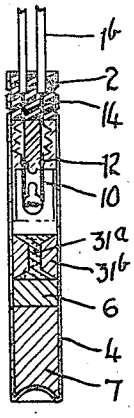


Fig. 4.

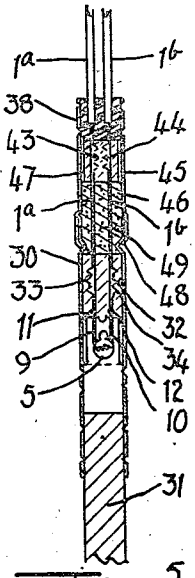


Fig. 5.

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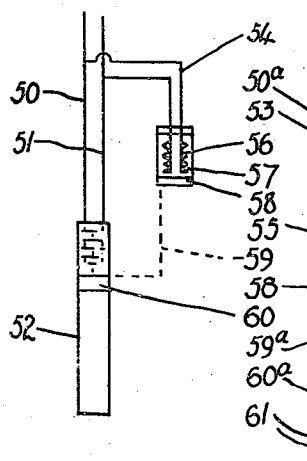


Fig. 6. Fig. 7. Fig. 8.

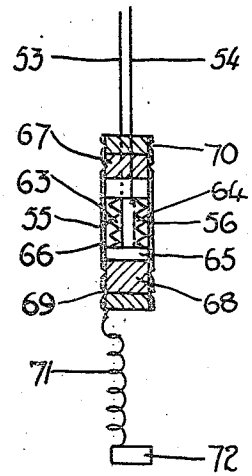


Fig. 9.

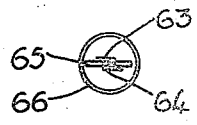


Fig. 10.

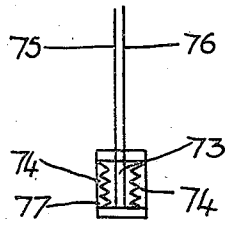


Fig. 11.

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MEANS FOR SAFEGUARDING ELECTRIC IGNITERS OF BLASTING DETONATORS AGAINST ACCIDENTAL FIRING

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Application August 18, 1942, Serial No. 455,236. In the Union of South Africa September 11, 1941

15 Claims. (Cl. 102—28)

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This invention relates to means for safeguarding the electric igniters of blasting detonators against accidental firing by electric currents or spark discharges produced respectively in, or in the vicinity of, the firing means of the igniter by atmospheric electricity.

This application is a continuation in part of my copending application No. 422,453.

It is obvious that a possible solution to this problem is to surround the two electric leads of the igniter at a position a safe distance from the firing means thereof by a grounded mass of a material which may be termed the ideal material, and which will exhibit a high resistance at voltages of the magnitude used for intentionally firing the igniter and a low resistance at voltages of the magnitude of the electrostatic charges which produce the currents and spark discharges aforesaid. One means of obtaining a solution of the problem has already been proposed, viz. to employ, as the grounded material, any material such as, e. g., galena, yellow crystalline iron pyrites or zincite which has the characteristic that its resistance to electric currents or discharges is an inverse function of the voltage applied. Another means is described in my co-pending patent application No. 422,453, viz. to employ a material, such as aluminum flakes, which offers a complete or substantially complete resistance to voltages of the magnitude used for intentionally firing the igniter and which, on its being subjected to voltages of the magnitude of electrostatic charges caused by atmospheric electricity, becomes locally conductive through coherer action along a path or paths permitting the passage therethrough of the high voltage charge.

In any of these cases, it will be understood, it is important that the path or paths to ground afforded by the mass of material (which may be termed the "safeguarding means") to high voltage charges should be such as to ensure that, as far as possible, the whole charge passes instantaneously to ground, without leaving any residual charge in one lead or the other which would produce a flow of current in the firing means, e. g. bridge-wire, sufficient to heat the latter to incandescence.

According to the present invention, means for safeguarding the electric igniters of blasting detonators as aforesaid comprises teeth, projections, edges or other means adapted to constitute discharge points which promote or facilitate the discharge of the high voltage charge from the leads or either of them into the mass.

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The teeth, projections, edges or other means adapted to constitute the discharge points may be formed or provided on bared parts of the electric leads (i. e. the wires of the igniter, fuze-head or other firing means, or the wires of the blasting circuit, or insulated conductors led off from the said wires) and/or on the interior of the casing containing the aforesaid mass adjacent to the leads.

If the said teeth, projections, edges or other means are formed or provided on the leads, those on the one lead are preferably directed outwardly and away from those on the other lead so as to promote, in respect of each lead, the high voltage discharge in a radial path through the mass to the igniter shell or ground. The teeth, projections, or equivalent means are particularly effective as a safeguard against a high voltage electrical surge arising in one lead only, since the teeth, projections or other means provided on or associated with that lead ensure the discharge of the whole surge direct to ground, without any residual surge passing on to the bridge-wire or other firing means sufficient to heat the latter to incandescence. In particular, this is an important safeguard for series blasting, where there is especial danger of a surge being set up in the one lead and causing premature firing in the manner stated.

The invention will now be described by way of example with reference to the annexed drawings, in which:

Fig. 1 is a sectional view in elevation of an instantaneous electric detonator embodying the invention.

Fig. 2 is a sectional view in elevation of an instantaneous electric detonator, enclosed in an inert body or so-called wax primer, embodying the invention.

Figs. 3, 4 and 5 are sectional views in elevation of electric igniters for delay-action detonators, embodying the invention.

Fig. 6 is a diagrammatic view of an alternative means for associating the discharge points and safeguarding mass indirectly with the igniter leads.

Figs. 7 and 8 are diagrammatic views of two embodiments of this alternative means applied to a group of detonators connected in series.

Figs. 9 and 10 are respectively a sectional elevation, and a sectional plan, of a convenient practical form of the alternative means.

Fig. 11 is a view of the alternative means showing an arrangement of teeth, projections or the like in or on the interior of the casing contain-

ing the safeguarding mass, instead of on the leads.

Referring to Figs. 1 to 5:

In Fig. 1, the insulated electric leads 1a, 1b pass through a rubber plug 2 crimped in the mouth of the copper or other conductive shell 4 of the detonator. In the usual manner the detonator shell 4 contains a fuze-head 5, a primary charge 6 and secondary charge 7. The fuze-head 5 has a bridge-wire 8 within the igniter composition or bead thereof, and the one end of the bridge-wire 8 is connected to a bridge-pole 9 and the other end to a bridge-pole 10. These poles 9, 10 are connected at soldering points 11, 12 to the respective leads 1a, 1b.

The leads 1a, 1b are bared at parts 13, 14 respectively spaced from the fuze-head 5 outside the zone of sensitivity thereof. The parts 13, 14 pass through a plug 15 provided within the detonator shell 4 between the rubber plug 2 and the insulating sleeve or body 16 of the fuze-head 5.

The plug 15, hereinafter referred to as the "safeguarding plug," may be a "coherer plug," as described in my co-pending patent application No. 422,453, or a plug consisting of galena or other material having the characteristic that its resistance to electric currents or discharges is an inverse function of the applied voltage, or any other material, such as aluminum flakes, which exhibits a high resistance at voltages of the magnitude used for intentionally firing the igniter and a low resistance at voltages of the magnitude of the electrostatic charges which produce the currents and spark discharges aforesaid.

The bared parts 13, 14 of the leads 1a, 1b are formed with pointed teeth 17, 18 respectively directed diametrically outwards towards the wall of the detonator shell 4. Any projections, edges or other means adapted to constitute discharge points may be employed in lieu of the particular teeth 17, 18 illustrated, so long as they fulfil the purpose of promoting discharge of a high voltage charge from the leads 1a, 1b, or either of them, into the safeguarding plug 15.

When the detonator is fired, the firing current passes in the normal manner through the one lead, say 1a, across the bridge-wire 8, and out through the other lead 1b, the bridge-wire being heated to incandescence and firing the igniter bead of the fuze-head 5. In other words, to the voltage of the magnitude used for the firing current, the safeguarding plug 15 reacts as an insulator. If, on the other hand, an electrostatic charge of high potential is induced in the firing circuit consisting of the leads 1a, 1b and bridge-wire 8, or if this circuit is struck by a lightning discharge, the plug 15 permits the passage of the high voltage charge along outward radial paths from the teeth 17, 18 to the wall of the detonator shell 4, and thence to ground. In this manner the firing circuit discharges its high potential to ground without any flow of current being produced in the bridge-wire 8, or spark discharges being produced in the vicinity of the fuze-head 5, such as would cause incandescence of the bridge-wire or premature ignition of the fuze-head.

By means of the teeth 17, 18 or similar discharge points, an effective safeguard is also provided against the consequences of a high voltage electric surge which may arise in one lead only of the detonator. The discharge teeth (say the teeth 17 if the surge arises in the lead 1a) effect complete discharge of that surge direct to the detonator shell 4, without any residual surge passing on to the bridge-wire 8. In this case, also, therefore, there is no flow of current through the bridge-wire such as might cause incandescence and premature firing of the fuze-head 5.

Fig. 2 shows the application of the invention to a detonator enclosed in an inert body or so-called wax primer 20. Reference numerals used in this figure similar to those used in Fig. 1 refer to similar parts. In this embodiment, the safeguarding plug or mass 21 is made in the form of a layer interposed between the inert or wax body 20 and a top inert or wax layer 22. The leads 1a, 1b are bared and formed with outwardly directed discharge teeth at 23 and 24 respectively, where they pass through the safeguarding layer 21.

In function, the embodiment shown in Fig. 2 is similar to that already described with reference to Fig. 1, and, as shown in Fig. 2, the toothed and bared parts 23, 24 of the leads 1a, 1b are preferably spaced outwardly from each other in the safeguarding layer 21 so as to afford the high voltage discharges a readier path to ground, i. e. to the rock or side of the borehole in which the wax primer is inserted.

In Fig. 3, similar numerals again denote similar parts. The embodiment shown in this figure is an electric igniter having a copper or other conductive cylindrical shell 30 into the lower open end of which there is crimped a flexible delay fuze 31, of which the other end (not shown) is crimped in known manner in the mouth of a detonator. A safeguarding plug 32 is in this instance inserted in the igniter shell 30 so as to surround the solder points 11, 12, the adjacent parts of the bridge-poles 9, 10, and the bared and toothed lower ends 33, 34 of the leads 1a, 1b. The upper end of the igniter shell 30 is closed by a rubber plug 35 crimped therein.

In any of the embodiments of the invention, more than one pair of sets of discharge points enclosed in a corresponding grounded plug or mass may be used in association with the one detonator or igniter. This modification is shown incorporated in the embodiment illustrated in Fig. 3, where, in addition to the safeguarding plug 32 surrounding the toothed parts 33, 34 of the leads within the igniter shell 30, a second safeguarding plug 36 is contained in a separate copper or other conductive sleeve or shell 37 which is crimped on rubber plugs 38, 39 as an independent unit around bared and toothed parts 40, 41 of the leads 1a, 1b outside the igniter shell 30.

When more than one grounded safeguarding plug or mass is thus used, discharge of high voltage charges from the firing circuit to ground may take place through either one or other or both of the said plugs or masses. If the safeguarding plug consists of a "coherer plug" as described in my co-pending application No. 422,453, steps may, if necessary, be taken to ensure that high voltage discharges, should they occur, will not take place through the coherer mass from one lead of the igniter or detonator across to the other. A safeguard against this happening is the outward direction away from one another of the sets of the discharge points in the respective leads as shown in Figs. 1 to 3. As an additional safeguard in such cases, however, the occurrence of discharges between the leads, and consequent short-circuiting of firing current, may be prevented by, for example, either spacing the leads 1a, 1b apart in the coherer mass (as in Fig. 2) a distance which is substantially greater than the distances between the respec-

tive leads and the detonator shell or ground, or inserting between the leads within the coherer mass (as in the case of the upper coherer plug **36** in Fig. 3) a paper sheet **42** or other insulating element.

Fig. 4 shows the application of the invention to a delay-action detonator of the Eschbach type. The construction of this detonator is similar to that of the instantaneous detonator shown in Fig. 1, with the exception that between the fuze-head **5** and the primary charge **6**, a delay composition **31a** (e. g. antimony and potassium permanganate) contained in a lead body **31b** is provided. Otherwise, similar reference numerals in the two figures denote similar parts.

In cases where the safeguarding plug or mass is not a "coherer plug" as aforesaid, but consists e. g. of a galena or like plug having the characteristic that its resistance is an inverse function of the applied voltage, another safeguard against a high voltage charge in one lead producing a dangerous flow of current through the fuze-head **5** is obtained by distributing, equalising or shunting the charge between that lead and the other lead across the portion of the safeguarding plug located between the discharge points of the leads, the discharge across the leads in these cases, i. e. cases other than those in which the safeguarding plug is a "coherer plug" not resulting in the resistance of the material between the leads being permanently reduced below the value necessary to prevent short-circuiting between the leads, through the safeguarding mass, of the ordinary firing current.

This modification is shown in Fig. 5, where, in addition to the discharge points **33**, **34** surrounded by the safeguarding plug **32**, auxiliary discharge points **43**, **44** are formed on the leads **1a**, **1b** respectively with their teeth or points directed towards each other and embedded in an auxiliary safeguarding plug **45**, which may be termed an equalising or distributing plug. This plug **45** is insulated from the copper or other conductive enclosing shell **46**, or ground, e. g. by a rubber or other insulating sleeve or tube **47**. The shell **46** is closed at the top by a rubber plug **38** crimped in the mouth thereof and is joined at the bottom to the top end of the igniter shell **30** by crimping **48**, the two plugs **32** and **45** being separated and insulated from each other by an intervening rubber plug **49** through which the leads **1a**, **1b** pass. With this construction, the equalisation of high voltage charges, between the leads **1a**, **1b** is effected in the upper or insulated plug **45**, and the discharge to ground is effected through the lower or grounded plug **32**, the discharges across the leads, and from the leads to ground, being facilitated in the particular directions desired in both instances.

The grounding or discharging function and the equalising or distributing function may, if desired, be performed by a single grounded plug or mass surrounding the leads, the bared part of each lead within this plug or mass having two sets of discharge points, the one set directed outwardly towards the igniter or detonator shell and the other inwardly towards the other lead. Alternatively, the ground connection, instead of being constituted by the grounded casing of the plug or mass may be constituted by a ground connection situated remote from the plug or mass, which in this case will be contained in an insulating casing.

While, in the drawings, the soldering points **11** and **12** are shown within the safeguarding plug,

these points may be outside the said plug and insulated from each other and from the igniter shell by being surrounded by a rubber or similar plug.

Referring to Figs. 6 to 11:

In these figures, an alternative means of associating the discharge points and safeguarding plug with the igniter leads is illustrated, such means comprising, generally, a safeguarding plug or plugs and discharge points which are not directly in the length of the leads but which are associated with bared ends or parts of insulated conductors led from the respective igniter leads.

Fig. 6 shows the application of this indirect means to a single detonator. The leads **50**, **51** of the detonator **52** are respectively tapped by insulated conductors **53**, **54**, the toothed ends or discharge points **55**, **56** of which are bared and surrounded by a safeguarding plug **57** contained in a grounded metal casing **58**. Desirably, but not necessarily, the casing **58** is electrically connected to the detonator **52** by a conductor **59** and conductive sleeve **60**. This ensures that the detonator casing is not at a lower potential than the discharge casing **58** and that therefore discharge to ground will not take place through the detonator shell in preference to the casing **58**.

Fig. 7 shows the application of the same means to a group of series-connected detonators **61**. The insulated conductors **53**, **54** are in this instance led from the wires **50a**, **51a** of the blasting cable, and the grounded casing **58** is connected by separate conductors **59a**, **59b** and sleeves **60a**, **60b** to the first and last detonators of the series respectively. Otherwise the arrangement is similar to that described with reference to Fig. 6.

Fig. 8 shows another application of the said means to a similar group of series connected detonators **62**. The insulated conductors **53a**, **54a** are led from the blasting wires **50a**, **51a** and their double-direction discharge points **55a**, **56a** inserted into separate safeguarding plugs **57a**, **57b** contained in separate grounded casings **58a**, **58b**. This is a specially effective safeguard against short-circuiting of the firing current, e. g. between the bared ends **55**, **56** (Fig. 7) of the conductors **53**, **54** through the safeguarding plug **57** if it consists of a coherer mass as described in my co-pending patent application aforesaid.

The outside arrangement of the safeguarding plug shown in the preceding Figs. 6 to 8 necessitates that the construction of the plug should be robust, in order to withstand rough handling. In particular, the internal spacing of the discharge points and the casing of the plug must not be disturbed during the charging operations. A rigid and easily made assembly is illustrated in Figs. 9 and 10. In this assembly, the discharge points **55**, **56** of the conductors **53**, **54** are constituted by two strips **63**, **64** of metal foil secured by an adhesive to the opposite sides of an I shaped piece **65** of cardboard or like insulating material, which is a neat fit into the metal casing **66**. This insulating piece **65** serves to position, and to maintain in position, the strips **63**, **64** with respect to the wall of the casing **66**, which is itself closed at top and bottom by sealing means **67**, **68** held in place by crimping **69**, **70**. In the construction shown in Figs. 9 and 10, a copper wire **71** is soldered at one end to the casing **66** and at its other end to a copper ring or sleeve **72**, for connection to the detonator casing (as already described with reference to Fig. 6).

Although the discharge points in Figs. 1 to 10 have been shown as formed on the leads or con-

ductors, they may be formed or provided on the casing of the discharge with their points projecting towards the leads, which may be either plain or themselves formed or provided with a complementary set of discharge points. Fig. 11 shows an outside safeguarding plug 73 with the discharge points constituted by copper strips 74 of zig-zag form placed parallel and adjacent to plain bared conductors 75, 76, and in contact with a conductive casing 77.

With the present invention, an electric detonator is obtained which is substantially safe against stray currents and which in addition is equally applicable to series, as to parallel, blasting.

In the appended claims, the term "electric leads" is to be understood as including the wires of the igniter and/or the wires of a blasting circuit, and/or conductors led from these wires.

I claim:

1. Means for safeguarding the firing means of blasting detonators against static charges, including a safeguarding material of a nature to provide high resistance against current voltages for intentional firing and low resistance to higher voltages of a static charge, means for grounding said safeguarding means, electric leads for the firing means, said leads having bared parts surrounded by the safeguarding material at a distance from the firing means, and discharge points in electrical continuity with said bared parts of such leads to thereby increase the static voltage discharge through said material.

2. A construction as defined in claim 1, wherein the discharge points are in the shape of a series of teeth projecting in opposite directions relative to the leads.

3. Means for safeguarding the firing means of blasting detonators against static charges, including a safeguarding material of a nature to provide high resistance against current voltages for intentional firing and low resistance to higher voltages of a static charge, a shell enclosing said firing means and containing said material, means for grounding the material through said shell, electric leads within said shell for the firing means, said leads within said material being bared and formed in such bared parts with discharge points extending from the respective leads toward but free of contact with said shell.

4. Means for safeguarding electric igniters of blasting detonators against static charges otherwise capable of firing the igniter, including a safeguarding material of a nature having a high resistance to normal firing voltages and a low resistance to higher voltages of a static charge, a shell for said material wholly free of and beyond the igniter, a pair of electric leads for the igniter, each of said leads leading respectively to and within said shell and having bared parts surrounded by said material within said shell, said shell being grounded, the bared part of each of said leads being provided with a series of discharge points within the safeguarding material to promote the discharge of high voltage current from said leads.

5. Means for safeguarding electric igniters of blasting detonators against static charges otherwise capable of firing the igniter, including a safeguarding material of a nature having a high resistance to normal firing voltages, and a low resistance to higher voltages of a static charge, independent shells arranged wholly free of and beyond said igniters, a pair of electric leads for said igniters, said leads being separately directed to and within the material in said shells respectively, the lead within the material of each of said shells being bared and provided on the bared area with electric discharge points, and means for grounding said shells.

6. A construction as defined in claim 5, wherein the discharge points in each shell are in electrical continuity with the lead therein but free of contact with the shell.

7. Means for safeguarding a group of series-connected detonators having electrically-controlled firing means, including blasting leads common to all detonators, a grounded shell independent wholly free of and beyond said detonators, a safeguarding material in the shell and of a nature to present a high resistance to voltages for intentionally firing the igniter and a low resistance to higher voltages of a static charge, electrical conductors leading from the blasting lead to and embedded as bared parts in said material, and connections from said respective shells to the leading and final detonator of the series, the bared parts of the conductors are each provided with a series of discharge points free of contact with the respective shells.

8. Means for safeguarding a group of series-connected detonators having electrically-controlled firing means, including blasting leads common to all detonators, a grounded shell for each lead, each shell being located wholly free of and beyond any detonator, a safeguarding material in each shell, said material being of a nature to present a high resistance to detonator firing voltage and a low resistance to higher voltages of static charges, a conductor from each lead embedded as a bared part in the material of the shell peculiar to that lead, and a conductor from each respective shell to the leading and final detonator of the series, the bared parts of the conductors in said shells being provided with discharge points.

9. Means for safeguarding electric igniters of blasting detonators against accidental firing by electric currents or spark discharges produced respectively in, or in the vicinity of, the firing means of the igniter by atmospheric electricity, comprising in combination a shell enclosing the igniter, a pair of electric leads for the igniter which are bared at parts, and a plug which surrounds said bared parts, said plug consisting of a coherer material of a character to present a high resistance to voltages of an intentional firing current for the igniter and presenting under coherer action a low resistance to voltages of a current to be shunted, the bared parts being each formed to present a plurality of discharge points embedded in said plug.

10. Means for safeguarding electric igniters of blasting detonators against accidental firing by electric currents or spark discharges produced respectively in, or in the vicinity of, the firing means of the igniter by atmospheric electricity, comprising in combination a shell enclosing the igniter, a pair of electric leads for the igniter which are bared at parts, and a plug which surrounds said bared parts, said plug consisting of a coherer material of a character to present a high resistance to voltages of an intentional firing current for the igniter and presenting under coherer action a low resistance to voltages of a current to be shunted, the bared parts being each formed to present a plurality of discharge points embedded in said plug, said discharge points extending toward but terminating short of the shell.

11. Means for safeguarding electric igniters of blasting detonators against accidental firing by

electric currents or spark discharges produced respectively in, or in the vicinity of, the firing means of the igniter by atmospheric electricity, comprising in combination a shell enclosing the igniter, a pair of electric leads for the igniter which are bared at parts, and a plug which surrounds said bared parts, said plug consisting of a coherer material of a character to present a high resistance to voltages of an intentional firing current for the igniter and presenting under coherer action a low resistance to voltages of a current to be shunted, the bared parts being each formed to present a plurality of discharge points embedded in said plug, the bared parts of the leads being spaced apart within the plug a distance materially greater than the distance of either bared part and the adjacent shell.

12. Means for safeguarding electric igniters of blasting detonators of a type including a firing means, an igniter therefor, spaced electric leads for the igniter, each having a definite non-insulated length thereof spaced from the firing means, and an electrically-conductive shell surrounding the parts, said safeguarding means including a coherer mass of aluminum flakes completely filling a definite area in the length of the shell spaced from the firing means and in contact envelopment of non-insulated parts of the electric leads, said aluminum flake mass being normally non-conductive to a predetermined firing voltage and becoming conductive through coherer action to electrical charges of relative higher voltage passing through the leads.

13. Means for safeguarding electric igniters of blasting detonators of a type including a firing means, an igniter therefor, spaced electric leads for the igniter, each having a definite non-insulated length thereof spaced from the firing means, and an electrically-conductive shell surrounding the parts, said safeguarding means including a

coherer mass of aluminum flakes completely filling a definite area in the length of the shell spaced from the firing means and in contact envelopment of non-insulated parts of the electric leads, said aluminum flake mass being normally non-conductive to a predetermined firing voltage and becoming conductive through coherer action to electrical charges of relative higher voltage passing through the leads, the space between the non-insulated portions of the leads within the safeguarding mass being materially greater than the distance between any one lead and the adjacent shell.

14. Means for safeguarding electric igniters of blasting detonators of a type including a firing means, an igniter therefor, spaced electric leads for the igniter, each having a definite non-insulated length thereof spaced from the firing means, and an electrically-conductive shell surrounding the parts, said safeguarding means including a coherer mass of aluminum flakes completely filling a definite area in the length of the shell spaced from the firing means and in contact envelopment of non-insulated parts of the electric leads, said aluminum flake mass being normally non-conductive to a predetermined firing voltage and becoming conductive through coherer action to electrical charges of relative higher voltage passing through the leads, each non-insulated portion of a lead within the safeguarding mass being of increased electrical conductive transverse area within the safeguarding mass to thereby reduce the conductive distance between each lead and the adjacent shell over the conductive distance between the leads.

15. A construction as defined in claim 14, wherein the increased electrical conductive transverse area of each lead is in the form of integral discharge points.

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