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ELECTRIC INITIATOR

Filed Aug. 13, 1962

Fig 1.

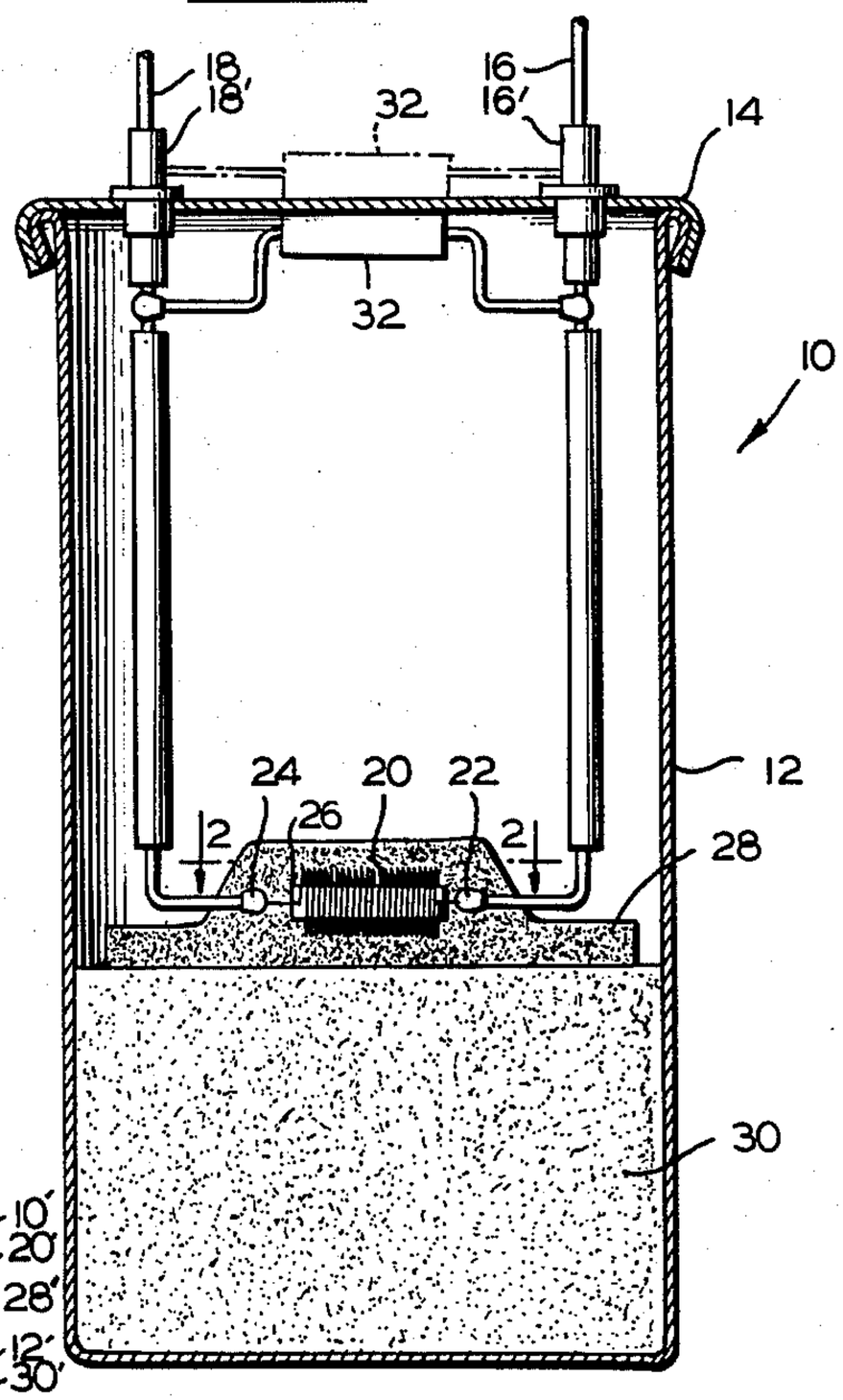


Fig 3.

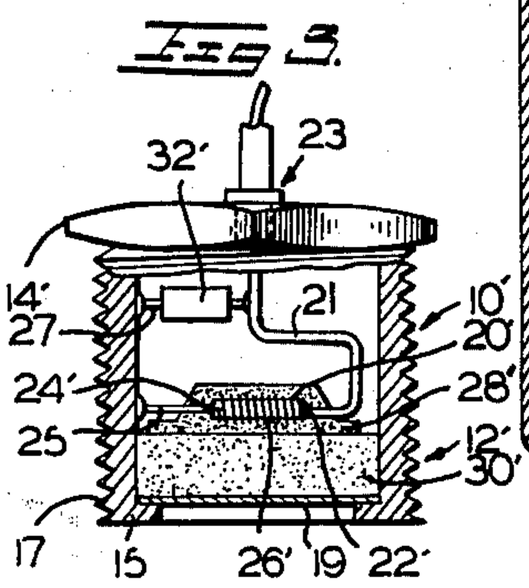
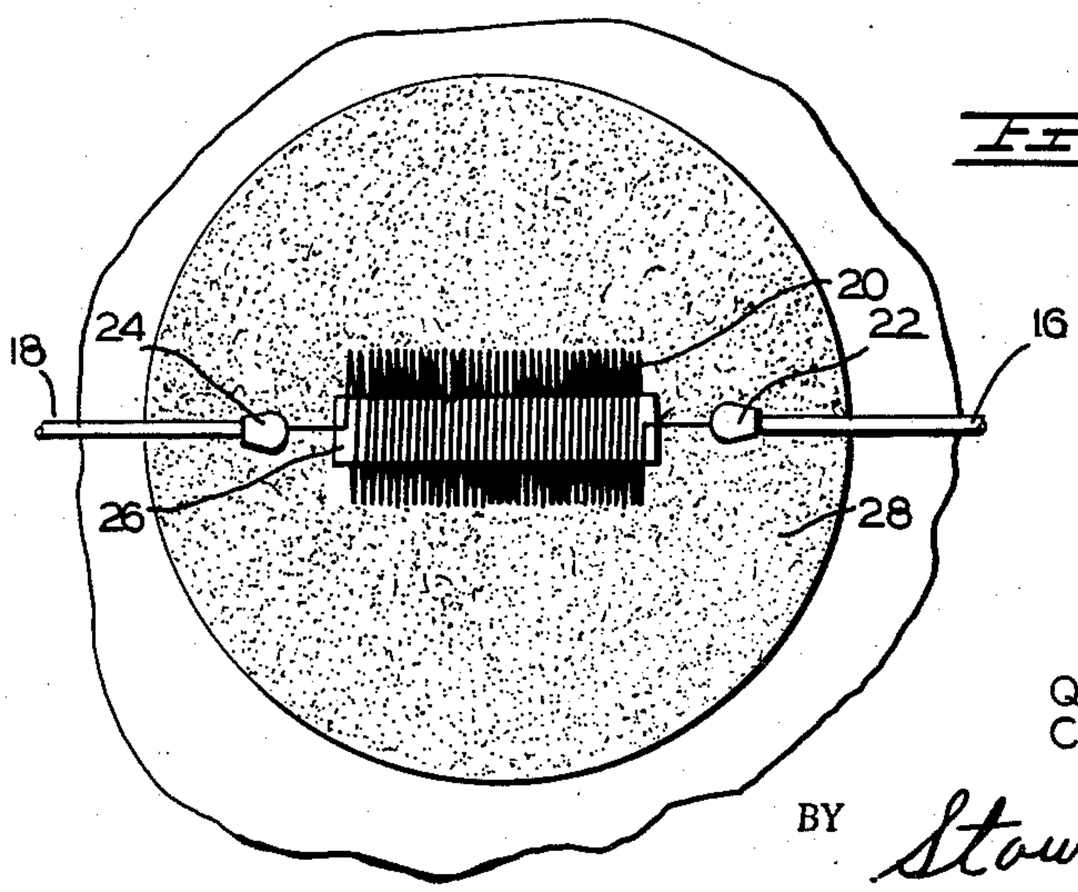


Fig 2.



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ELECTRIC INITIATOR

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7 Claims. (Cl. 102—28)

This invention relates to improvements in electric firing initiating devices and, more particularly, to electric initiators which are highly resistant to premature firing by radio frequency currents induced therein.

The invention relates to electric firing initiating devices which generally include a casing in which is disposed a heater device in contact with a heat sensitive ignition composition or matchhead which, in turn, is embedded in or located adjacent to an explosive charge.

Electrical firing initiating devices are commonly employed to initiate explosive compositions used in conventional blasting caps, in ordnance applications and as igniters for reaction motors of the liquid, gas or solid propellant types. In general, initiators are designed to be actuated by direct current; however, the art has long recognized the dangers inherent in premature discharge of electric initiators by accidentally induced radio frequency currents. This danger of premature initiation is particularly acute in the application of electric initiators in space vehicles where radio frequency initiated guiding systems and control means are employed together with the electrical firing intiating devices.

It is, therefore, a primary object of this invention to provide a direct current initiated electric initiator safeguarded against premature or accidental initiation by radio frequency induced currents.

A further object is to provide improved radio frequency protected electric initiators without substantially reducing the degree of sensitivity of the electric initiator to initiation by direct current.

Another object is to provide an improved initiator protected against premature initiation by radio frequency currents that is relatively inexpensive to manufacture, reliable in use and relatively small in size.

These and other objects and advantages are provided by an electric initiator assembly safeguarded against premature initiation by alternating current induced therein comprising a closed casing, an electrical conductor having one end extending into said casing and selectively connectable at the other end to one terminal to a source of initiating direct current, a fuse wire, the fuse wire being formed into a coil having high reactance at radio frequencies and connected at one end to the electrical conductor within the casing, a metallic core of high permeability within the high reactance coil, a heat sensitive ignition composition in heat exchange relationship to the coil, and a non-inductive resistor adjacent the casing remote from the heat sensitive composition, said non-inductive resistor having one terminal connected to said conductor in parallel with the high reactance coil and positioned in heat exchange relationship to the casing and means for conducting current from the other terminal of the source of direct current to the other end of the high reactance coil and to the other terminal of the non-inductive resistor.

The invention will be more particularly described with reference to the illustrative embodiments thereof shown in the accompanying drawings wherein:

FIG. 1 is an enlarged vertical sectional view through an embodiment of the improved electric initiator of the invention;

FIG. 2 is an enlarged sectional view on line 2—2 of FIG. 1; and

FIG. 3 is a vertical sectional view, similar to FIG. 1, of a modified form of the electric initiator of the invention.

Referring to FIGS. 1 and 2 of the drawings, **10** generally designates the improved electric initiator safeguarded against premature initiation by radio frequency electromagnetic wave energy induced therein. The initiator includes a casing **12** having a cover **14** secured thereto. The casing **12**, including its cover **14**, is preferably constructed of a moisture impervious, electrical and heat conductive material. Metals such as aluminum, copper and silver have been found to provide very satisfactory casings. Metallic casings provide good electrical shielding for the initiator, reduce moisture deterioration of the heat sensitive and explosive compositions and provide a good conductive heat sink for unwanted heat from a shunting resistor as to be more fully described hereinafter.

The initiator includes a pair of electrical conductors **16** and **18** provided with conventional insulation **16'** and **18'** respectively. The remote ends of the electrical conductors **16** and **18** are connectable to a source of firing initiating direct current, not shown in the drawings, while the other ends of the conductors **16** and **18** extend into the interior of the casing **12**. Where the source of firing direct current has one terminal grounded or one terminal connected to the initiator casing, only a single conductor **16** or **18** would be employed as described with reference to FIG. 3 of the drawings.

A fuse wire generally designated **20** is connected across the ends **22** and **24** of the electrical conductors **16** and **18** interiorily of the casing **12**. The fuse wire **20** is formed into a coil having high reactance to radio frequencies, thus limiting the passage of radio frequency current therethrough without substantial interference with the flow of the firing initiating direct current.

It has been found that a .001 inch diameter copper wire formed into a .01 inch diameter coil consisting of 100 turns and having a winding length of .1 inch would have a direct current resistance of about 150 ohms and heating of the coil when subjected to radio frequency waves as low as .5 mc. would only be a fraction of the heat produced by direct current for a given voltage.

Further protection against accidental initiation of the initiator is provided by the metal core **26** for the high reactance coil **20**. A metal core **26** having a permeability of about 2,000 in combination with the high reactance coil described above would have the following inductive reactance X_L:

Frequency (mc.):	X_L (ohms)
0.5	1331
1	2662
10	26620
100	266200

The high reactance coil **20** is as illustrated in the drawings in heat exchange relationship to a heat sensitive primer or matchhead **28** which, in turn, is in contact with a heat sensitive initiator or explosive composition **30**. A suitable primer or matchhead may comprise, for example, mercury fulminate or lead azide.

From the foregoing description of an embodiment of the present invention, it will be seen that the high reactance coil **20**, wound about a metal core having a high permeability, which forms the resistance element of the initiator **10** provides substantial protection for the initiator against initiation by radio frequency currents induced in the conductors **16** and **18** of the device without substantially reducing the effectiveness of the direct current during firing of the initiator.

The inductive reactance of the metal cored coil varies directly as the permeability of the core and by proper selection of the core substantial control of the inductive

reactance of the coil can be obtained. In the above example the core had a permeability of about 2000; by merely employing a core having a permeability of, for example, 100,000, the inductive reactance X_L at .5 mc. would be about 66,500 ohms and at 50,000 cycles per second the inductive reactance would be about 6,655 ohms without changing the D.C. resistance of the fuse wire. Today cores having a permeability of about 1,000,000 can be commercially obtained.

Further radio frequency protection is provided by connecting a non-inductive resistor **32** in parallel with the high reactance coil **20**. The resistance of the resistor **32** may be the same, less or greater than the direct current resistance of the fuse wire **20**, and the resistor **32** is positioned, in the full line illustrated form of the device, within the casing **12** remote from the heat sensitive ignition composition **28** and in good thermal contact with the wall of the cover **14** of the heat conductive casing **12** whereby heat generated in the non-inductive resistor **32** by induced radio frequency current is harmlessly dissipated. It will be recognized that the non-inductive resistor **32** may be positioned externally of the casing, as illustrated in broken lines, and, for example, in contact with the external surface thereof.

In general, it has been found that the D.C. resistance of the shunting resistor ranging from about one-half of the D.C. resistance of the fuse coil to about twice the D.C. resistance of the fuse coil will provide satisfactory results.

It will be appreciated by those skilled in the art that the present invention fully accomplishes the aims and objects hereabove set forth and that various modifications may be made in the disclosed form of the invention without departing from the scope of the appended claims. For example, while the illustrated embodiment of the invention is designed to provide radio frequency protection over an extended range of frequencies, the protection provided by the device may be varied by proper selection of the number of turns on the coil and the permeability of the metallic core; the D.C. resistance of the coil depends on the kind, size and length of the wire in coil.

The resistance of the non-inductive resistor **32** in parallel with the fuse wire coil can be varied depending upon current output of the firing source, and on the reactance built into the fuse coil for a given degree of protection. A low resistance relative to the coil would be preferred so that RF energy would be bypassed through the resistor; however, a low resistance would require a higher initiating current from the igniting source, and the resistor would have to dissipate more heat due to the greater fraction of total current which passes through it. On the other hand a non-inductive resistance greater than that of the fuse coil might be tolerated in view of the high values of reactance which can be obtained in the fuse coil using high permeability core material.

It may be calculated that reactance values obtainable in the fuse coil may be of the order of three to thirteen-hundred kilohms and beyond, when commercially available core material of a permeability value ranging from two-thousand to one-million is utilized; as described in the foregoing examples and the modified form of the invention which follows.

Referring to FIG. 3 of the drawings, there is shown a modified form of the present invention wherein structures corresponding to those illustrated in FIGS. 1 and 2 are provided with primed reference characters.

In FIG. 3 the improved electric initiator **10'** generally includes a casing **12'** having a metallic cylindrical barrel portion **15** provided with external threads **17** and an integral cover **14'**. The cover **14'** is hexagonal in plan whereby the initiator **10'** may be readily screw-connected to the device to be detonated or fired. The lower end of the casing **12'** is closed by a metallic barrier **19** and within the casing **12'** is maintained a heat sensitive initiator

or explosive composition **30'**, a heat sensitive primer or matchhead **28'** and the high reactance coil **20'** wound about a high permeability metallic core **26'**.

One end **22'** of the high reactance coil **20'** is electrically connected to electrical conductor **21** which passes through an insulated opening **23** in the cover **14'** of the initiator **10'**. The opposite end **24'** of the high reactance coil **20'** is connected by an electrical conductor **25** to a wall of the metallic casing **12'**.

As in the form of the invention shown in FIGS. 1 and 2, the assembly also includes a non-inductive resistor **32'** in contact with the inner curved wall of the barrel portion **15** of the casing **12'** having one terminal connected to the electrical conductor **21** and the other terminal connected by conductor **27** to a wall of the metallic casing **12'**.

In operation of this form of the invention the electric initiator **10'** is tightly screwed into the device to be detonated or fired to provide good electrical conduction between the device and the casing **12'**. The device to be detonated or fired or the casing **12'** is then connected to one lead of a source of firing direct current while the other terminal provided by electrical conductor **21** is selectively connected to the other terminal of the source of firing initiating direct current.

In this form of the invention, the high inductance coil **20'** has a length of 0.2 inch and is formed from 40 turns of copper wire 0.005 in. in diameter. The coil has a diameter of 0.05 in.

This coil is wrapped about a metallic core having a permeability of about 500,000.

The D.C. resistance of the coil is about 15 ohms and the high reactance coil has the following inductive reactance X_L:

Frequency (mc.):	X_L (ohms)
0.05	62,800
.5	628,000
1.0	1,256,000

We claim:

1. An electric initiator assembly safeguarded against premature initiation by radio frequency current induced therein comprising a closed casing, an electrical conductor having one end extending into said casing and selectively connectable at the other end to one terminal of a source of initiating direct current, a fuse wire, said fuse wire being formed into a coil having high reactance of the order of three to thirteen-hundred kilohms at a radio frequency of one megacycle and connected at one end to the electrical conductor within the casing, a metallic core of high permeability of the order of two-thousand to one-million positioned within the turns of the high reactance coil, a heat sensitive ignition composition in heat exchange relationship to said coil and means for conducting current from the other terminal of the source of direct current to the other end of the high reactance coil.

2. An electric initiator assembly as in claim 1 further including a non-inductive resistor adjacent the casing remote from the heat sensitive ignition composition and positioned in heat exchange relationship to the metallic casing; one terminal of said non-inductive resistor being connected to said conductor, and the other terminal being connected to said last-named means for conducting current.

3. An electric initiator assembly safeguarded against premature initiation by radio frequency current induced therein comprising a closed casing, an electrical conductor having one end extending into said casing and selectively connectable at the other end to one terminal of a source of initating direct current, a fuse wire, said fuse wire being formed into a coil having high reactance at radio frequencies and connected at one end to the electrical conductor within the casing, a metallic core of high permeability within the high reactance coil, a heat sensitive ignition composition in heat exchange rela-

tionship to said coil, a non-conductive resistor within the casing remote from the heat sensitive ignition composition, one terminal of said non-inductive resistor being connected to said conductor, and means for conducting current from the other terminal of the source of direct current to the other end of the high reactance coil and to the other terminal of the non-inductive resistor.

4. The invention defined in claim 3 wherein said means for conducting current from the other terminal of the source of direct current to the other end of the high reactance coil and to the other terminal of the non-inductive resistor comprises a second electrical conductor having one end extending into said casing and selectively connectable at the other end to the other terminal of the source of initiating direct current.

5. The invention defined in claim 3 wherein said means for conducting current from the other terminal of the source of direct current to the other end of the high reactance coil and to the other terminal of the non-inductive resistor includes electrical conductors connecting the other end of the high reactance coil and the other terminal of the non-inductive resistor to said casing and said casing comprises an electrical conductive member.

6. An electric initiator assembly safeguarded against premature initiation by radio frequency current induced therein comprising a closed casing, a pair of electrical conductors having one end extending into said casing and selectively connectable at the other end to a source of initiating direct current, a fuse wire, said fuse wire being formed into a coil having high reactance at radio frequencies and connected across the pair of electrical conductors within the casing, a metallic core of high permeability within the high reactance coil, a heat sensitive ignition composition in heat exchange relationship to said coil and a non-inductive resistor within the casing

remote from the heat sensitive ignition composition, said non-inductive resistor being connected to said pair of conductors in parallel with the high reactance coil.

7. An electric initiator assembly safeguarded against premature initiation by radio frequency current induced therein comprising a closed metallic casing, a pair of electrical conductors having one end extending into said metallic casing and selectively connectable at the other end to a source of initiating direct current, a fuse wire, said fuse wire being formed into a coil having high reactance at radio frequencies and connected across the pair of electrical conductors within the metallic casing, a metallic core of high permeability within the high reactance coil, a heat sensitive ignition composition in heat exchange relationship to said coil, and a non-inductive resistor within the casing remote from the heat sensitive ignition composition, said non-inductive resistor being connected to said pair of conductors in parallel with the high reactance coil and positioned in heat exchange relationship to the metallic casing.

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SAMUEL FEINBERG, *Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,180,262 April 27, 1965

Claude P. Talley 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 1, line 49, for "terminal to" read -- terminal of --; column 4, line 60, strike out "metallic"; column 5, line 1, for "non-conductive" read -- non-inductive --.

Signed and sealed this 7th day of September 1965.

SEAL)
test:

RNEST W. SWIDER
testing Officer

EDWARD J. BRENNER
Commissioner of Patents