MILD DETONATING FUSE LOGIC COMPONENTS

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ABSTRACT

Mild detonating fuse is used to construct explosive circuit elements. Specifically, a non-destructive explosive crossover, two explosive diodes, an explosive gate, an explosive switch, and two explosive Y junctions are disclosed.

15 Claims, 7 Drawing Figures
MILD DETONATING FUSE LOGIC COMPONENTS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to explosive circuit logic components and more particularly to explosive logic circuit components that are constructed from mild detonating fuse.

2. Description of the Prior Art

There have been three prior applications related to explosive circuitry, now pending application Ser. No. 478,676, filed June 30, 1965, by Denis A. Silvia; now pending application Ser. No. 644,432, filed May 29, 1967, by Denis A. Silvia; and Richard T. Ramsey; and U.S. Pat. No. 3,430,564 to Silvia, Ramsey and Spencer. In the previous explosive circuits 0.025 inch thick deta sheet (EL30 GC) or powder explosive was placed in individual tubes. The present invention eliminates the construction of explosive circuits with much lower explosive output than the prior art explosive circuits. All of the logic operations described in the prior art applications can be done with mild detonating fuse components more simply and with much less attention to manufacturing detail and precise dimensions.

SUMMARY OF THE INVENTION

In order to improve the explosive circuit elements of the prior art, the present invention provides a series of configurations of mild detonating fuse. Fuses having different explosive outputs and different casing thickesses are used, and these differences are taken advantage of by proper spacing of fuse lengths to construct explosive circuit logic components. This new system performs all the functions of the prior art systems but with as little as 20 percent as much explosives. This means explosive circuits can be more compactly made and with no fear of damaging neighboring systems. The reduction in size of explosives does not impair the ability of this explosive system to initiate a secondary explosive.

OBJECTS OF THE INVENTION

It is an object of this invention to provide explosive circuitry having a low explosive output.

Another object of this invention is to provide explosive circuitry which can be made from explosive fuse.

A further object of the invention is to provide explosive circuitry which can be simply constructed with relatively little concern for precise tolerances and dimensions.

A still further object of the invention is to provide explosive circuitry having improved operating characteristics.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a non-destructive crossover according to the present invention;
FIG. 2 shows an explosive diode according to the present invention;
FIG. 3 shows an alternate diode made according to the present invention;
FIG. 4 shows an explosive gate according to the present invention;
FIG. 5 shows an explosive switch made according to the present invention;
FIG. 6 shows an explosive Y junction made according to the present invention; and
FIG. 7 shows an alternate Y junction made according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a crossover according to the present invention made from two lengths of mild detonating fuse 11 and 12. Mild detonating fuse is a conventional term of art for fuse having a low explosive output. The crossover can be used to either convey a detonation from A to D or not convey a detonation from A to D depending on the condition at C. C may be any kind of device or explosive circuit element which can vary the time necessary for a detonation to travel from point B in fuse 11 to point B in fuse 12. For example, C could consist of two alternate explosive paths, one of slow burning explosive and one of fast burning explosive. These paths could be connected to another, prior operating, explosive network which would burn one of the paths leaving only the other path available to conduct the detonation in fuses 11 and 12. Which path is burned by the prior operating explosive circuit would depend on the desirability, under the existing conditions, of a detonation reaching point D. By selecting the spacing and relative sizes of fuses 11 and 12 at point B, a circuit element can be constructed so that if the detonation is delayed in C, the effects of the detonation of fuse 11 at point B will have cut fuse 12 at point B by the time the detonation proceeds through C and arrives at point B in fuse 12. This will prevent a detonation from reaching D. However, if the detonation proceeds quickly through C, the effects of detonation of fuse 11 at point B will not have had a chance to completely cut fuse 12 at point B by the time the detonation arrives there. This will allow a detonation to reach D.

FIG. 2 shows a diode in accordance with the present invention comprising a small mild detonating fuse 14 and a large mild detonating fuse 15 with the end of the small fuse 14 being perpendicular to fuse 15. With this arrangement a detonation proceeding from A to C will jump the gap CD and initiate the large fuse 15. This situation is shown in FIG. 3 and 4. By controlling the total length of the fuse to jump the gap DC it is possible to control the time for the large fuse to 14, 16, and 10 grain mild detonating fuse is used for the large fuse 15, 16, then the gap CD and GH should be approximately 0.045 inches.

FIG. 4 shows an explosive gate made of a small mild detonating fuse 19 and a large mild detonating fuse 20 crossing and spaced from fuse 19. A detonation beginning at A will proceed along fuse 19 to B without initiating fuse 20 because large fuse 20 has a relatively strong casing and is spaced from fuse 19 so that the effects of detonation of fuse 19 will not penetrate this casing. If, however, fuse 20 is initiated first, it will cut fuse 19 and prevent a detonation from proceeding from A beyond E.

FIG. 5 shows an explosive switch which employs explosive gates to change the output from one mild detonating fuse to another. This is similar to prior art explosive switches except that mild detonating fuse is used. A detonation beginning in cord 21 proceeding from A to B will be switched to C if fuse 25 first cuts fuse 24 at D. If this happens the detonation will proceed through fuse 22 to point C. However, if fuse 25 is not detonated to cut fuse 24, the detonation in fuse 26 will detonate fuse 26 which cuts fuse 22 thereby preventing a detonation from reaching point C and a detonation will therefore reach only point B. Fuse 24 is small relative to fuse 25 and fuse 22 is small relative to fuse 26 so that detonation of fuses 25 and 26 will provide gaps large enough to prevent propagation of a detonation.
FIG. 6 shows one embodiment of a Y junction. The use of this element allows one detonation trail to meet a second fuse at a point and leave on a third without initiating the second fuse. Basically FIG. 6 shows a Y junction made of two diodes, fuse 34 and 31 forming one diode and fuse 34 and 32 forming another diode. A detonation from either point A or D will be propagated through fuse 31 or 32 to fuse 34, however, neither the detonation of fuse 31 or 32 will be propagated to the other of the two fuses because of their spacing and because of the protective effect of the fuse casings. A detonation beginning at F fuse 34 will not be propagated to either fuse 31 or 32. FIG. 7 shows an alternate and more compact design for a differently functioning Y junction. With this arrangement a detonation in a large fuse 30 will jump to small fuse 28 and proceed to point J, however, it will not detonate fuse 29. A detonation beginning in fuse 29 will also jump to fuse 28 and detonate J, however, it will not jump to fuse 30. A detonation beginning at point J will proceed up fuse 28 and detonate both uses 29 and 30. This result is brought about by placing fuse 28 close to the ends of fuses 29 and 30 so that its casing will not protect it from detonation in response to detonation of fuses 29 and 30. Because of the larger spacing between fuses 29 and 30 and buffer effect of cord 28, detonations will not transfer from cord 29 to fuse 30 or vice versa.

All of the above elements can be made from almost any size of fuse. Mild detonating fuse is used because of its low explosive output which minimizes the danger of damage to neighboring systems. In experiments and practice the small fuse lengths have been made from 2 grain per foot mild detonating fuse and large fuse lengths have been made from 5 and 10 grain per foot mild detonating fuse. The larger the explosive output of the fuses which are used, the smaller the operating time required for the circuit. However, generally, the decrease in operating time does not justify the increase in the explosive output due to using large explosive fuses. Obviously many modifications and variations of the present invention are possible in the light of the above teachings. For example the sizes of the fuse lengths can be varied to suit particular requirements, and gap widths required can easily be determined for the particular size of fuse used. Many other circuit elements and combinations of elements can be devised with the instant inventive concept by varying the spacing between fuses and varying the size of fuses used.

What is claimed is:
1. An explosive crossover comprising:
a first explosive fuse;
a second explosive fuse crossing said first fuse at a point and being spaced therefrom a predetermined distance; means connecting said first fuse and said second fuse selectively actuable to either relatively delay or relatively not delay a detonation in passing between said first and second fuses; and said predetermined spacing between said first and second fuses being correlated with the explosive output of said first fuse, the protective capacity of the casing of said second fuse, the length of said first and second fuse between said crossing point in said first fuse and said crossing point in said second fuse, and the length of possible delay of a detonation in passing between said first and second fuse, so that a detonation proceeding first through said first fuse will cut said second fuse at said crossing point before said detonation reaches said crossing point in said second fuse only if said detonation is subsequently relatively delayed by said connecting means.
2. An explosive diode comprising:
a first fuse having an exposed end;
a second fuse having a protective casing at an angle to said first fuse and spaced a predetermined distance from an end of said first fuse; and said predetermined distance being correlated with the explosive outputs of said first and second fuses and the protective capacity of the casing of said second fuse so that a detonation proceeding first through said second fuse will cause initiation of said first fuse through said exposed end, but a detonation proceeding first through said first fuse will not cause initiation of said second fuse.
3. The explosive diode of claim 2 wherein said first fuse is of larger explosive output than said second fuse.
4. An explosive diode comprising:
a first fuse of relatively large explosive output;
a second fuse of relatively small explosive output having an end aligned with and spaced a predetermined distance from an end of said first fuse; and said predetermined distance being correlated to the relative explosive outputs of said first and second fuses so that a detonation proceeding first through said first fuse will cause initiation of said second fuse but a detonation proceeding first through said second fuse will not cause initiation of said first fuse.
5. An explosive gate comprising:
a first fuse having a casing; and a second fuse crossing said first fuse and being spaced therefrom a predetermined distance; and said predetermined distance being correlated to the explosive output of said second fuse and the protective capacity of the casing of said first fuse so that a detonation proceeding through said second fuse will cut said first fuse.
6. The explosive gate of claim 5 wherein said second fuse is of greater explosive output than said first fuse.
7. The explosive gate of claim 6 wherein said predetermined distance is further correlated to the protective capacity of the casing of said second fuse so that a detonation proceeding through said first fuse will not cut said second fuse.
8. An explosive device for switching a detonation beginning at a first point so that it will arrive at either a second point or a third point, said device comprising:
a first fuse connecting said first point and said second point; a second fuse connected to said first fuse adjacent said first point extending to said third point; a third fuse connected to said first fuse adjacent said second point and crossing and spaced from said second fuse to cut said said fuse by detonation of said third fuse; a fourth fuse crossing and spaced from said first fuse to cut said first fuse at a point between said second and third fuses by detonation of said fourth fuse; and the length of said second fuse between said first fuse and said third fuse being such that a detonation proceeding through said first fuse past said fourth fuse will detonate said third fuse to cut said second fuse before the detonation in said second fuse passes said third fuse.
9. An explosive Y junction comprising:
a first fuse; a second fuse at an angle to said first fuse and spaced a predetermined distance from an end of said first fuse; a third fuse at an angle to said first fuse and spaced said predetermined distance from said end of said first fuse and spaced another predetermined distance from said second fuse; the predetermined distance between said end of said first fuse and said second and third fuses being correlated with the explosive outputs of said first, second, and third fuses and the protective capacity of the casings of said second and third fuses, so that a detonation proceeding first through either said second or third fuse will initiate said first fuse but a detonation proceeding first through said first fuse will not initiate either said second or third fuses; and the predetermined distance between said second and third fuses being correlated with their explosive outputs and the protective capacities of their casings so that a detonation in either one of said second or third fuses will not initiate the other.
10. The explosive Y junction of claim 9 wherein said first fuse is of relatively large explosive output and said second and third fuses are of equal relatively small explosive output.
11. An explosive Y junction comprising:
a first fuse;
a second fuse having an end thereof aligned with and spaced
a predetermined distance from an end of said first fuse;
a third fuse at an angle to said first and second fuses
between the adjacent ends of said first and second fuses;
and
said predetermined distance being correlated to the explosive outputs of said first, second, and third fuses, the physical size of said third fuse, and the protective capacity of the casing of said third fuse, so that a detonation in either said first or second fuse will initiate said third fuse but not the other of said first or second fuse, and a detonation in said third fuse will initiate both said first and second fuses.

12. The explosive Y junction of claim 11 wherein said first and second fuses are of equal relatively large explosive output and said third fuse is of relatively small explosive output.

13. Fuse explosive circuitry consisting of:
a first fuse;
a second fuse spaced a predetermined distance from said first fuse;
said predetermined distance being correlated with the explosive output of one of said fuses and the protective capacity of the casing of the other, so that detonation of said one fuse will cut said other fuse.

14. The circuitry of claim 13 wherein said predetermined distance further is such that detonation of said other fuse will not cut said one fuse.

15. Explosive circuitry consisting of:
a first fuse;
a second fuse spaced a predetermined distance from said first fuse; and
said predetermined distance being correlated to the relative explosive outputs of said first and second fuses, so that detonation of one of said fuses will initiate the other but detonations of the other of said fuses will not initiate said one fuse.