Dec. 8, 1964 W. C. MORGAN 3,160,789

INSULATED EXPLODING BRIDGEWIRE HEADER

Filed Dec. 26, 1961

FIG. 1

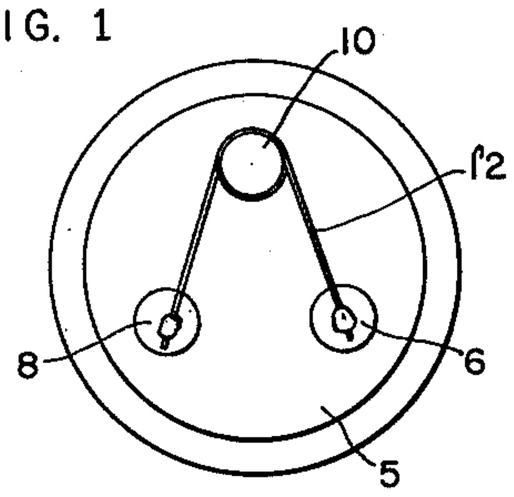


FIG. 3

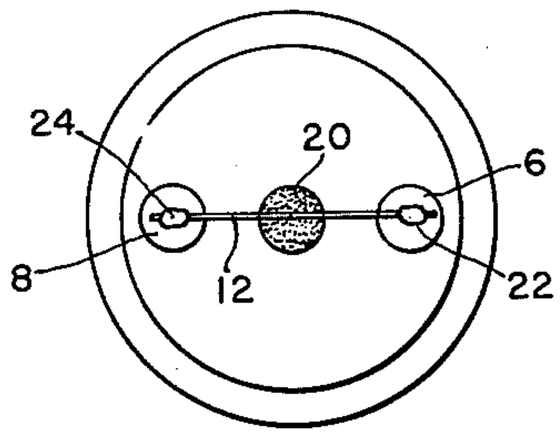


FIG. 2

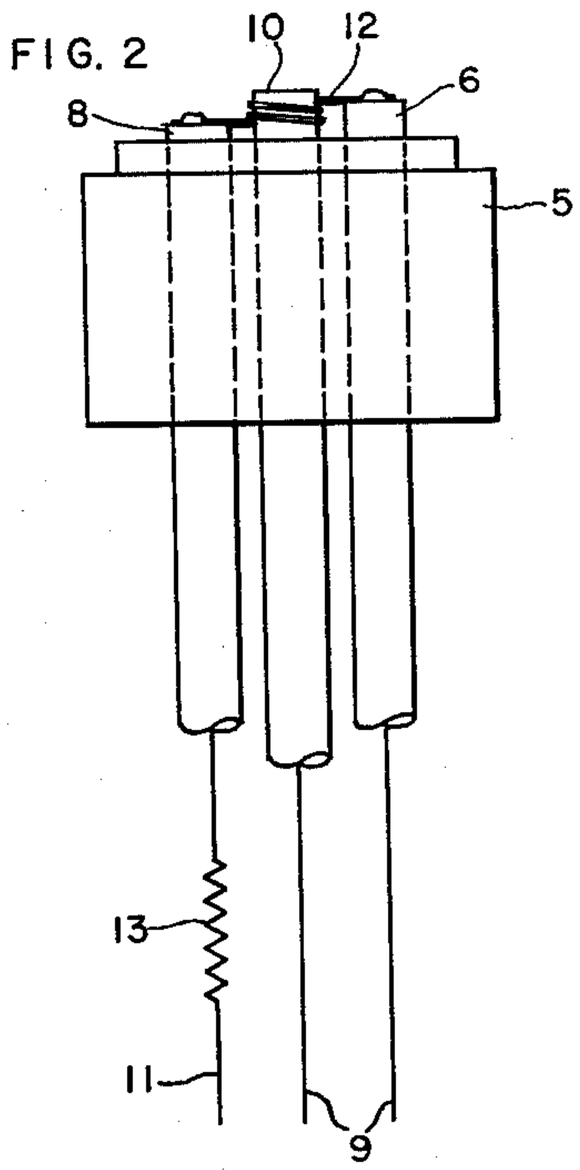
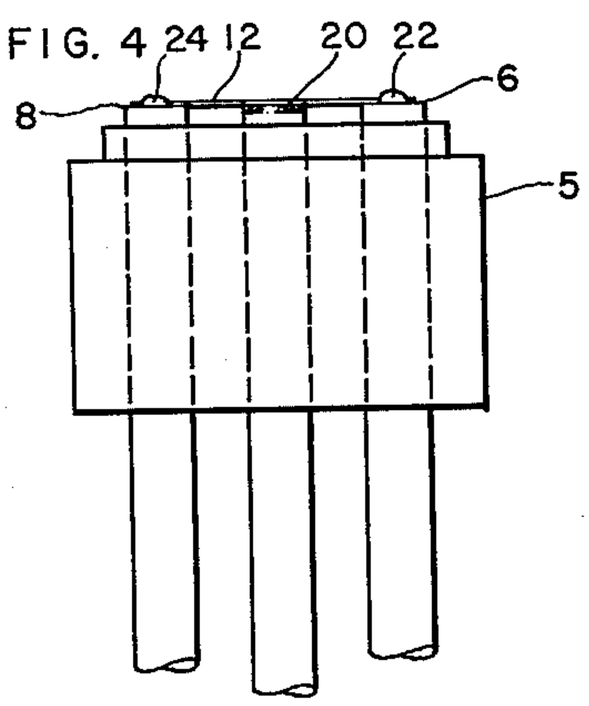


FIG. 4



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3,160,789

INSULATED EXPLODING BRIDGEWIRE HEADER

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This invention relates to a novel and improved exploding bridgewire and more particularly to a novel and improved insulated exploding bridgewire header.

The problem of providing safety means for electrical explosive devices, heretofore, has been solved largely by providing in the electrical firing circuit in series with the firing wire, a series safety spark gap either air or other gases, or by the use of a solid state element such as a diode, or by the provision of a solid dielectric in series between the wire and its supporting lead post for the purpose of preventing actual actuation, or dudding of the electrical explosive device due to stray or accidental electrical currents. A complete exposition on this problem and description of one solution therefore, is to be found in co-pending patent application, Serial Number 165,923, filed January 12, 1962, entitled, "Solid Dielectric Exploding Bridgewire Safety Element," William C. Morgan, R. Rhoades and R. Stresau, inventors, in which a solid dielectric element is provided between the header post and the exploding bridgewire. Prior art safety devices of this type encountered objectionable difficulties because of the difficulty and often times complete inability to test the electrical explosive device for electrical continuity prior to actual firing, without resorting to complex and usually remotely located auxiliary test equipment. None of the tests devised, having systems of this sort, are entirely satisfactory for various reasons, and particularly because a positive definite continuity of the wire itself, could not be tested when a gap insulation element is placed in series therewith, for the simple reason that, if sufficient current is applied to the circuitry to bridge the gap or pass through the insulation, the exploding bridgewire of the electrical explosive device is either burned to a "dud" or an actual firing of the explosive device occurs. If auxiliary test equipment is applied to the circuitry instead of passing an actual current through the bridgewire and the circuit, only a simulated test is performed and this cannot give a positive indication of a break or opening in the wire itself.

One object of this invention is to provide an exploding bridgewire header having all of the safety features of the insulated bridgewire assembly in which electrical continuity of the bridgewire can be positively tested and the integrity of the bridgewire assembly be established.

Other objects and advantages of this invention will become apparent as the invention proceeds and when taken in connection with the accompanying claims and drawings, in which:

FIGURE 1 shows an end view of a bridgewire header utilizing a preferred form of insulated exploding bridgewire assembly embodying my invention;

FIGURE 2 is a side view of the bridgewire header shown in FIGURE 1;

FIGURE 3 shows a modified form of header illustrating how the particular arrangement of the exploding bridgewire and lead posts can be rearranged; and

FIGURE 4 shows an enlarged elevational view illustrating how the exploding bridgewire in the preferred embodiment of my invention is connected to the lead posts in FIGURES 1 and 2.

Briefly described, my invention comprises the provision of an exploding bridgewire or conventional electrical explosive device having a pair of electrical leads or posts connected to the two extreme ends of the bridgewire and a third lead or post disposed between the pair of leads,

with the bridgewire wrapped around the center lead and insulated therefrom and in direct electrical contact with the two outer pair of leads.

Turning now to a detailed description of my invention. In FIGURES 1 and 2, there is shown a pair of bare wires or non-insulated electrical leads or lead posts designated by the numerals 6 and 8. The lead posts 6 and 8 are mounted in a support or case 5 and extend therethrough, as shown in FIGURE 2. A third bare wire electrical lead post, designated by the numeral 10, is provided in case 5, as shown. Leads 6 and 10 are connected to a suitable firing circuit 9 and lead 8 is connected to a monitoring circuit 11. A resistance 13 preferably, if desired, may be provided in circuit 11 or may also be provided in the circuit connected to lead 6. Bridgewire 12 is electrically connected, as by soldering or welding, at its two ends to lead posts 6 and 8, as shown. The exploding bridgewire 12 is wrapped around lead post 10 and is insulated therefrom. In the preferred embodiment of my invention, shown in FIGURES 1 and 2, the bridgewire 12 is a conventional insulated wire, the insulation of which is a dielectrical coating such as mylar or the like. It is to be understood here, that the particular insulation material forms no part of this invention and that various types of insulations such as the epoxies, resins or even enamels, could be used depending upon the conditions expected to be encountered in the utilization of the wire and therefore, form no part of this invention. In actual practice, a number of methods of insulating the exploding bridgewire 12 from post 10 have been tried, and depending upon various circumstances and conditions have been found to be successful. For example, in addition to using conventional insulated wires, it has also been found satisfactory to insulate the lead or post 10, and when desirable, it has been found that the exploding bridgewire 12 and the lead post 10 can both be bare and that various suitable hardening insulating materials can be applied to the lead 10 or the wire 12 with varying degrees of success without departing from the spirit of my invention.

Before turning to an explanation of how the preferred form of my invention operates, a detailed modification of my invention will be first described.

In FIGURE 3, there is illustrated a modified form of insulated exploding bridgewire header, embodying my invention, which, for manufacturing purposes, is found desirable to use and has been successfully tried and tested. The two lead posts 6 and 8 are provided the same as in the embodiment shown in FIGURE 1, but in a straight line therewith is a center post 20, as shown. Center post 20 is comparable in all respects to center post 10. In this case, the exploding bridgewire is electrically connected, as by soldering or welding, to the end posts 6 and 8, as explained in connection with FIGURE 1 and is then drawn tightly between posts 6 and 8 but across post 20. The wire 12 can either be insulated itself, as explained in connection with FIGURES 1 and 2, or the top of post 20 can be insulated and the wire 12 completely bare.

The enlarged elevational view, shown in FIGURE 4, explains more clearly the manner in which the wire 12 is connected to posts 6 and 8 as well as the manner in which the wire 12 is wrapped around post 10. As will become apparent from studying the drawings, the wire 12 is soldered or welded to posts 6 and 8 at 22 and 24.

Turning now to an explanation of the operation of my invention. As is customary in exploding bridgewire and also in ordinary conventional electrical explosive firing devices, a current of suitable energy will be impressed across terminal posts 6 and 10. The dielectric or insulation between the post 10 and wire 12 will break down to the point where it is without resistance and the entire amount or approximately the entire amount of current will then pass through wire 12 causing the same to explode

or heat to incandescence and initiate either a primary or secondary explosive, all of which is well known in the art and which forms no part of the invention and is therefore deemed unnecessary to explain in more detail in order to clearly understand the function of this invention.

However, with insulating material separating the terminals of lead post **10** and the exploding bridgewire **12**, it is impossible to test the bridgewire **12**, in situ, with a lower current than is required to bridge the gap and break down the insulating dielectric. Conventionally and suitably, the current necessary to break down the insulation must also be sufficient to explode the wire. Therefore, it is impossible to positively determine, by passing a current of lower amplitude than that necessary to fire the wire through the wire itself, whether or not the wire is properly electrically connected to the terminals of the posts and is unbroken. This inability of the normal insulated exploding bridgewire header and even to the conventional series safety gap bridgewire headers to respond to conventional electrical safety tests is undesirable and under some conditions is completely intolerable.

In solving this problem and overcoming this objection, the wire **12** extending electrically between two posts and insulated from a third post, permits the transmission of an electrical current of low amplitude well below the firing voltage required through the entire bridgewire, and from this transmission of current, it can be positively ascertained that the wire is unbroken and is properly electrically connected to its terminals without, in any manner, damaging or breaking down the solid dielectric gap provided between the wire and the second of its electrical firing terminals. Obviously, when a current of an amplitude safely below that required to first the wire is applied to the circuitry connected to posts **6** and **8**, an instantaneous reading of continuity of the wire **12** will be given in order to control the current amplitude transmitted to posts **6** and **8**, resistors **13** are preferably placed in series in the circuit and the size of the resistor is such that it is impossible to transmit a current amplitude to the bridgewire sufficient to fire the bridgewire or damage the bridgewire assembly. The firing circuit under the embodiment of my invention, shown in FIGURES 1 and 2, obviously could be connected across terminals **6** and **10** or **8** and **10**, or as a practical matter, if desired, a dual firing of the wire **12** between posts **10** and **8** and **10** and **6** could be accomplished by having the input firing voltage connected on one side to terminal **10** and in parallel on the other side to terminals **6** and **8**. Quite obviously, this would create two detonations or firings of wire **12**. On the other hand, if desirable, it could be possible to fire the wire **12** between terminals **6** and **10** and **8** and **10** serially.

In the other forms of my invention, shown in FIGURE 3, the operation of my invention is identical with that explained in connection with the preferred embodiment, shown in FIGURES 1 and 2. The explanation of the operation of my invention applies equally and obviously to both forms of this invention illustrated.

For the type of insulation and the type of exploding bridgework, reference is again made to the co-pending application, Serial No. 165,923, filed January 12, 1962, Morgan et al., inventors. It is also further pointed out in this connection, that the particular material of the exploding bridgewire, its size and length is dictated by practices well known in the art and as this forms no part of my invention and my invention will operate equally well, regardless of the exploding bridgewire used, it is deemed unnecessary to go into details in this respect in this application. The same is true of the solid dielectric materials used and, as pointed out above, it is a matter of production and manufacturing as to whether the insulating or solid dielectric material is first applied to the wire **12** or whether it is applied to the sides of

the post **10** or, as shown in FIGURE 2, is applied to the top of post **20** and modifications of wire dielectric material, location, etc., can be resorted to without departing from the spirit of my invention. It is also to be further understood, that the electrical firing circuit, forming no part of this invention, can be of conventional design and modification in current applied, voltage applied and the like can be resorted to for firing this header in any number of several conventional manners without departing from the spirit of this invention.

It is to be understood that various changes can be resorted to without departing from the spirit of my invention. For example, one center post with two outside posts has been illustrated. If preferred, two insulated center posts could be used and the exploding bridgewire fired from the two center posts and tested from the two outer posts.

I claim:

1. An insulated exploding bridgewire header comprising
   (A) a pair of lead posts;
   (B) an exploding bridgewire positively electrically connected to each of said lead posts;
   (C) a third lead post positioned adjacent said pair of lead posts and mounting said bridgewire intermediate said pair of posts; and
   (D) a solid dielectric insulation disposed between said bridgewire and said third lead post, whereby the continuity of said bridgewire can be tested between said first and second lead posts and fired between either of said pair of lead posts.

2. An insulated exploding bridgewire header comprising:
   (A) a pair of lead posts;
   (B) an exploding bridgewire positively electrically connected to each of said lead posts;
   (C) a third lead post disposed between said pair of lead posts said exploding bridgewire being mounted upon and insulated from said third lead post; and
   (D) a solid dielectric insulation on said third lead post disposed between said bridgewire and said third lead post, whereby the continuity of said bridgewire can be tested between said first and second lead posts and fired between either of said pair of lead posts.

3. An insulated exploding bridgewire header comprising:
   (A) a pair of lead posts;
   (B) an insulated bridgewire positively electrically connected to each of said pair of lead posts; and
   (C) a third lead post disposed between said pair of lead posts, said insulated bridgewire being wrapped around said third lead post and insulated therefrom whereby the continuity of said bridgewire can be tested between said first and second lead posts and fired between either of said pair of lead posts.

4. An insulated exploding bridgewire header, according to claim 1, in which there is a resistance located adjacent to and in series with one of said pair of lead posts adapted to prevent the overloading of said bridgewire during continuity testing.

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