Aug. 7, 1956 G. TOWELL ET AL 2,757,566

DELAY ELECTRIC BLASTING CAPS CONTAINING SPIRAL DELAY ELEMENTS

Filed Nov. 10, 1953 2 Sheets-Sheet 1

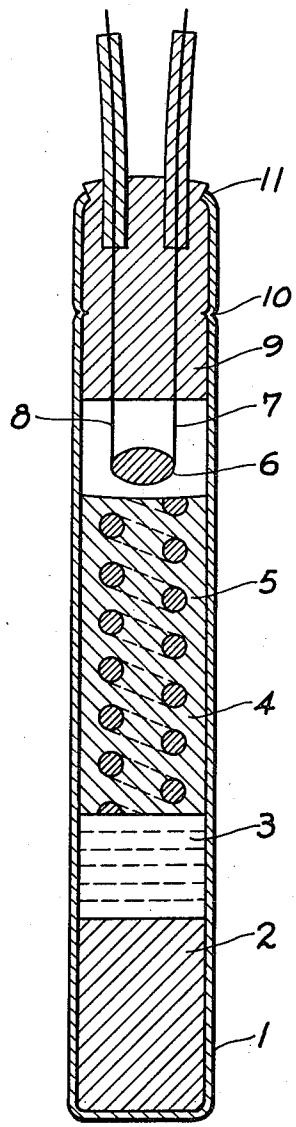


Fig 1

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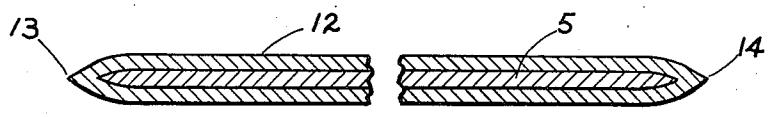


Fig 2

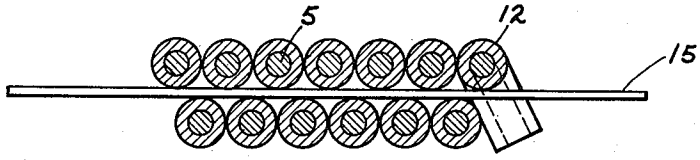


Fig 3

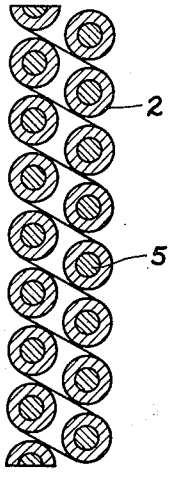


Fig 4

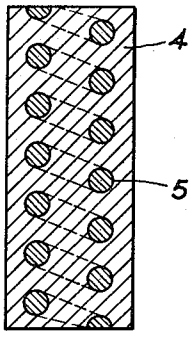


Fig 5

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DELAY ELECTRIC BLASTING CAPS CONTAINING SPIRAL DELAY ELEMENTS

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2 Claims. (Cl. 86—1)

Electric blasting caps containing a delay element to provide a definite time interval between the passage of current through the cap and the initiation of the base charge and the consequent detonation of the blasting explosive are widely used in blasting practice. This time interval is usually controlled through the variation in the length of the delay element inserted between the matchhead or loose charge ignition composition and the secondary or base charge. This delay element normally contains some type of fuse powder or other composition which has a definite linear burning rate. The principal disadvantage of this type of delay system is the length of the element required when a relatively long delay period is desired. This becomes particularly evident when the period is greater than two seconds.

The length of the delay element results in an overall greater length for the finished cap. This long cap is difficult to make and troublesome to use, particularly when it is necessary to insert the cap in a small explosive charge.

Further, it is well known that the accuracy of the burning of the delay element becomes more erratic as the burning speed of the delay composition is made slower. As a result, the use of a fast burning composition of longer length, rather than a shorter, slower burning delay element, results in a more accurate blasting cap. The utilization of this method of improving the accuracy of timing in delay electric blasting caps of longer delay periods has been limited by the practical limitation of the overall cap length.

It is readily understood that if the delay element could be inserted into the blasting cap in the form of a helix or spiral rather than a straight element, the disadvantages due to excessive length may be overcome.

U. S. Patent 1,493,881 proposes the use of a spiral delay train in an igniter but this application has failed to find acceptance in blasting cap manufacture because of the high incidence of instantaneous or premature firing of the base charge due to flash from the ignition system.

It is an object of this invention to provide a delay electric blasting cap having a long delay interval that can be controlled accurately. It is a further object to provide a long period delay electrically-fired blasting cap of standard length. It is a still further object to provide an electric blasting cap with a spiral or helical delay element which can be readily assembled in such a manner that there is no danger of premature detonation of the base charge.

We have found that the provision of a spiral delay train with no possibility of permitting premature detonation, may be provided in an electric blasting cap. In one example, a lead tube filled with a compacted fuse powder is wound in a closed spiral around a small diameter mandrel. The spiral is then removed from the mandrel and is cut to proper length and then swaged to compact the individual convolutions and close the central hole left by the mandrel. The result is a solid lead cylinder containing a uniform spiral of delay composition which as such may easily be incorporated into the structure of the usual type of blasting cap by pressing the cylinder into the cap casing above the base charge and inserting the normal match head, leg wires and plug assembly and crimping the top of the case to hold this assembly in place.

The construction of such a cap and the process of drawing, winding and swaging of the lead tube carrying the delay composition may be illustrated by reference to the drawings.

Figure 1 shows a cross-section of a completed blasting cap embodying the spiral element. It comprises a metal shell of copper or aluminum or the like which has a pressed base charge **2** in the closed end upon which may or may not be superimposed a priming charge **3** such as a lead azide-lead styphnate mixture. **4** is the compacted lead spiral with the delay mixture **5** running in a continuous helix through it. The match head **6** is positioned on the ends of the lead wires **7** and **8** just above the end of the spiral element. The lead wires are supported rigidly by a plug which may be sulphur, asphalt, rubber or a combination of any of those or other plastic insulating materials. In this case the plug **9** is a rubber plug and is held in the end of the shell by circular crimps **10** and **11** which also insure water tight closure.

Figures 2 to 5 illustrate a method of making the spiral delay element. Figure 2 shows the lead tube **12** after it has been drawn down to the required diameter. The tube is closed off at **13** and **14** in order to avoid loss of the delay mixture **5**.

Figure 3 is a sectional view showing the lead tube **12** containing the delay mixture **5** in the process of being wound in a tight spiral around the mandrel **15**.

Figure 4 shows a cross-section of the tight spiral with the mandrel removed and cut to a desired length. **12** is the lead tube and **5** the delay mixture.

Figure 5 illustrates the cross-section of the delay element as shown before insertion in a blasting cap such as illustrated in Figure 1 and after swaging in a proper die. The individual convolutions have been compacted to a virtually solid lead cylinder **4** with the delay mixture **5** spiralling through it.

To further illustrate our invention the following example is given.

A lead tube 0.625 in. outside diameter, 0.325 in. inside diameter and 13 in. long is closed at the bottom by swaging and is filled with a fuse powder of the following composition:

	Percent
Red lead	70
Silicon	16
Silica	14

The powder is added to the tube in small increments and tamped down with a wooden tamp rod. The filled tube holds approximately 42 grams of the composition. The top end of the tube is now closed off by swaging and the tube is reduced in diameter by drawing through a set of drawing dies until the outside diameter of the tube is reduced to 0.120 in. and the length is about twenty feet.

This small diameter tube is wound in a tight spiral around a piece of 0.04 in. piano wire mounted in a lathe. The resulting spiral has a 0.250 in. outside diameter and has between 7 and 8 turns per inch. The total length of this spiral is about six feet.

The piano wire mandrel is now removed from the centre of the spiral and 1.2 inch sections of the spiral are cut by means of a guillotine cutter. These pieces are placed one at a time in a 0.257 inch diameter hole in a steel die and pressed longitudinally under a dead load of 600 pounds by a steel pin of such a diameter that it will fit very closely into the hole in the die.

Under this pressure, the lead flows to fill all gaps between the individual turns and flows to fill up the central hole left by the mandrel. The final result has the appearance of a solid, uniform lead cylinder, having a length of 0.92 inch and a diameter of 0.257 inch.

This element is then inserted into a 3 inch long copper cap shell of 0.263 inch inside diameter containing a standard pressed base charge of tetryl or the like and a priming charge such as a lead azide-lead styphnate mixture. A 300 pound pressure acting through a steel pin with a rounded end is used to press the element into place and effectively seal the space between the element and the cap shell wall. The cap assembly may then be completed in the normal manner by inserting a rubber plug carrying two insulated lead wires terminating in a resistive bridge wire around which is moulded a heat sensitive match head. This assembly is held in place by crimping the upper walls of the copper shell around the rubber plug.

In a test run on a cap produced using this method a delay period of 2.404 seconds was measured between the time of application of a firing current and the detonation of the base charge.

The delay period may be altered by cutting the coiled spiral shorter or longer, as desired, or an alteration in the composition of the fuse powder in the spiral may be combined with cutting to achieve extreme effects.

By way of example, a series of caps was constructed containing a fuse powder with the following composition:

	Percent
Red lead	70
Silicon	18.75
Silica	11.25

The length of the spiral delay elements in these caps was varied and the delay intervals which resulted is given in Table 1.

Table 1

Length of pressed element:	Delay interval, seconds
0.532 inch	0.974
0.641 inch	1.192
0.777 inch	1.414
0.905 inch	1.645
0.986 inch	1.811
1.118 inches	2.023

By way of comparison a cap was assembled containing a straight element of conventional design 0.640 inch long. This element contained the same composition as was employed in the caps under test and listed in Table 1. A delay interval of 0.250 second resulted with this conventional design as opposed to the spiral cap which gave a delay interval of 1.192 seconds. A cap was made employing a delay composition of 70% red lead, 16.7% silicon and 13.3% silica in an element 1.932 inches long. The delay period resulting was 7.230 seconds.

To illustrate other variations in delay compositions, several trials were made using black powder of the type normally employed in safety fuse manufacture and having a burning speed of 51 sec./yd. as a spiral delay train in a blasting cap. Delay intervals were recorded as listed in Table 2.

Table 2

Length of pressed element:	Delay interval, seconds
0.300 inch	0.714
0.527 inch	1.422
0.716 inch	1.627

In general, this black powder composition is slower burning than red lead-silicon-silica compositions.

In a further example of varying the delay composition, a cap was constructed as described with the following delay train composition employed:

	Percent
Potassium permanganate	69
Antimony	29.5
Boron	1.5

The spiral element was cut to a length of 1.260 in. and was inserted into a cap, its pressed length being 0.838 in. The delay period proved to be 6.095 seconds. A straight element of the same composition and a length of 0.825 in. gave a delay time of 0.696 second.

Alternative construction of the cap may include the substitution of a loose charge ignition composition for the match head assembly. A loose charge consisting of a mixture of 70 parts of red lead and 30 parts silicon has produced satisfactory and accurate results. The rubber plug closure may be replaced by a cast sulphur plug to position the lead wires and a poured asphalt seal to make the cap gas tight.

A further modification in the making of the spiral delay element may include the winding of the spiral upon a mandrel made of a softer metal which is allowed to remain within the spiral and is later cut and compressed along with it.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that this invention is not limited to the specific embodiments thereof except as defined in the appended claims.

Having thus described our invention what we claim is:

1. A method of manufacturing delay elements for blasting caps which comprises filling a tube of a ductile malleable metal with a delay composition, swaging the ends of the tube to seal said tube, drawing said tube through a sufficient number of dies to reduce its external diameter to a predetermined value, winding said reduced diameter tube around a mandrel to produce a regular helix, removing said mandrel from the centre of said helix, cutting off sections of said helix to a predetermined length and swaging said helical sections employing a die having a cylindrical hollow of the shape of the finished element to compress the helical sections into the shape of a solid metallic cylinder having the delay composition within as a regular helix.

2. The method of manufacture as claimed in claim 1 wherein the ductile malleable metal is selected from the group comprising lead and lead alloys.

References Cited in the file of this patent

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