

[54] **MANUFACTURE OF DETONATING FUSE CORD**
[72] Inventor: **David Martin Welsh**, Brownsburg, Quebec, Canada
[73] Assignee: **Canadian Safety Fuse Company Limited**, Montreal, Quebec, Canada
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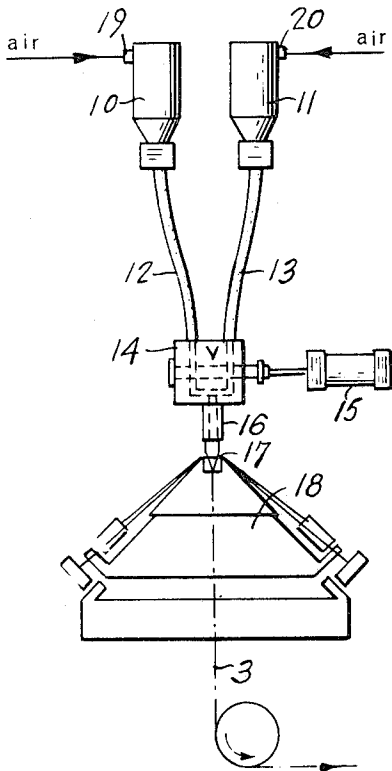
Primary Examiner—Samuel W. Engle
Attorney—Bernard F. Roussin

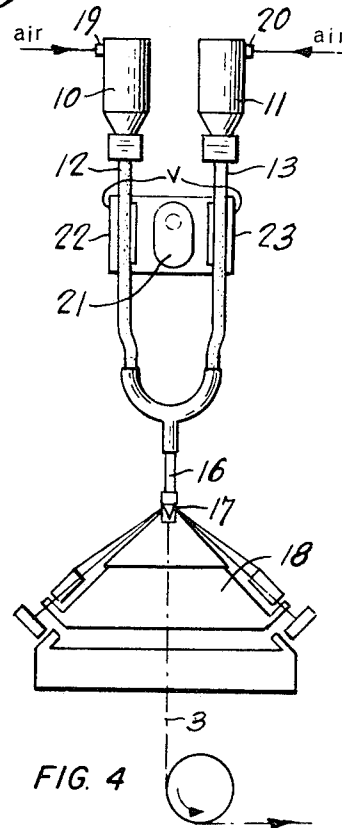
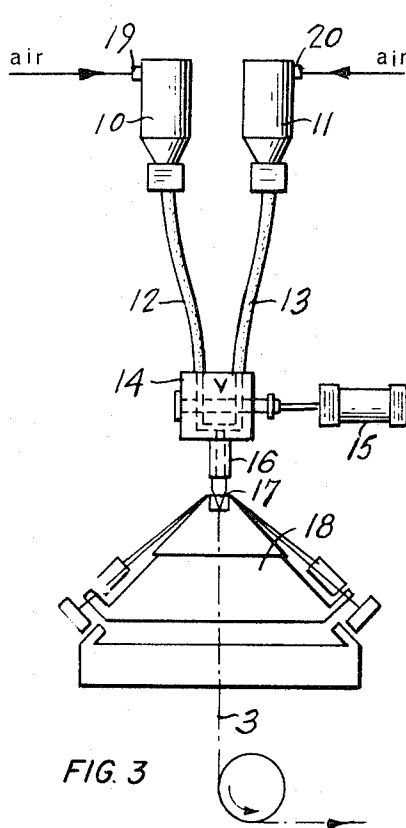
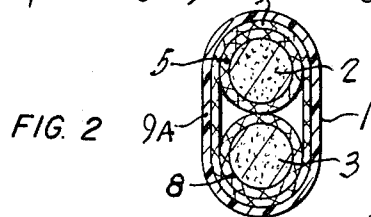
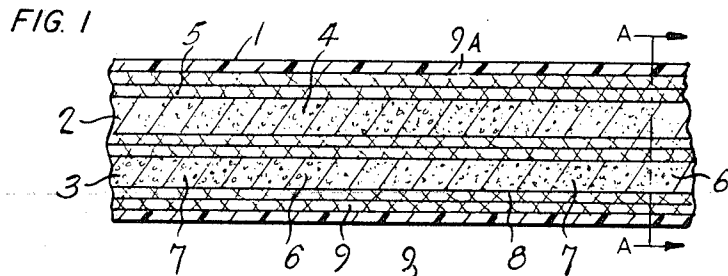
[30] **Foreign Application Priority Data**
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[57] **ABSTRACT**
A method of manufacturing a detonating cord having a dual explosive core is described. The total quantity of explosive in the dual core varies along the length of the cord and the product is useful in metal expansion operations.

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5 Claims, 5 Drawing Figures





INVENTOR
David Martin WELSH

Bernard F. Rineau

PATENT AGENT

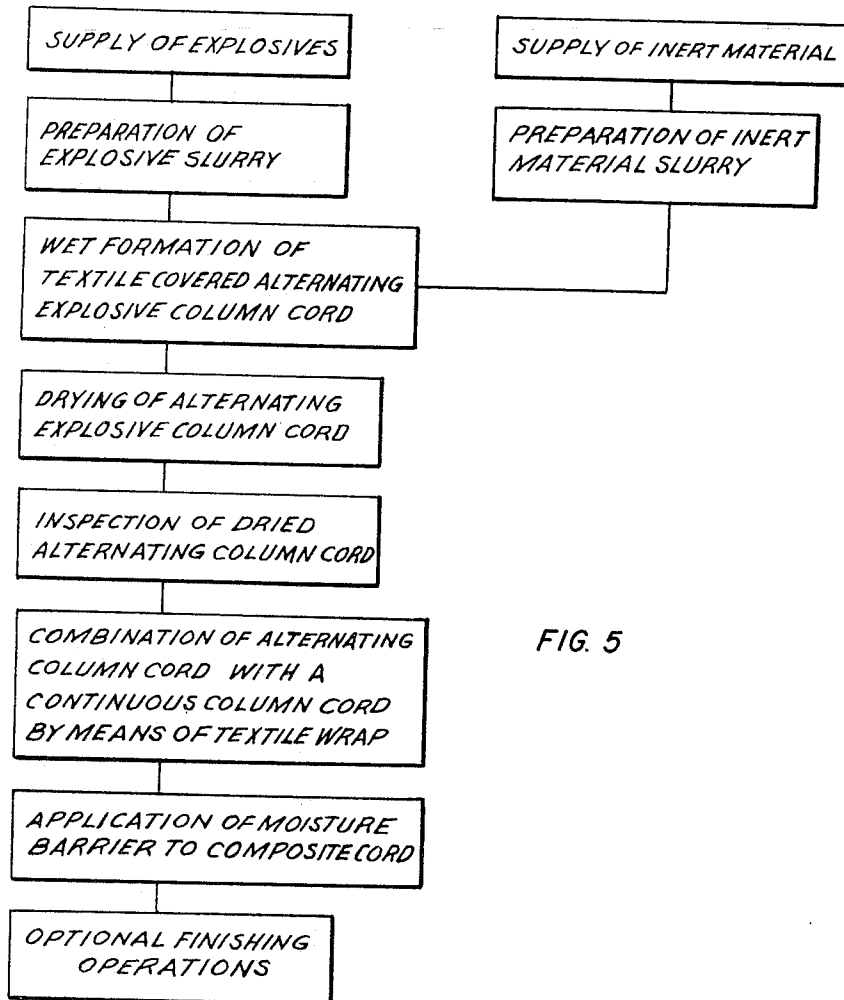


FIG. 5

INVENTOR
David Martin WELSH

Bernard J. Kinnison

PATENT AGENT

MANUFACTURE OF DETONATING FUSE CORD

This invention relates to detonating cord and in particular, to the manufacture of a composite detonating cord having a dual explosive core of controlled variations. Such a detonating cord has particular use in, for example, metal expansion applications.

As is known in the explosives art, detonating cords are normally produced in long or continuous lengths and comprise essentially a single, uniform core of explosive encased in a protective wrapping or sheath. Originally, the protective sheath consisted of a soft metal such as lead but these lead sheathed cords have now generally been superseded by those having sheaths consisting of water resistant tape or textile wrappings, synthetic plastics and the like. The amount of explosive per foot of length in the core may vary from a small quantity of from 0.1 to about 10 grains as in low energy detonating cord (LEDC), to as much as 50 grains or more. Typical explosives employed as core material are, for example, pentaerythritoltetranitrate (PETN), cyclotrimethylenetrinitramine (RDX), nitromannite, lead azide, trinitrotoluene (TNT), cyclotetramethylenetrinitramine (HMX), lead styphnate or tetryl and mixtures of these.

In the explosives industry detonating cords are manufactured by one or other of the dry or wet processes. In the dry process relatively coarse, particulate, dry explosive which comprises the core material of the cord is encased in a continuous column by means of a wrap of tape-like material and thereafter encircled by means of textile yarns of the like. The cord may thereafter be coated with a waterproofing surface layer of pitch, thermoplastic or the like. The dry process is normally employed in the manufacture of detonating cords having a core load of 25 grains or more of explosive per foot of length.

In the wet process, the core is formed from a thickened aqueous slurry of particulate explosive which is wrapped with a textile braid and covered in much the same manner as that employed in the dry process. Generally the wet process is employed in the manufacture of detonating cord having a core load of 4 grains or more of explosive per foot of length.

It has heretofore been the object and concern of the explosives industry to manufacture detonating cords having an absolute minimum of core load variation throughout the cord length in order to ensure constant detonation characteristics along the cord, in particular, uniform lateral energy output. It has now been found that in certain applications such as metal expansion, it is desirable to provide a detonating cord having an alternating or pulsating lateral energy output with a substantially constant linear velocity of detonation.

Accordingly, it is an object of the present invention to provide a method of manufacture of a detonating cord wherein the cord contains an explosive core load, which core load comprises alternating areas of greater and lesser explosive energy.

It is an additional object of the invention to provide a novel detonating cord comprising two explosive energy cores commonly encased in a protective sheath in side-by-side relationship, one of said energy cores having areas of greater and lesser explosive content.

Other objects of the invention will become obvious from a consideration of the following disclosure and claims.

The novel method of manufacture of the invention comprises continuously forming a first braided textile stocking and directing a stream of slurried particulate explosive through an orifice in a continuous and uniform column into said textile stocking. A second braided textile stocking is formed and a stream of at least one slurried particulate explosive is directed through an orifice in a manner such that the stocking contains alternating areas of greater and lesser explosive energy. The two braided explosive-containing stockings are then bound together in side-by-side relationship so as to form a composite cord unit having regular alternating sections of explosives of different energy output.

The method of the invention and the product thereof may be more fully understood by reference to the accompanying drawings wherein:

FIG. 1 is a sectional view of one embodiment of a finished detonating cord made by the method of this invention;

FIG. 2 is a cross-sectional view taken along the line A—A of FIG. 1;

FIG. 3 is an elevational diagrammatic view of a portion of the apparatus suitable for use in the method of the invention;

FIG. 4 is an elevational diagrammatic view, partly in section of a portion of an alternative apparatus suitable for use in the method of the invention; and

FIG. 5 is a flow diagram of the process steps of the method of the invention.

Referring in detail to FIGS. 1 and 2, there is shown a detonating cord 1 having two inner explosive core sections 2 and 3. Core section 2 comprises a continuous column of explosives 4 encircled by braided textile stocking 5. Core section 3 comprises a continuous column containing alternating explosives sections 6 and inert or non-explosive material sections 7. Core section 3 is encircled by braided textile stocking 8 and the core sections 2 and 3 are bound together by encircling textile wrap 9. An outer covering 9A of, for example, a flexible thermoplastic material is shown covering the whole.

Referring to FIG. 3, there is shown pressurized storage containers 10 and 11, container 10 containing a quantity of slurried, particulate explosive, for example, PETN, and container 11 containing a quantity of inert particulate material, for example, a thermoplastic, a water insoluble inorganic salt or a water insoluble organic salt. Leading from containers 10 and 11 are delivery lines 12 and 13 respectively, which lines terminate at air-operated valve 14. Air cylinder 15 is adapted to operate valve 14. Valve 14 comprises an exit line 16 having an orifice 17 to which the slurried explosive and slurried inert material may be delivered from containers 10 and 11. Below orifice 17 is textile braiding head 18 by which means a braided textile stocking is formed on orifice 17 and is continuously withdrawn from orifice 17 as it is formed while at the same time the slurried particulate explosive and inert material are alternately forced out of the center of orifice 17. Below braiding head 18, the textile covered cord 3 is delivered to a drying operation (not shown) preparatory to inspection and wrapping in side-by-side relationship with a second continuous explosive core cord 2 which second cord is made by well known stan-

dard wet process methods. After wrapping, the two cords have applied thereto an outer protective sheath or coating. Air lines 19 and 20 enter containers 10 and 11 respectively and pressurized air (from sources not shown) is directed into each of these containers. The pressure of the air in container 10 may, if desired, be different from the pressure of that of the air in container 11.

Referring to FIG. 4, there is shown an apparatus similar to that shown in FIG. 3 except that the valve 14 and air cylinder 15 of FIG. 3 are replaced by excentric cam 21 which is rotated by drive means (not shown) to activate pinch valves 22 and 23 which alternatively close off the flow of slurry through lines 12 and 13 respectively.

Referring to FIG. 5, there is shown in sequential steps the various operations employed in the method of the present invention.

In one operation of the method of the invention employing the apparatus as shown in FIG. 3, a supply of typical detonating cord explosive, for example, PETN in suitable particulate form is prepared as an aqueous slurry by combining the PETN grains with a quantity of water and a suitable thickening agent such as, for example, hydroxy ethyl cellulose. A quantity of the PETN/water slurry is placed in container 10. A quantity of non-explosive or inert slurry material of similar consistency is placed in container 11 and air pressure is applied to the surface of the slurry in each container through air lines 19 and 20. The pressure of the applied air is adjusted to provide the desired rate of slurry flow. Air cylinder 15 operates valve 14 in timed reciprocating motion by well known means (not shown) to allow delivery of the explosive slurry and the inert material slurry in alternating sequence from containers 10 and 11 and delivery lines 12 and 13 to exit line 16 and orifice 17. As the slurries are successively forced from orifice 17 and into the braided stocking, a cohesive, string-like configuration is assumed having along its length regularly alternating explosive and non-explosive sections. The textile sheathed cord is then passed to a drying operation (not shown) and, thereafter inspected. The alternating section cord is then wrapped by means of a textile braid in side-by-side relationship with a second continuous explosive cord and an outer covering of, for example, thermoplastic material is applied. The thus completed two-core composite detonating cord may then be wound on a take-up spool for storage or shipment.

In the operation of the method of the invention employing the apparatus as shown in FIG. 4, all the steps described heretofore with respect to the apparatus of FIG. 3 are the same with the exception of the means employed to achieve an alternating or pulsating extrusion of the slurry.

Referring to FIG. 4, it can be seen that when excentric cam 21 is rotated by a drive means (not shown) the flow of slurry through lines 12 and 13 is interrupted in a sequential manner by pinch valves 22 and 23 thus permitting the extrusion of the slurry at orifice 17 in a column of alternating explosive and non-explosive sections.

In the operation of the method employing either the apparatus of FIG. 3 or FIG. 4 and using a PETN explosive of grain size normally used for the manufacture of

detonating cords of 4 grains or more of explosive per foot of length containing a small percentage of water and thickener, it has been found that air pressure of about 10 p.s.i. on container 10 produces a detonating cord core section containing an average explosive load of 24 grains per foot of length when the orifice 17 has an internal cross section of 0.166 inch. An air pressure of about 40 p.s.i. produces an average core load of 52 grains of explosive per foot of length through the same orifice. With an inert material such as, for example, powdered polypropylene resin having a slurry consistency and grains size similar to that of the PETN, slurry similar core loads of inert material are provided.

The composite cord comprising the bound-together continuous and non-continuous core cords provide a finished detonating cord having sections of greater and lesser quantity of explosive which sections may be any length as desired since the section length is a function of the length of time each slurry is permitted to flow from the alternative sources of supply. It will be obvious that the quantity of explosives in each of the greater and lesser energy sections of the composite detonating cord can be varied depending on the thickness or density of the explosive and the inert slurries and on pressure of the air delivered to each of the storage container. Too thin a slurry will generally result in an unsatisfactory product.

It will be appreciated that, if desired, in the production of alternating core cord 3 using either the apparatus of FIG. 3 or FIG. 4, one of container 10 or 11 containing inert slurry material may be left empty and the air supply to the empty container may or may not be cut off. As a consequence of such procedure, the resultant cord 3 will comprise void areas or sections within the braided stocking 8 in place of sections containing inert slurry material. Several advantages may be gained through the use of such procedure. Labor and material involved in making the inert slurry is eliminated and additionally the sections of greater energy in the final composite cord may be more readily identified by a bumpy cord appearance.

It will be obvious from the foregoing description that a composite detonating cord comprising alternating sections of greater and lesser explosive energy may also be produced through the use of, for example, explosives having different energy values or strengths in the manufacture of the irregular or alternating core cord 3 of FIG. 1 and FIG. 2. That is to say, continuous column core may comprise, for example, PETN explosive while the alternating core may comprise TNT as the explosive ingredient. It will also be obvious that a combination of quantities and kinds of explosives may be used in the alternating core cord. For example, one section may comprise a core load of, say, 50 grains per foot of PETN and the adjacent section may comprise a diluted explosive content, say 10 grains per foot of PETN or TNT instead of a completely inert non-explosive material. The production of such cords using the apparatus shown in the figures of the drawing may be readily accomplished by placing a selected slurry of PETN in container 10 and a selected slurry of adulterated PETN or TNT in container 11. Application of appropriate air pressure to each container will provide extruded sections through orifice 17 of explosive of alternating explosive energy. Similarly the explosive

adapted for use in the continuous core cord 2 of FIGS. 1 and 2 may comprise a useful particulate explosive such as PETN mixed with an inert adulterant in order to further reduce the actual quantity of explosive present and hence also reduce the actual explosive energy upon detonation of the portion of the composite cord.

It will be appreciated that a wide variety of slurriable particulate explosives and mixtures thereof may be utilized for the process described.

What we claim is:

1. A method of producing a dual core detonating fuse cord having along its length regular alternating sections of different potential energy outputs comprising the steps of:

- a. continuously forming a first braided textile stocking;
- b. ejecting a stream comprised of regularly alternating portions of slurried particulate explosive and slurried particulate inert non-explosive through an orifice in a continuous column into said first textile stocking;
- c. drying the filled, first braided, textile stocking;
- d. continuously forming a second braided textile stocking;
- e. ejecting a stream of slurried particulate explosive

through an orifice into a continuous column into said second textile stocking;

- f. drying the filled, second braided, textile stocking;
- g. wrapping together in side-by-side, linear relationship said filled, first and second textile stockings to form a dual cord; and
- h. covering the wrapped dual cord with a protective sheath.

2. A method as claimed in claim 1 where a void is substituted for the slurried particulate non-explosive in the said first textile stocking.

3. A method as claimed in claim 1 wherein the streams of slurried explosive and non-explosive are ejected by pneumatic force.

4. A method as claimed in claim 1 wherein the particulate explosive is selected from the group consisting of pentaerythritoltetranitrate, cyclotrimethylenetrinitramine, nitromannite, lead azide, trinitro-toluene, cyclotetramethylenetetranitramine, lead styphnate, tetryl and mixtures of these.

5. A method as claimed in claim 1 wherein the particulate inert non-explosive is selected from the group of particulate thermoplastics, water-insoluble inorganic salts and water-insoluble organic salts.

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