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## MANUFACTURE OF SAFETY EXPLOSIVES

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This invention relates to safety explosives of the type in which the explosive charge is provided with an annulus, sheath, covering or casing comprising one or more flame-quenching and cooling materials, hereinafter referred to collectively as cooling materials.

Among the methods previously proposed for sheathing or encasing the explosive in cooling material there may be mentioned:—(1) loading the cooling material into a paper jacket surrounding the cartridge, the jacket being formed by a suitable arrangement of the wrapping paper; (2) forming the cooling material, together with a binding agent such as plaster of Paris, into a jacket surrounding the explosive charge and then treating it with water; and (3) casting or moulding the cooling material into the required annular shape for surrounding the explosive charge. It has also been proposed to impregnate the material of stiff paper cartridge containers with solutions of cooling materials and to dry the product.

According to the present invention, I surround, sheath, cover or encase the explosive in a jacket, consisting of fibre bonded cooling material in flexible sheet form, prepared by mixing a loose fibrous pulp with an aqueous suspension of one or more cooling materials, draining the solid mixture to form a felt, and drying the felt so that it may be handled without damage.

The fibrous pulp which I use may be a cellulose pulp, or carded or pulped cotton textiles, or asbestos fibre material, kraft pulp is a particularly suitable material. The essential property of the pulp used is that the fibres should not be felted or compressed together, but should be in loose form. Thus, if the raw material is in board form, it must be disintegrated and pulped. Subject to this requirement practically any fibrous material may be used. I prefer, however, to use a cellulose pulp in which the fibres are not all the same length. I prefer that the cellulosic fibres should have undergone a beating process designed to cause "fibrillation", i. e. teasing out of the ends of the fibres; as I find that the tensile strength of the bonded material subsequently made from these fibres is thereby greatly enhanced.

The invention is applicable to the ordinary cooling materials for explosives, such as calcium fluoride, sodium fluoride, sodium chloride, or sodium bicarbonate, or a mixture of two or more of such salts; deliquescent materials, however, are unsuitable. The amount of fibre may be as low as 2% by weight of the dry weight of the fibre bonded cooling material, but preferably amounts of about 4–10% are used.

In the case of cooling materials which are insoluble in water, water is a suitable medium in which to mix the fibres with the cooling materials; and in the case of water-soluble materials I may use an aqueous solution previously saturated with respect to the soluble materials.

In carrying out my invention, I mix the fibres (which may be in the water-wet state) and the cooling materials in the liquid medium with thorough agitation. The suspension is then filtered through a screen, preferably one having about 30 to 100 meshes per linear inch, and the liquid medium is removed as much as possible, for instance by pressing or suction. The damp felt is then dried at a slightly raised temperature, for example 40° C. When the solubility of the salts used does not greatly increase with rise of temperature, a higher drying temperature may be used. From 1 to 5% of moisture may conveniently be left in the material. In order to prevent loss of flexibility by undue evaporation from the material, I may add to the composition small quantities of a non-volatile hygroscopic substance compatible with the other constituents of the mixture, such as glycerine. However, this is not usually necessary.

I then wrap the explosive cartridge, which is preferably already wrapped in paper, within a sheet of the dried felt. The join may be made with gum, or other adhesives. An outer wrapping of paper may be applied simultaneously or subsequently. If the felt is made with a thickness exceeding 0.05 in., it may be found convenient to mark one surface during manufacture with a series of grooves or striations to assist it in conforming to the shape of the explosive cartridge. If it is desired to use more than one cartridge in a borehole, the sheath should have open ends, so that the propagation of the explosion is not hindered. If desired, the sheathing material may be rolled into the form of a tube before the introduction of the explosive.

In preparing the flexible sheathing material of

my invention, I may adapt, for my purpose, various types of paper-making machinery. The best proportion of liquid to solids varies considerably, depending on the type of machine in use. For example, I find that a suspension containing not over 1.5% total solids will give a satisfactory felt when used on a cylinder mould machine, provided good agitation is ensured in the supply of liquid to the machine. Using a machine of the Fourdrinier type, I may use the ratio of one part of total solids in 8 parts of suspension supplied to the machine. Still higher concentrations of suspended material require the use of apparatus of the continuous rotary filter type.

The invention is illustrated by the following examples in which the parts are given by weight.

*Example 1*

Materials used:—

| | Parts |
|---|---|
| Bleached sulphite wood pulp board (dry weight) | 7.5 |
| Solid sodium bicarbonate | 94.9 |
| Saturated aqueous solution of sodium bicarbonate | 350.0 |

The wet cellulose fibres (37.5 parts) produced by beating the wood pulp board with water are added to the saturated solution of sodium bicarbonate and mixed therewith in order to cause further disintegration of the bundles of fibres. The solid sodium bicarbonate is then added, due allowance having been made for the amount of sodium bicarbonate required to saturate the water in the pulp and provide a suspension of solids in which the proportion of sodium bicarbonate to cellulose fibre is 95:5. The ingredients are stirred with a mechanical stirrer for a period of 3 minutes before transferring them to a cloth or metal screen on which they are allowed to drain. Some of the moisture in the drained product is removed by suction, and the sheet is then passed to couching rolls; or alternatively the mass may be placed between the absorbent pads, which are then subjected to pressure in order to expel excess water and promote cohesion of the fibres. the felt is then dried at atmospheric pressure for 16 hours at 40° C.

A 6 in. x 1¼ in. cartridge of Polar Saxonite explosive, previously wrapped in waxed manila paper, is wrapped in a sheet (5¼ in. x 4 in.) of the felt prepared in the above manner, having a thickness of 0.1 in. and weighing about 30 gm. The felt is laid on top of a larger sheet of unwaxed paper, so that the sheath and this outer wrapping are applied together. The ends of the outer wrappings are folded in and the whole is dipped in melted wax.

*Example 2*

Materials used:—

| | Parts |
|---|---|
| Wet beaten Caima St. L. pulp or kraft pulp containing 5 parts of dry fibre | 25 |
| Solid sodium bicarbonate | 96.6 |
| Saturated aqueous solution of sodium bicarbonate | 400.0 |
| Dextrine | 2.5 |

The felt is manufactured from these materials in a similar manner to that described in Example 1.

A 5½ in. x $1\frac{7}{32}$ in. cartridge of Polar Saxonite explosive is wrapped in waxed manila paper and is wrapped in a sheet (5¾ in. x 12 in.) of the felt and the sheathed explosive is finally wrapped in plain paper.

*Example 3*

Materials used:—

| | Parts |
|---|---|
| Wet beaten Caima St. L. pulp or kraft pulp containing 5 parts of dry fibre | 25 |
| Solid sodium bicarbonate | 96.6 |
| Saturated aqueous solution of sodium bicarbonate | 400.0 |
| Magnesium chloride | 1.0 |

The felt is manufactured from these materials in a similar manner to that described in Example 1.

A 5½ in. x $1\frac{7}{32}$ in. cartridge of unwrapped Polar Saxonite explosive is wrapped in a sheet (2 in. x 12 in.) of the felt and the ends are folded to form a complete casing. The whole is then dipped in melted wax.

*Example 4*

Materials used:—

| | Parts |
|---|---|
| Wet beaten Caima St. L. pulp or kraft pulp containing 5 parts of dry fibre | 25 |
| Solid sodium bicarbonate | 48.3 |
| Solid sodium chloride | 48.3 |
| Saturated solution of sodium bicarbonate | 200.0 |
| Saturated solution of sodium chloride | 200.0 |

The felt is manufactured from these materials in a similar manner to that described in Example 1.

A tube, 8 in. in length and of internal diameter $1\frac{7}{32}$ in., is rolled from a sheet of the felt of sufficient width to give between two and three thicknesses. One end is folded and crimped and a 5½ in. x $1\frac{7}{32}$ in. cylinder of Polar Saxonite explosive is inserted. The other end of the sheath is then folded and crimped.

*Example 5*

This example shows the preparation of a felt on a machine of the Fourdrinier type. 20 lb. of wet kraft pulp containing 3 lb. of dry pulp are mixed with 50 lb. of sodium bicarbonate and 400 lb. water with good agitation. The suspension is supplied to the distributing device on the machine and flowed on to the travelling screen running at a linear speed of 4 ft. per minute. The screen speed is preferably lower than is customary in paper manufacture. The felt was pressed, detached and further dried for storage purposes. The thickness of the final sheet was 0.062 in.

I claim:

1. A flexible safety sheathing material for blasting explosives, said material being characteristically of salt and comprising in sheet form a preponderating proportion of a material consisting of at least one substantially non-deliquescent cooling salt, bonded together by a uniformly distributed amount of cellulosic fiber, said cellulosic fiber being present in the amount of from 2 to 10% of the total weight of the dry constituents of said sheathing material.

2. Sheathing material as in claim 1 to which a small amount of a non-volatile hygroscopic liquid dampening agent has been added to prevent the hardening of said sheathing material.

3. A blasting explosive cartridge sheathed with the material according to claim 1.

4. The sheathing material of claim 1 in which the cooling salt comprises sodium bicarbonate.

5. A flexible safety sheathing material for blasting explosives, said material being charac-

teristically of salt and comprising in sheet form a uniform mixture of cellulosic fiber and a preponderating proportion of a material consisting of at least one cooling salt, together with a small amount of a non-volatile hygroscopic liquid dampening agent to prevent the hardening of said sheathing material, said cellulosic fiber being present in the amount of from 2 to 10% of the total weight of the dry constituents of said sheathing material.

6. A safety sheathing material for blasting explosives, said material being characteristically in the character of a sheet of cooling salt, as distinguished from an ignitable base material carrying a modicum of salt, such sheet of cooling salt comprising a thin body of salt felted into a sheet with merely sufficient cellulosic fiber distributed therethrough to impart coherence and flexibility of the sheet, adapting the salt to the wrapping of blasting explosives.

7. A safety sheathing material for blasting explosives, said material being characteristically in the character of a sheet of cooling salts as distinguished from an ignitable base material carrying a modicum of salt, said sheet of cooling salts comprising a thin body of at least one substantially non-deliquescent cooling salt felted into a sheet with merely sufficient cellulosic fiber distributed therethrough to impart coherence and flexibility to the sheet, whereby to adapt the salt to the wrapping of blasting explosives.

8. The sheathing material of claim 7 in which the cooling salt comprises sodium bicarbonate.

9. An explosive cartridge comprising a blasting explosive enveloped in a sheathing material of the character of a cooling salt in sheet form, as distinguished from an ignitable base material carrying a modicum of salt, said sheathing material comprising a thin body of salt felted into a sheet with merely sufficient cellulosic fiber distributed therethrough to impart coherence and flexibility to the sheet, whereby to adapt the salt to the wrapping of blasting explosives.

10. An explosive cartridge comprising a blasting explosive enveloped in a sheathing material of the character of a cooling salt in sheet form, as distinguished from an ignitable base material carrying a modicum of salt, said sheathing material comprising a thin body of at least one substantially non-deliquescent cooling salt felted into a sheet with merely sufficient cellulosic fiber distributed therethrough to impart coherence and flexibility to the sheet, whereby to adapt the salt to the wrapping of blasting explosives.

11. The explosive cartridge of claim 10, wherein said cooling salt comprises sodium bicarbonate.

12. The explosive cartridge of claim 10, wherein said sheathing material contains sufficient non-volatile hygroscopic liquid dampening agent to prevent the hardening of said sheathing material.

13. A safety sheathing material for blasting explosives, said material being characteristically in the character of a sheet of cooling salts, as distinguished from an ignitable base material carrying a modicum of salt, said sheet of cooling salts comprising a thin body of salt, together with sufficient non-volatile hygroscopic liquid dampening agent to prevent the hardening of said sheathing material, felted into a sheet with merely sufficient cellulosic fiber distributed therethrough to impart coherence and flexibility to the sheet, whereby to adapt the salt to the wrapping of blasting explosives.

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