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METHOD AND APPARATUS FOR PACKING EXPLOSIVES

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15 Claims. (Cl. 86—1)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for packaging explosives are provided in which a stream of air is directed against a sheet of wrapping material from a plurality of radial positions thereby folding the wrapping material about a long columnar body of explosive that is self-supported at least in the folding zone, to completely enclose the body of explosive in the wrapping material.

This invention relates to a method and apparatus for packaging explosives, and more particularly, it relates to a method and apparatus for packaging explosives, in which a relatively long sheet of wrapping material is folded along its longitudinal axis about a body of explosive material.

U.S. Patent No. 3,216,307 discloses a method and apparatus for packaging explosives in which a continuous sheet is passed through a forming guide and folded along its longitudinal axis about a column of explosive. The folding device is generally rectangular in shape, and the sheet as it is drawn therethrough is folded over itself until the edges of the sheet overlap to form a tube having a longitudinal seam.

In a process such as this, and in similar processes which employ relatively long sheets and fold them along their axes about an explosive, by passing the sheet through a folding device, friction developed between the folder and the sheet interferes with the folding operation. The interference becomes serious, if the sheet is provided with a strip of glue or adhesive to seal the longitudinal seam, and the sheet can foul or buckle in the folder, and can be imperfectly folded over the explosive, such that the ends do not overlap. This is particularly undesirable in the packaging of explosives, where loose explosive can be dangerous, and may detonate in the packaging apparatus.

The instant invention overcomes these difficulties by applying a stream of gas against the sheet of wrapping material, to fold the wrapping material about the explosive, and form the package.

The instant invention also provides an apparatus for folding a relatively long sheet of wrapping material along its longitudinal axis, with the folded-over edges of the sheet abutting each other in a generally longitudinal seam, to package a body of explosive, featuring means for applying a stream of gas to the sheet, in a manner to fold the sheet along its longitudinal axis over the body of explosive until the edges meet or overlap, thereby to package the explosive within a wrapper formed by the folded sheet.

This invention can be used in the explosive packaging method and apparatus disclosed in U.S. Patent No. 3,216,307. However, as indicated above, this invention is also applicable to other similar explosive packaging methods and apparatus in which a relatively long sheet of wrapping material is folded generally longitudinally about an explosive. For example, see French Patent No. 1,129,156 to Ehlenger.

The explosive generally can be in any form, such as a powder, gel, semi-solid, substance or even liquid, as long as it is capable of being packed within a folded wrapper of relatively long size. The preferred explosive compositions are semi-solid, and several examples are disclosed in U.S. Patent No. 3,265,778.

The explosive can be extruded in the form of a continuous column, as is disclosed in U.S. Patent No. 3,216,307, but it need not be.

The explosive also can be laid on the wrapper from a hopper or the like by an auger filler, or merely poured therefrom if in a powdered or particular form, or in the form of semi-fluid mass. If it is extruded, the wrapper can be drawn along with the explosive in the manner described in U.S. Patent No. 3,216,307. Extrusion is preferred.

The stream of gas applied to the wrapper to fold it in accordance with this invention can be applied within a folding guide of conventional type, if desired. The gas alone can suffice, however, if applied with sufficient force, and an array of jets or nozzles arranged in a helical pattern can be used to fold the wrapper sheet over the body of explosive. Such an array also constitutes a folding guide in accordance with the invention. Needle jets are useful for this purpose. In either case, the gas pressure in effect encloses and contracts the wrapper so as to fold it about the column of explosive, and is aply referred to as an envelope of gas pressure.

A folding guide can be used that is generally tubular, and its cross-sectional configuration is one that is selected to correspond to the cross-sectional shape of the explosive body. For example, if a cylindrical column of explosive is desired, the folding guide should have at least a cylindrical inner surface in cross-section. Such a guide should have a somewhat tapered longitudinal section.

The wrapping material is gradually folded by the gas envelope surrounding it to progressively smaller diameters as the gas flow is contracted in its passage through the guide, until it is the correct size and shape for the explosive column. If the explosive column is elliptical in cross-section, then the envelope of gas pressure describes an elliptical form about the wrapper. Such an envelope also should be tapered along its length. Similarly, if a rectangular cross-section were desired for the explosive, the gas is made to describe an envelope that is rectangular in cross-section. It should also be tapered along its length.

For this purpose, a folding guide can be formed as a volute or duct that surrounds the explosive and the wrapper. It need not completely surround the explosive, and normally the folding guide has a wedge-like opening in its side, since this simplifies construction. It is also possible to form the folding guide in two sections, each being generally semi-circular, semi-elliptical or semi-rectangular in cross-section.

The guide is arranged so as to make it possible to fold the wrapper by gas pressure. For this purpose, the folding guide can have an inner porous wall formed in the desired shape as described above, with means for supplying gas thereto under pressure, to apply gas pressure to the wrapper sheet within the guide. The inner wall can be made of wire mesh, or can be made of a sheet having perforations, apertures, or the like, well distributed over its surface. The folding guide and its porous inner wall can be made of any material, such as metal or plastic.
The progressive folding of the wrapper can be accomplished by positioning the jets, nozzles, ducts, etc., to form a stream of gas that guides the edge of the wrapper around the explosive. This path is somewhat helical, and the nozzles can be arranged in a helical line. However, it is preferred to form an envelope of gas by directing gas flow from a number of nozzles in the direction of folding.

To ensure a tight and progressive fold about the explosive, sufficient gas pressure must be maintained on the wrapper as it is folded to ensure that the gas stream envelops the wrapper at least at the end of the folding operation. This can be done by progressively increasing the gas pressure along a folding guide, or by placing an array of nozzles, ducts, etc., progressively closer to the wrapper along the guide. The nozzles should be placed along a line just inside of the line described by the edges of the sheet as they are folded over to eventually overlap and form a longitudinal seam.

A folding guide or array of jets can have one or more supply lines communicating therewith for the supply of gas thereto. The gas can be supplied from any convenient source, and can be pumped from its source by a compressor. The supply lines and the guide are connected by a wiring guide. Any gas that is inert to both the explosive and to the wrapping material can be used. Air is preferable for use in this invention, but carbon dioxide and nitrogen are also very satisfactory. Steam can also be used, and air is preferred since it can reduce the stiffness of wrapping material, such as paper and thus facilitate folding.

The necessary gas pressure to supply sufficient force to fold the wrapper is to some degree determined by the flexibility of the wrapper. In general, gas pressures within the range from about 0.5 to 200 p.s.i. are normally sufficient, and pressures within the range from about 25 to about 100 p.s.i. are preferred. The steam should be continuous and of sufficient force to hold the wrapper away from any guide that is used, thus cushioning the wrapper and preventing friction and snagging of the wrapper on the folding guide.

The wrapper can be made of paper, metal foil, or plastic sheets of polyvinyl chloride, polyethylene, polypropylene, and the like. It should be sufficiently flexible to be foldable, and preferably be freely pliable. If desired, it can be provided with longitudinal glue lines at the seam that can be heat-sealed after folding. However, other methods of holding the package closed such as windings of filamentary material wrapped about the package are also suitable. It is also possible to seal the package by inserting thermoplastic material for the wrapper and heat or solvent softening the butting edges of the wrapper at the seam to seal it. See U.S. Patent No. 3,216,307.

The wrapper can be folded directly onto and about the explosive, or it can be folded around a material, and the explosive then packed within it.

A mandrel is used, it could comprise an extruding nozzle such as is shown in U.S. Patent No. 3,216,307. After the wrapper has been wrapped about the explosive to form a generally longitudinal seam, strings and the like can be applied. As indicated, the seam can be sealed in any manner desired, thus completing the package.

The preferred embodiment of this invention is more particularly described in connection with the following drawings, in which:

FIGURE 1 is a plan view of an apparatus for packaging explosive incorporating a folding guide of the instant invention.

FIGURE 2 is a view in greater detail of a folding guide of FIGURE 1, and

FIGURE 3 is an enlarged view in cross-section, taken along the line 3--3 of FIGURE 2.

The explosive packaging apparatus shown in FIGURE 1 is similar to that disclosed in U.S. Patent No. 3,216,307, and comprises an extrusion device 1 for extruding an explosive into a continuous column. A preferred extruder is shown in U.S. Patent No. 3,216,307. The explosive 3 is a semi-solid composition of nitrostarch, grained ammonium nitrate, grained sodium nitrate, flake ammonium, guar gum, Oil No. 5, zinc oxide and water. It is extruded through a relatively long extruder nozzle 4, extending from the extruder through the folding guide 5 of the instant invention. A storage roll of paper wrapping material 2 is disposed adjacent to the extruder. This is provided with glue lines 8 that are adapted to seal the overlapping seam of the package, best seen by reference to FIGURE 3. The continuous sheet is threaded through the folding guide 5 where it is folded longitudinally about the explosive.

The folding of the paper and the structure and operation of the folding guide of the instant invention are described below.

The folding guide of the instant invention as shown is conical, and has an open side 6. An exterior wall 15 and a perforated interior wall 19 define a gas passage therebetween. Two ducts 21 communicate with the gas passage for supply of a stream of gas from one or more compressed gas sources 23. The perforations of the wall 19 are disposed such that air is directed against the wrapping material from a forward-facing angle of about 45° to the wrapper and the wrapping material 1 is progressively folded along the guide 5. At the entrance, the perforations are located to direct air at the sheet and along its edges. The pattern of the perforations is semi-circular in cross-section. The number of holes is progressively increased along the guide to form a "C" in cross-section, and further increased until the perforations completely surround the wrapper as shown in FIGURE 3. This configuration of the perforations progressively folds the wrapper as it is passed through the guide. A tight fold is ensured by placing the perforations at the discharge end of the guide closer to the wrapper than the perforations at the entry end. This ensures that there will be sufficient gas pressure on the wrapper to fold it at the end. The folding guide is tapered to accomplish this.

In operation, the paper is drawn from the roller 7 and is folded about the nozzle 4 of the extruder which acts as a mandrel. As it passes through the folding guide, the gas stream that is flowed continuously into the gas passage through all perforations of the inner gas wall 19 under a pressure of 80 p.s.i. forms a cushion of gas between the wall and the wrapper. The stream is directed by the perforations against the edges of the wrapper such that the wrapper is progressively folded around the nozzle and about the explosive along its longitudinal axis into a tube of progressively smaller diameter until the edges of the wrapper overlap in a seam 25, thus forming a cylindrical package having a generally longitudinal seam 25 about the explosive. This can best be seen by reference to FIGURE 2.

As the explosive 3 passes from the end of the nozzle 4, the folded wrapper is drawn about it. The package is then provided with a plurality of continuous windings 11 in a double-stranded helix by a string winding device 10. It then passes onto a conveyor belt 12 driven by two rollers 14. The conveyor is provided with a heating apparatus 16 that is adapted to soften the glue lines 8 on the wrapper and seal the seam. The packaged explosive is now in the form of a continuous column of packaged explosive and is rolled up on a collection roller 50 and stored in a coiled form 51. As indicated above, the tube former can take any desired configuration and could be adapted to wrap an explosive of rectangular, elliptical, or any other cross-sectional configuration.

Having regard to the foregoing disclosure, the following is claimed as the inventive and patentable embodiments thereof.

1. In the process of packaging explosive compositions, which comprises folding a relatively long sheet of wrap-
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5. Filing material along its longitudinal axis about a relatively long columnar explosive body, the improvement which comprises disposing the explosive body in a self-supported free-standing position in a folding zone; placing a sheet of wrapping material in the zone at a point spaced from the explosive body and in position to be freely folded without obstruction directly about the explosive body; and applying a stream of gas against the sheet of wrapping material at a plurality of radial positions to fold the wrapping material over and about the explosive body and into contact therewith, and encloses it within the folded wrapping material, with the edges of the wrapping material forming a generally longitudinal side seam, thereby forming a package with the wrapping material in contact with the explosive body.

2. A process in accordance with claim 1, in which the gas is air.

3. A process in accordance with claim 2, in which the gas is supplied against the wrapper at a pressure of from about 0.5 to about 200 p.s.i.

4. A process in accordance with claim 1, in which the wrapping material is a relatively long sheet of paper.

5. A process in accordance with claim 1, in which the stream of gas is directed in a helical path against the sheet of wrapping material.

6. A process in accordance with claim 1, in which the stream of gas is directed against the edges of the sheet as it is folded.

7. In the process for packaging explosive compositions, which comprises folding a relatively long sheet of wrapping material along its longitudinal axis about an explosive body, the improvement which comprises disposing the explosive body in a self-supported free-standing position within and spaced from the sides of a folding guide; placing the sheet of wrapping material in a position with one side adjacent the explosive body and spaced therefrom and the other side facing the folding guide and spaced therefrom; and applying a stream of gas against the other side of the sheet from a plurality of radial positions under a pressure of from about 0.5 to about 200 p.s.i. in a manner to fold the sheet of wrapping material closely about the explosive body to enclose it therewith and form a package of the wrapping material with the edges thereof overlapping in a generally longitudinal side seam without contact between the sheet and the folding guide.

8. A process in accordance with claim 7, in which the gas is steam.

9. A process in accordance with claim 7, in which the relatively long sheet is provided with glue lines for sealing the side seam.

10. The process in accordance with claim 7, including winding filamentary material about the package.

11. A process in accordance with claim 7, in which the stream is directed from points that are located progressively closer to the wrapper as it folds.

12. A folding guide comprising a longitudinally tapered chamber having an inner porous wall for directing a stream of gas about a relatively long sheet of wrapping material disposed about an explosive, said inner wall being adapted to direct the stream of gas against the sheet to progressively fold the sheet longitudinally along its axis over the body of explosive to form a generally columnar package having a generally longitudinal seam.

13. An apparatus in accordance with claim 12, including a gas supply line communicating with the chamber for the passage of the stream of gas into the chamber.

14. A folding guide in accordance with claim 12, in which the inner wall is perforated.

15. A folding guide in accordance with claim 12, in which the folding guide is generally conical in shape.

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