Nov. 9, 1965 G. L. GRIFFITH 3,216,307

METHOD FOR PACKAGING EXPLOSIVES

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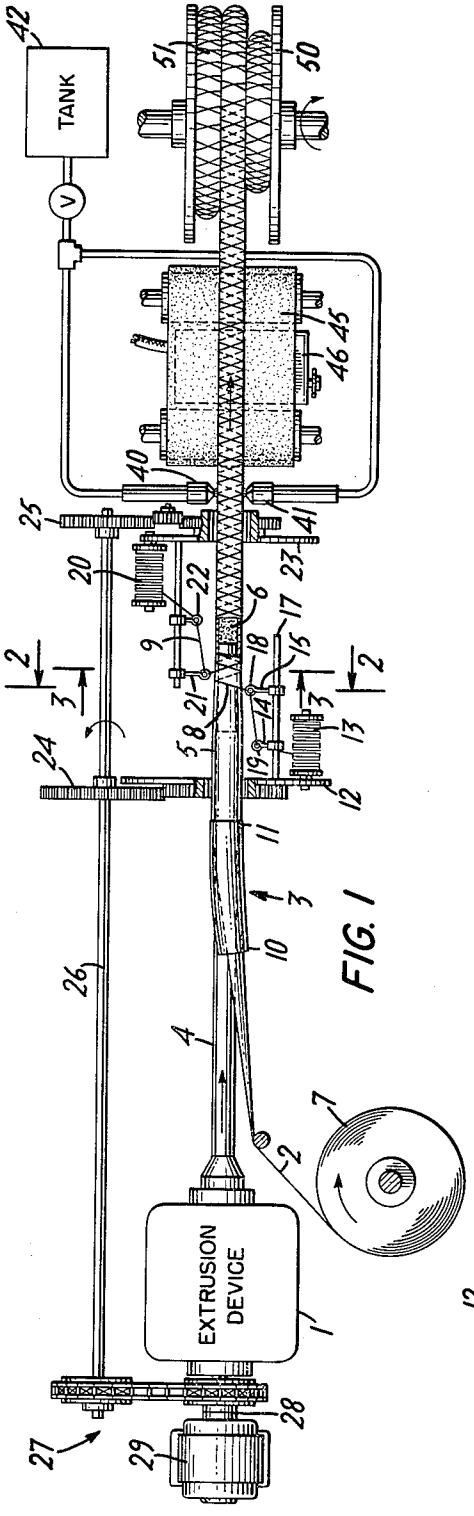


FIG. 1

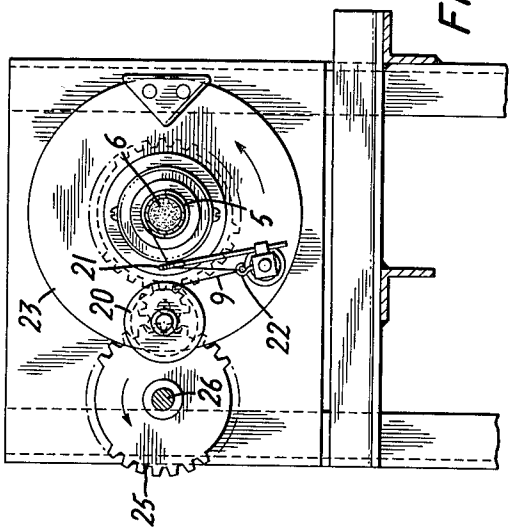


FIG. 3

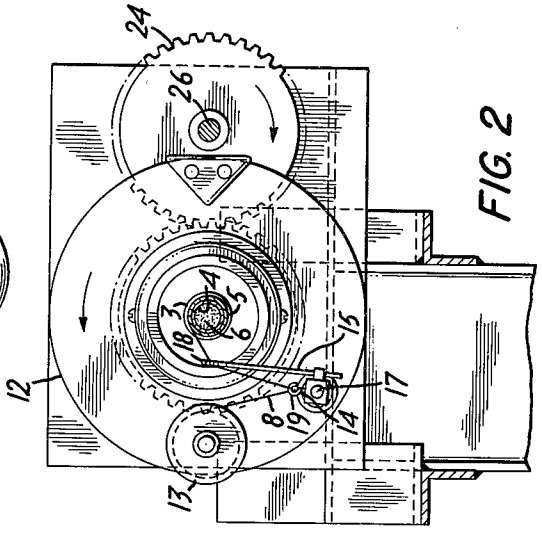


FIG. 2

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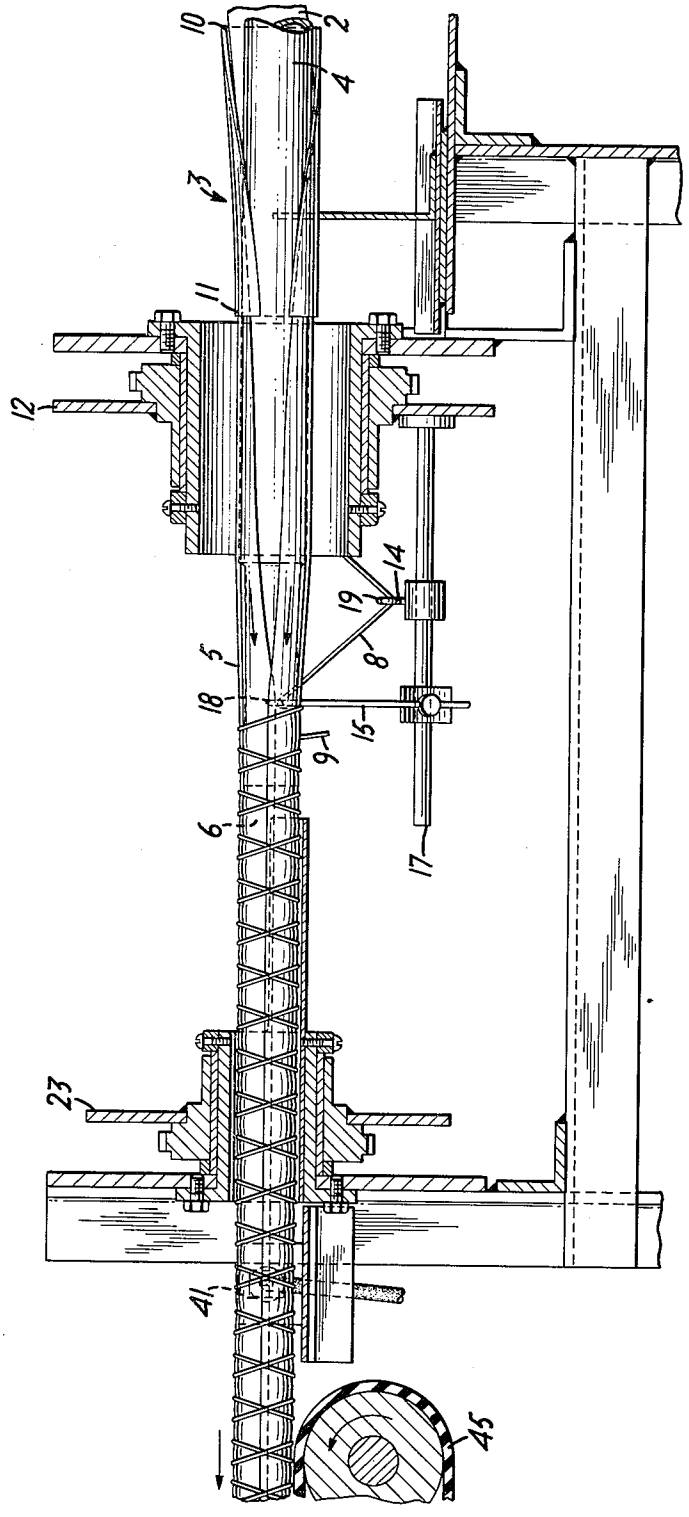


FIG. 4

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METHOD FOR PACKAGING EXPLOSIVES

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This invention relates to a method and apparatus for the packaging of explosives, and more particularly, to a process for extruding and then enclosing a column of explosives composition within a package, and to apparatus for carrying out this process.

The explosives industry customarily has packaged explosive compositions in individual containers, which are filled with explosive, usually in the form of a dry powder or slurry, and then closed. Such a packaging procedure requires a large, costly, inefficient plant. It is necessary to roll the explosive shell containers in a shell rolling house, after which the empty shells are sent to a punch house where they are filled in a loading or punching machine, either manually or mechanically. The shells are loaded at one station of the machine, crimped at the second station, and expelled for packing at the third station. This procedure is essentially a batch procedure, and it has been impossible to mechanize this such that packaging could be carried out in a completely continuous operation, starting with the formation of the shell and ending with a filled, closed package.

Recently, machinery has been made available which preforms an explosive composition, and this is then wrapped automatically in paper and crimped at both ends, to produce a completed shell rather quickly as compared to the conventional procedure. This, however, is also an intermittent operation, which produces shells of a fixed length. Due to certain mechanical restrictions, as well as the investment cost of the machine, it is not feasible to manufacture finished shells having a length in excess of sixteen inches. Furthermore, the production rate of the machine is rather low, and the finished explosive package requires multiple paper wrappings to lend it sufficient strength to withstand handling and packaging. Paper is costly, and the use of an unusually large amount of paper is undesirable, since paper produces unfavorable fume characteristics when the explosive is detonated.

The authoritative Swedish text "Nitroglycerin Och Dynamit" by Nauckhoff and Bergstrom, published in 1959, summarizes the history of explosives manufacture and packaging. However, no example is given in the book of the continuous packaging of a finished explosive.

The packaging of ammonium nitrate explosives presents a particularly severe problem, from the standpoint of economics. Ammonium nitrate is a cheap raw explosive material, which can be sensitized rather inexpensively with fuel oil or some other form of carbon or carbonaceous material to form what are termed the nitrocarbonitrates, which have explosive properties. Such mixtures can be brought in bulk to the explosive site where they can be filled directly into small diameter bore holes having a diameter of as low as one inch, and then shot. This technique poses a particularly difficult packaging problem, since, using conventional explosive packaging procedures, it has been practically impossible to package an inexpensive product in a practical manner at a price sufficiently low to be competitive with the ammonium nitrate-fuel oil bulk compositions which can be blown directly into the holes without packaging.

A further problem created by individual packaging of explosive compositions arises from the necessity of propagating the charge from one cartridge to another in the train. It has always been necessary to use an explosive

composition in the package of such sensitivity that it is capable of shooting through a discontinuous column of explosive, the discontinuity being brought about by the fact that for practical purposes explosives are loaded normally in lengths of less than 24 inches, and usually in lengths of 4 to 8 inches. Thus, an explosive column in a small diameter hole of great length usually consists of four to twelve sticks of powder, and the composition must necessarily have sufficient sensitivity so that the detonating wave will not die out as it travels through the discontinuous column of a plurality of sticks. Furthermore, a discontinuous column has less water resistance, since the point where two shells butt together is the first point at which water desensitizes the composition, presenting a zone through which the shock wave often fails to pass from one cartridge to the next. Obviously, if it were possible to prepare an explosive column of great length, so that a continuous column could be loaded in the hole in place of a discontinuous one, composed of a plurality of sticks in close juxtaposition, it would be possible to use an explosive composition of less sensitivity, since there would be no need to propagate the explosive wave from one cartridge to another. Such a column would also have greater water resistance than the discontinuous one, since there would be no point at which water could enter between one portion of the explosive and another.

The packaging of water slurry or water gel explosives has also presented a problem. These are difficult to package in an efficient manner so that they can be sold at a price which is competitive to ammonium nitrate-fuel oil compositions. These difficulties basically are due to the lack of a method for packing long continuous tubes in an economical manner.

Casings of any desired length can be fabricated from plastic materials, such as regenerated cellulose, polyethylene, polypropylene, and the like. These are extruded in the desired diameter, and then filled by means of a long loading tube through which the filling material is extruded into the casing. This method has been used for many years in the manufacture of sausages in the meat industry. However, it is not adapted for explosive compositions. It is quite difficult by this method to load a one inch diameter or smaller casing four feet or more in length, where the casing has to be pushed over a loading tube and then loaded under relatively high extrusion pressures. Unless the material being extruded is completely free of occluded air, there is a tendency for air pockets to form in the column of explosive. Any air pocket cuts off the detonating wave in the powder. In addition, it is necessary to use extremely light gauge casing to avoid imparting unfavorable fume characteristics to the finished product. A larger amount of casing material such as would be present in a thick casing causes the formation of large quantities of carbon monoxide as well as carbon dioxide, both of which are poisonous, and dangerous when present in underground working. If the casing material is not manufactured with great care, it will possess portions of uneven diameter, both thick and thin, as well as pin holes. Pressure from the extruded explosive is unevenly distributed along the length of the tube, causing the tube to swell at the thin spots, and to be thinner at the thick spots. This results in an explosive package of nonconstant diameter which leads to difficulties in the field. Furthermore, if there is only an extremely thin coating of plastic material to protect the enclosure, there is a chance for the casing enclosure to rupture and lose its contents during loading or shipping. Very thin spots also result in a low support for the cartridge, and the finished sticks are flimsy and limp, so that difficulty is encountered when these are to be loaded into conventional

holes filled with rock which may have rough corners and surfaces.

In accordance with the instant invention, explosive compositions are packaged by extruding the compositions in a column of the desired configuration and length while forming an explosive package about and enclosing the extruded column of explosive. The extruded column is brought into contact with the enclosing wrapper shortly after leaving the extruder, and through frictional engagement therewith draws with it the wrapper and the sheet of wrapping material. Upon continued outward movement of the wrapper with the extruded column, the wrapping material is caused to form an envelope about the column, thereby enclosing it in a package of wrapping material. Preferably, the wrapping material is folded lengthwise over a forming mandrel, such as over the extrusion tube or nozzle, using a wrapping sheet of such width as to completely enclose the extruded column plus a small overlap to strengthen the longitudinal seam where the two edges of the wrapper join. Pressure is applied to the surface of the package sufficient to retain the explosive therewithin, and prevent distortion of the package under the pressure of extrusion. The lapped edges of the wrapper are closed, and perfectly sealed, and the package is then complete. Any desired length of package can be obtained by measuring and cutting off an appropriate length of column.

The pressure necessary to hold the seam together before sealing can be applied to the package by any of several means. The open seam between the edge or fold of the wrapper can be glued promptly after forming. The wrapped package also can be retained between vanes or a series of circular rolling surfaces. One simple and preferable method is to encircle the package with two sets of opposed spiral winds of filamentary material, such as string, cord, or wire, one set being wound clockwise and the other counter-clockwise about the package. Such retaining filaments can be applied by conventional means which are well known to those skilled in the packaging art, and form no part of the instant invention. Such filaments can if desired be bonded to the package by application of the same means used to bond the seam.

The retaining filaments are preferably of a material such as fiber glass which does not result in generation of an appreciable amount of fumes when the package is exploded.

The wrapping material may have a tendency to wrap itself spirally about the loading mandrel under packing conditions. This spiraling tendency can be counterbalanced by an opposite force sufficient to restrain it. This counterbalancing force can be applied by means of a belt or other means which slips over the package and tends to wind the package in a direction opposite to that of the spiraling tendency of the wrap. The application of a filament wound about the package in the direction opposite to the spiraling also is effective. While one filament wind to counterbalance the tendency of the paper strip to wrap itself about the loading mandrel is usually adequate, a double wind in both directions gives a far greater and more satisfactory strength to the package.

The open seams of the wrapper can be bonded by any desired means appropriate to the wrapper material used. A bonding agent or composition can be applied, or the overlapped edges can be sealed by application of heat and pressure or solvent and pressure. The entire package can be coated with a surfacing material, if desired, to add greater strength and rigidity to the package, and this coating material will at the same time cover over and seal any open seams. Thus, for example, paper can be bonded by application of glue or wax through spraying or brushing of the package, or by application of kissing rolls, or by passing the package over a continuous surface or film of the bonding material. Thermoplastic synthetic resinous materials such as polyvinyl chloride or polyethylene can be sealed by application of heat and pressure or by application of a solvent for the resin and pressure, removing the solvent by heating.

After the seam or seams have been bonded, there is no longer any need to apply external pressure to retain the package, and any filamentary material wound about it can be removed.

It is apparent from the above description that by this method it is quite unnecessary to form, separately, empty containers which then must be filled with explosive composition. The wrapper or package can be formed continuously with the extrusion of the explosive composition, and the method is accordingly appropriate to package any explosive composition which can be extruded. Such compositions range from dry powders to plastic semi-solid explosive compositions which have sufficient rigidity to retain the extruded configuration until enclosed with wrapper material.

The method makes it possible to employ plastic materials, such as polyvinyl chloride, polyethylene, and polypropylene, for the packaging material, because the method eliminates the possibility of trapping air pockets in the package. Any air which may be extruded with the explosive composition will leak rapidly from the shell through the open seam or seams along the extrusion nipple, and the extruded column will move forward, drawing the wrapper material with it, only when explosive material is being pushed forward. Where there is an air pocket, there is no explosive mass to apply force, and hence, there is no further movement of the extruded explosive until the air pocket has been eliminated.

The extruded package can be handled in any manner known to the art. Very long and continuous columns can be prepared by winding the extruded package on a spool or roll. Columns may be packaged to any desired length by cutting them off, either automatically or manually, at the desired length. The exposed ends can be protected or closed off by spraying, dipping, applying caps, or other well known packaging methods. In many cases it is unnecessary to protect the ends, since the finished explosive columns can be shipped in cases which are themselves closed, and thereby prevent atmospheric moisture from entering the package. It is also possible to improve the strength of the outer covering by means of gluing, spraying or continuous dipping. All such procedures are well known to those skilled in the explosives and packaging arts.

FIG. 1 is a plan view of an apparatus for carrying out the invention employing a sheet of wrapping material which is applied lengthwise of the extruded mass of explosive and showing the extruder nozzle, the mandrel about which the wrapper is folded in forming the explosive package, and the mechanism for spirally winding about the package two opposed spirals of filaments to retain the explosive within the package prior to sealing.

FIG. 2 is a cross-sectional view on an enlarged scale through the apparatus of FIGURE 1, taken along the line 2—2, and showing one winder.

FIG. 3 is a cross-sectional view on an enlarged scale taken along the line 3—3 of FIGURE 1, and showing the other winder.

FIG. 4 is a view on an enlarged scale and partly in section of the wrapping portion of the apparatus of FIGURE 1, viewed in the opposite direction.

The apparatus shown in FIGURE 1 comprises an extruder 1 equipped with an extrusion nozzle 4 from which the explosive composition emerges in the form of an extruded column 6. Positioned at a point a short distance from the extruder is a folder 3 in the form of a flared hemi-cylinder, at the near side end 10 where it first engages the wrapping material having a diameter approximately twice that of the extruder, and at the outside end 11 having a diameter very closely approximating that of the extrusion nozzle. Wrapping material 2, for example, paper, from the storage roll 7 is brought into con-

tact with the flared near side end of the folder, and there folded about the extrusion nozzle 4, and is formed into a tube at the tip of the extrusion nozzle upon the application of strings 8 and 9.

Adjacent the end of the folder and also encircling the extrusion nozzle is a string winder assembly. Mounted on the winder gear 12 are a storage spool 13 of string and a pair of winder arms 14 and 15, each fitted with eyes 18 and 19 through which string 8 from the spool 13 is passed. Rotation of the string winder gear and accompanying assembly in a clockwise direction draws string from the spool by means of the arms, and the string is thus wound clockwise about the extrusion tube. A second string winder assembly is positioned slightly beyond the first, and also is equipped with a spool 20 and winder arms 21 and 22, all mounted on winder gear 23. The second string winder is to be rotated counter clockwise about the tube. The winder assemblies are rotated through fixed gears 24 and 25 operatively connected by the shaft 26 to a driven belt and pulley arrangement 27 operated from the extrusion shaft 28 driven in turn by motor 29.

Beyond the second string winder is positioned a pair of applicator nozzles 40 and 41, which feed bonding composition to the tube package from the reservoir 42. These are in close juxtaposition to the wrapped tube of explosive emerging from the second string winder, one nozzle 40 being directed at the seam thereof. A carrying belt 45 is provided to support the wrapped explosive package, and apply heat thereto from heater 46 to dry bonding composition applied by the nozzles. Finally, a storage roll 50 receives and winds up sealed packaged explosive 51 emerging from the system.

In operation, explosive composition 6 is extruded through extruder 1. The wrapping material 2 in sheet form is drawn from storage roll 7 to and through the folder 3, where it is folded over the exterior of the extruder nozzle 4 and then brought forward along the outside of the extruder nozzle 4 over the end thereof, at which point it comes into contact with the column 6 of explosive composition emerging from the extruder nozzle. The explosive composition draws the wrapping material with it as it emerges from the extruder, and thus continually feeds a supply of wrapping material 2 from the storage roll 7. Simultaneously, the wrapping material 2 is formed into a hollow tube 5 having sufficient retentive strength to retain the explosive composition therein without distortion through the application of a double opposed wind of strings 8 and 9. The strings 8 and 9 are applied by means of the string winders, the first applying string 8 from the spool 13 clockwise and the other applying string 9 from the spool 20 counterclockwise. The end of the extrusion tube is beyond the point at which the second string is applied, thus furnishing internal support for the tube formed under the pressure of the strings. The strings

are bonded to the wrapping material by application of glue or other bonding agents from nozzles 40 and 41, and heated to complete the bond. The finished continuous explosive shell 51 emerges from the system in a continuous length, which can be wound up on a storage roll 50 as shown, and cut in any desired length.

I claim:

1. A process for packaging explosive compositions, which comprises pressure-extruding the composition in the form of an elongated continuous column with a motive force due to the pressure of extrusion, moving the column forward under the pressure of extrusion into close contact with a sheet of flexible wrapping material, drawing the sheet forward in contact with the column by the said motive force, and by the said motive force holding the sheet thereover into close contact therewith in a manner to completely enclose and thereby package the column within the folded sheet, with the folded-over edges thereof adjacent each other in a generally longitudinal seam, applying sufficient external pressure to the package to hold the seam closed and retain the explosive column within the package under the pressure of extrusion required to cause the column to draw the sheet forward and form the said package, consolidating the column under the pressure of extrusion to fill substantially all of the volume of space within the package permitting gases to escape and thereby eliminating gas-filled voids therein, and thereby forming an elongated continuous explosive package of substantially uniform density.

2. A process in accordance with claim 1 wherein the external pressure applied to the package to hold the seam closed and retain the explosive column therewithin is by means of a spiral wind of filamentary material.

3. A process in accordance with claim 2 wherein opposed spiral winds of filamentary material are applied.

4. A process in accordance with claim 1 which includes sealing the longitudinal seam.

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