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METHOD OF MAKING EXPLOSIVES

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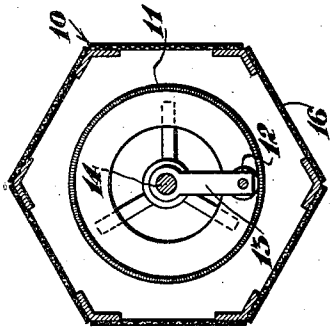


Fig. 2

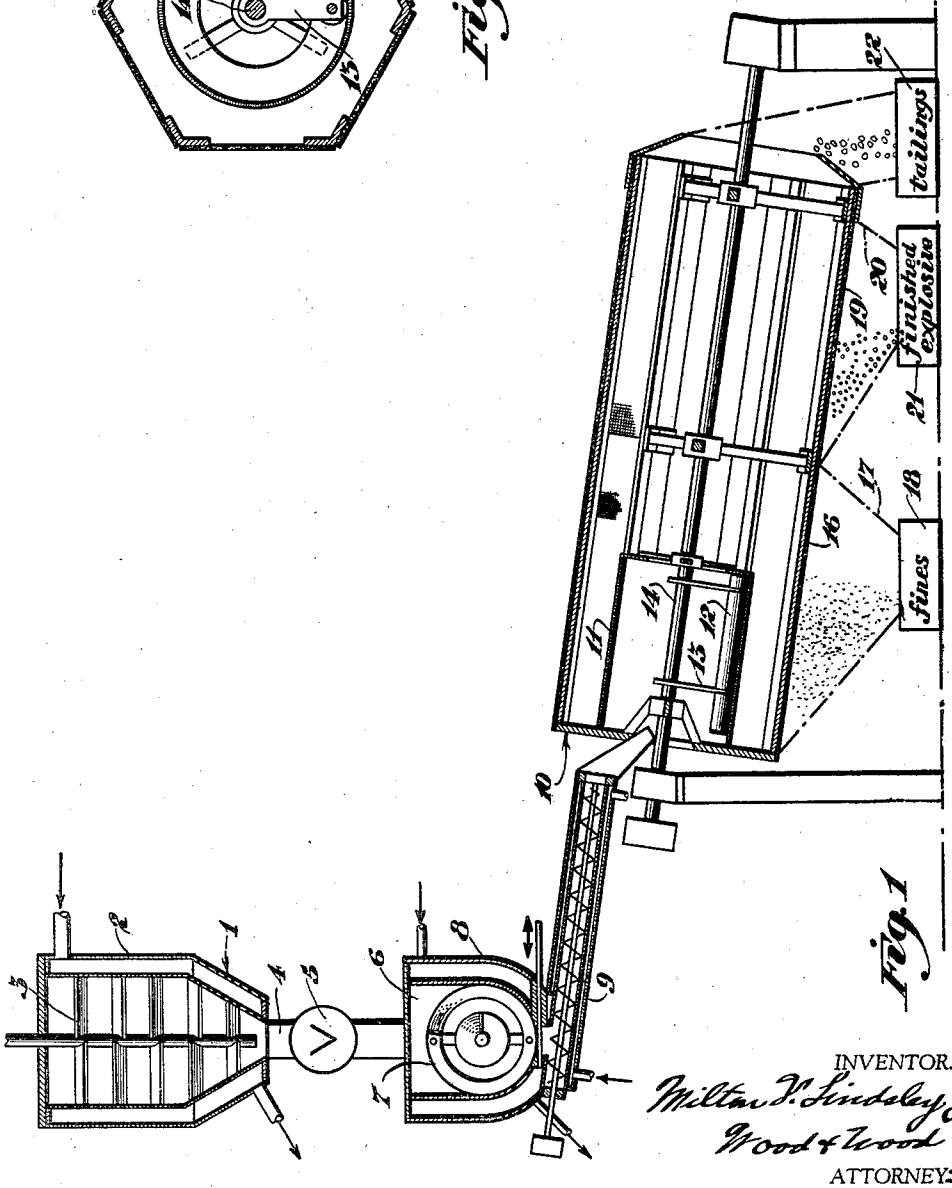


Fig. 1

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METHOD OF MAKING EXPLOSIVES

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8 Claims. (Cl. 52—19)

This invention is directed to new and improved explosive compositions and to a method of making them. The invention is disclosed particularly in relation to the manufacture of granular, high explosive materials suitable for blasting, mining, and commercial demolition, but it is also useful for the manufacture of explosives of the deflagrating type, or so-called low explosive compositions.

These materials may exhibit explosive strength from approximately 20 to 70%, as determined by the du Pont ballistic mortar, and may exhibit packed, volumetric densities varying from approximately 0.5 to 1.2. So far as I am aware, the novelty of the invention resides in the facility with which the explosives are made, the convenience with which both their physical and chemical characteristics are controlled, and in the fact that each grain individually is a complete explosive composition in and of itself.

At present, most high explosives used for commercial blasting purposes, are made of intermixed ingredients such as ammonium nitrate, sodium nitrate, other oxidizing agents, fuels, stabilizers, etc. These ingredients are mechanically blended together in a suitable mixing machine, such a dynamite mixer, and then sensitizing agents such as nitroglycerine, nitro starch, nitrocellulose or the like are added. In the finished explosive compositions the component materials remain individual particles in admixture.

In the manufacture of low explosives, for instance, those of the type of black powder, the various materials are homogenized in a wheel mill. The cake which is obtained when the components have been completely intermixed and compounded is compressed into slabs in an hydraulic press, and the press cake is then corned or grained, to obtain the desired granular product. The operations are conducted upon successive batches of material, and the operating units are judiciously spaced from one another in isolated localities to reduce the hazards.

Granular high explosives also are made by a process similar to that employed in the manufacture of low explosives. When this is done, however, it is requisite or desirable that an appropriate amount of water be present in the compositions to obtain the proper cake formation in the pressing operation, prior to the granulation. This water is removed after the press cakes have been granulated by treating the material in a dry house in which dry, warm air is circulated. Wholly aside from the handling operations which are incidental to the transportation of the partly processed material from one unit to the next, the drying operation is a tedious and expensive one; the moisture serves no useful purpose, and in fact is very undesirable, in the finished composition.

These various processes, moreover, impose limitations upon the products which can be made by them.

In the present invention a number of objectives are involved. For the most part, as previously stated, the commercial high explosive compositions, e. g. the dynamites, of the past have been made up of discrete, individual component particles mechanically intermixed. It has been the objective of the inventor to provide granular explosives of which each grain is a complete balanced explosive composition in and of itself.

A further objective has been to provide a process for making granular explosives in which the use of water is avoided, so as to eliminate drying of the finished material.

Another objective has been to provide a process for making granular explosives approaching one of continuity in order to avoid the expenses which are inherent in the production of successive batches of material.

A further objective has been to provide finished granular explosive compounds of slow average speeds of detonation and high sensitivity, for instance, explosives exhibiting sensitivity of 5 centimeters and greater, as determined by the Standard halved cartridge method (1¼ x 8 cartridges), without employing nitro sentisizers such as the liquid nitroglycerine or the like.

It also has been the objective to provide a process sufficiently safe that such explosives may be made continuously, as distinguished from individual segregated batches. Other objectives also are disclosed in the description of the invention which follows.

The components entering explosive compositions, whether they be of the detonating or deflagrating kind, may be divided into two classes: (*a*) the materials which are liquefiable or melt under the influence of heat and (*b*) the materials which are of a solid, non-liquefiable nature. Ammonium nitrate is a typical example of an explosive ingredient of the first group, while tar char, cereal, and charcoal are typical examples of non-meltable material. Other liquefiable and non-liquefiable explosive ingredients are disclosed at a later point in the specification.

It is the concept of the present invention first to melt or liquefy one or more of the liquefiable com-

ponents of which an explosive is to be made. This is done preferably by placing this component part in a suitable vessel or container, and heating while stirring or agitating it until it melts or becomes of liquid or semi-viscous consistency.

Meanwhile, the remaining ingredients of the composition intended to be made, that is, the non-liquefiable components (and whatever liquefiable components that have not been melted in the preceding step) are placed in a mixer and thoroughly admixed with one another. In this operation no heat necessarily is added. Next, the melted, hot component or components, which are now in the liquid state, are added to and thoroughly incorporated with the admixed non-liquefiable components and the whole mass is stirred and agitated until all of the ingredients are thoroughly associated with each other. As a practical matter, in this operation the components preferably are associated to such a degree that they lose their individual physical identities.

The temperature or cooling is so controlled that the mass, now comprising the liquid components associated with the non-liquid components, is of a plastic nature, somewhat dough-like and tacky in consistency. Otherwise expressed, the temperature is maintained sufficiently high to avoid solidification but the temperature is below that at which the material would tend to ignite, or exothermally decompose.

In the next step this plastic mass is formed into grains. A preferred technique for accomplishing this result is to subdivide the plastic mass into particles of predetermined size by passing the mass through a screen, perforated membrane, or plate, while it still is hot. Otherwise expressed, the mass is subdivided during the period of transition in which solidification of the mass is taking place. The grains finally obtained are characterized in that each one of them is a complete fully blended explosive. In this respect they differ in kind from the commercial high explosives which always heretofore have been made up of mechanical admixtures or blends of discrete individual particles admixed in much the same way that sand and gravel are admixed in a concrete mixer.

The process of the present invention is not a fully continuous one in the ordinary meaning of the word, but is distinguished from the conventional methods in that the raw materials are brought together at a central point and then incorporated with one another to yield granular explosive compositions finished and ready for use in a short period of time, for example, an hour or two. The finished material is conveyed from the point of manufacture either to a storage magazine or to the pack house.

By first melting the liquefiable components of the finished composition and then adding the non-meltable ingredients, the dangers of spontaneous ignition are avoided and the process proceeds with safety. If the fuel, oxidizing and binding agents were associated with a meltable material, for example, ammonium nitrate, and the whole mass then heated to liquefy the ammonium nitrate, spontaneous ignition would occur almost certainly; the danger, at least, would be so great as to preclude any practical usage of the idea.

On the other hand, if the ammonium nitrate, or other meltable components, be first melted and then this mass be added to and incorporated with the remaining materials, the temperature at no time approaches the temperature at which ignition might occur. The relatively high temperature required for melting the liquefiable materials prevails only during the period of safety, and decreasing or relatively low temperatures are employed during the otherwise dangerous phase, that is, when all of the components are being admixed with one another and when a finished explosive composition is being operated upon.

This safety feature is based upon the fact that the meltable components used in explosives manufacture, either hot or cold, are relatively stable in and of themselves but their stability decreases as the other materials are admixed with them. In the present process, the relatively increasing instability of the mass, as the materials become more intimately associated, is offset by permitting the mass to cool and the temperature to decrease during this phase.

For forming of the grains of finished explosive the temperature of the mass is controlled so that it is of a plastic doughy nature. To subdivide this mass into granules it is forced through a screen or perforated membrane which serves to provide discrete, granular particles. The plastic mass, before subdivision, dissipates its heat quite slowly. However, the ratio of surface area to volume of the subdivided particles emerging from the forming membrane is much greater. These particles, therefore, lose their plastic nature and become set in their physical form quite quickly. In some instances a film or hard casing is formed upon the particles. The rapidity with which the particles become set is dependent largely upon the temperature of the atmosphere surrounding them as they emerge from the forming screen or membrane. The particles, therefore, retain their individuality sufficiently to permit them to be sorted as to size, packed, or treated with surface sensitizing material without waiting for them to cool completely. As a matter of economy, the very fine particles and any lumps or large particles are recovered and later admixed with the non-liquefying ingredients to which the liquefied ingredients or components are to be added in the manufacture of a subsequent batch of the material.

Chemical ingredients

In the present description, the material melted is termed the liquefiable or meltable component. This designation is intended to include inorganic metallic nitrates, meltable carbohydrates having usage in explosives manufacture, and materials of similar function. Combinations of materials which tend to form eutectic mixtures melting at lower temperatures than the components of them preferably are used to avoid unnecessarily higher temperatures. For instance, admixtures of ammonium nitrate, sodium nitrate, sugar, dextrine and the like may be used, both for the purpose of lowering the melting point of the mixture and for the purpose of contributing to the chemical composition and physical characteristics of the explosive itself. This term also is intended to include such materials as starches, water soluble carbonates, resins and gums which function in the finished explosive compositions as binders, stabilizers or fuels. All of these materials are characterized in that their use in the manufacture of explosives is recognized by those skilled in the art, and in that they, or combinations of them, melt to become fluid or viscous when heated to temperatures below the temperatures of decomposition or ignition.

In this description the term non-meltable or

non-liquefiable ingredients is intended, as the term implies, to designate the materials entering the explosive composition which do not melt or liquefy under the influence of heat. Typical materials of this group are coal, charcoal, cereals, wood pulp, starch, metallic sensitizing agents, etc.

In addition to these solid and meltable materials, there is a group of materials used in explosives manufacture which are liquid at room temperature or have very low melting points. Paraffine, mineral, vegetable and animal oils, and explosive organic nitro compounds are typical of this group. They are not compatible with the materials of the melt, nor safe to be heated with it. When such materials are to be used they are best added after or as the melted and non-meltable materials are incorporated with each other.

As an illustration of the various type of explosives to which the method of the present invention is suited the following table of representative compositions is provided. In this table the materials which are melted, and the materials which are of non-liquefiable nature are classified under the corresponding headings.

accordance with the method of the invention, has been accepted as permissible at the present time by the United States Bureau of Mines.

The explosives which are made in accordance with the process of the invention, when sensitized according to the technique disclosed in the aforesaid Lindsley Patent No. 2,126,401 exhibit desirable slow speeds of detonation peculiarly coupled with high sensitivity. In general, it has been well recognized in the past that the practical sensitivity of an explosive in cartridges increases as the diameter of the cartridge is increased. The sensitivity of the explosives packed in cartridges of large diameter, for example, five inches, is relatively unimportant since the diameter is so much greater. On the other hand, it is necessary to use cartridges of small diameter, for example 1¼ to 1½ inches, particularly because of the economy, or necessary to drill small instead of large bore holes. However, it has been impossible in the past to obtain reliable slow speed explosives of this class, sufficiently sensitive when devoid of nitrated glycerine or glycol, to be packed in cartridges of such small diameter. As a practical matter, the problem of obtaining reliable results with small diameter

Representative compositions

	Low explosive granular or pellet	Low explosive granular or pellet	High explosive	High explosive	High explosive	High density high explosive (loaded 1.13)	Low density high explosive (loaded .56)	Permissible type high explosive	High explosive without coating for large diameter
Melting materials:									
Ammonium nitrate	15		58.5	87.5	58.5	57.0	84.5	84.75	58.5
Sodium nitrate	60	70	29.0		29.0	27.5		6.5	27.5
Sugar	3	6	2.5	6.0		3.0		2.0	3.0
Dextrine							4.0		
Other ingredients:									
Sulphur	10	11.5	3.0	2.0	3.0	3.0	1.5	1.5	3.5
Paraffine						1.0			
Tar char			6.0		8.5	7.0			5.0
Charcoal	9	9.5							
Wood pulp	3	3		3.5			9.0	3.0	2.5
Aluminum			1.0	1.0	1.0	1.5	1.0	2.25	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Strength			40%	60%	40%	40%	60%		40%

Ir place of the wood pulp employed in the foregoing compositions ivory meal, cereals, bagasse, almond shells, corn meal, rice hulls and other carbonaceous fuels may be used. The aluminum employed in the foregoing compositions serves as a sensitizing agent. Where control of the speed of detonation of the ultimate compositions is desirous, in conjunction with the control of the sensitivity, the aluminum may be of powdered form and applied as a surface sensitizing material in accordance with Lindsley Patent No. 2,126,401, issued August 9, 1938. Otherwise, the aluminum may be incorporated directly with the other non-meltable material; compositions similar to Ammonal may thus be prepared. In place of aluminum as a surface sensitizing agent other sensitizing ingredients also may be employed, for instance, as described in the aforesaid patent.

In the exemplary compositions disclosed in the foregoing table the tar char serves as a binder and also as a waterproofing agent as described in Lindsley United States Patent No. 2,079,558 issued May 4, 1937.

The sulphur, paraffine, charcoal, wood pulp and other ingredients fulfill their usual functions in the explosive compositions. From this table it will be noted that the explosives may be of low or high strength, as well as of the permissible type. A permissible type of explosive, made in

cartridges loaded with slow speed explosives, even sensitized with nitro glycerine, has been so great in the industry that large diameter cartridges are coming to be used more and more despite the extra cost of preparing for the use of them.

The materials made by the process of the present invention exhibit high sensitivity coupled with slow speed of detonation, to a remarkable degree. For instance, the present compositions may exhibit speeds of detonation, as determined by the du Pont ballistic pendulum or Mettegang recorder, of approximately 4000–7000 feet per second, and yet be so sensitive that detonation will be propagated when the two halves of a 1¼ inch cartridge are separated by a gap of 5 centimeters, and even greater, in accordance with the Standard halved cartridge technique. Detonating explosives having extremely slow speeds of detonation, for instance 1800–2000 feet per second, also have been made by the present method.

These characteristics of slow speed combined with suitable sensitivity make the compositions of the present process particularly suitable for commercial blasting purposes. Since this sensitivity is obtained without the employment of liquid nitro explosive sensitizers, the explosives do not lose their sensitivity when properly stored.

The grains of the explosives produced by the process may be packed immediately, as previous-

ly described, they may be surface coated and then packed, or they may be fed into a pelleting press after which the usual procedures are followed. The granules of material also may be further sensitized by the impregnation of them with liquid nitro explosives in a process of the type employed in the manufacture of present day dynamite. When this is done, the sensitivity is augmented, but with corresponding increase in the speed of detonation.

Manufacturing controls

Most of the components of the typical granular explosive compositions are poor conductors of heat. If all of the components of a given explosive are admixed and then heated, local portions, for instance, those adjacent the walls of the heating vessel, become overheated and initiate exothermic decomposition of the mass as a whole. By first melting the components which will liquefy under the influence of heat, in the absence of the other materials which will not liquefy, the dangers of overheating are avoided since the heat is transferred more readily throughout the mass as it becomes fluid. The liquid mass, in turn, is very easy to incorporate intimately with other materials. A recognition of this differentiation is important in the practice of the invention.

In making the melt, raw materials of commercial moisture content are used, and pre-drying of them is not necessary since the heating tends to drive off the moisture. In some instances the addition of a small quantity of moisture, for example, up to about 1% of the materials being melted, is employed for the purpose of decreasing the time required to make the melt. This added quota of water serves as a conductor of heat to the interior of the mass; it is driven off as the melting proceeds, sufficiently that the finished explosive need not be subjected to the usual drying process. Explosive grains made by the process, but intended to be made into pellets, may contain up to about 6–8% of water; this water may be added at the time the melt is being made, but, of course, it must be removed after the pellets have been formed.

Ammonium nitrate alone melts at a temperature of about 305° F. The addition of sodium nitrate to the ammonium nitrate decreases the temperature at which the mass melts by forming or tending to form eutectic mixtures. Like materials, for instance, sugar and dextrine may be used in place of the sodium nitrate or in conjunction with it for the same purpose.

It is preferable to employ a steam jacketed kettle for melting the materials to avoid open flames and to provide for better control of the temperature. The steam jacketed kettle is equipped with a mechanical mixer or agitator for stirring the material.

In mixing the ingredients to which the melt is to be added, a trough or dough-type mixer is suitable. The nonmeltable components are placed in the trough and commingled until the mass in the trough is of uniform consistency. The trough may be jacketed, either for the application of steam to it in order to prevent too rapid cooling of the mass after the melted material is added, or for the application of cooling water to lower the temperature. When the proportion of melted material to the whole is relatively high, the mass obviously is of a very plastic nature. In some instances, it may be too plastic to be formed easily into grains by the forming membrane, and in these cases cooling water is applied after the components have been mixed thoroughly. On the other hand, when the proportion of melted materials to the whole of the mass is relatively low it may tend to set or congeal very quickly. In this case the mixing trough may be warmed by the application of steam to the jacket to prevent the mass from congealing into hard lumps before it is formed into grains.

Improperly sized particles of finished explosive made during a previous run may be added and admixed with the non-meltable materials. It is best to do this prior to the addition of the melted components.

The admixture of meltable materials and non-meltable materials constitutes a finished explosive in the plastic state which is ready to be formed into grains. This dough-like substance next is conveyed from the mixing trough to the forming membrane and is then formed, preferably as promptly as possible into grains of finished explosive.

By controlling the temperature of the atmosphere upon the side of the forming membrane at which the grains emerge, the rapidity with which they congeal and set into physically hard particles may be controlled. Some plastic explosive masses have a much higher latent heat than others; this factor depends largely upon the nature of the ingredients of which the explosive is made, and, to a lesser degree, upon proportions. If the grains be expelled into a chilled or frigid atmosphere, then a hard casing upon them is formed quickly, and the particles, although frangible, retain their individuality sufficiently for them to be sized and sorted in the usual riddle as they emerge from the forming operation. In such instances the granules present jagged, somewhat crystallitic surfaces. These surfaces are particularly adapted to receive surface sensitizing agents and provide highly sensitive explosive compositions.

In other instances granules of relatively smooth, rounded surface are desirous. In such cases, the temperature prevailing as the grains are formed can be somewhat higher so as to prevent the particles from setting and congealing too quickly. If such particles are passed directly after their formation the mechanical riddling action tends to smooth the outer surfaces.

For explosives intended for blasting and commercial demolition purposes the forming membrane may be a screen having openings approximately 3 x 3 to 14 x 14. In place of employing a screen or foraminous membrane for forming the grains, extrusion machines or pelleting machines may be used.

It usually is not necessary to dehumidify the atmosphere at the discharge side of the membrane though this may be desirable in the summer time, or during rainy seasons when the humidity of the air is very high. In the winter time the air may be heated, if necessary, to prevent the particles from being chilled too rapidly.

The manner in which the grains are formed in the process of the invention, as previously explained, enables highly sensitive explosive compositions to be made. The surfaces of the granules are particularly receptive to sensitizing agents of the type of aluminum. One explanation of this feature may reside in the fact that there is greater intimacy of contact between the surface sensitizing agent and the surface of the grain, due to the nature of the surface of the grain as provided by the process

through which it was formed. The interior of the grains, so far as I have been able to determine, are quite porous. While the sensitivity of 5 centimeters, or greater, as determined by the Standard halved cartridge method, may be obtained without the use of nitro glycerine or nitro glycol sensitizers, the grains may be treated with such nitro sensitizers if desirous. Moreover, the interiors of the grains are much less sensitive than the outer sensitized surfaces, and gas is liberated somewhat in the same manner as gas is liberated from black powder. The efficient release of gas, coupled with low rate of pressure development of the gas and slow speed of detonation, enables the compositions to provide exceptionally good lump formation when friable coals and the like are being blasted.

In the drawing, which illustrates one type of apparatus suitable for the practice of the invention, the vessel in which the meltable materials are heated is indicated at 1. This vessel preferably is provided with a heating jacket 2 and an agitator 3 arranged so as to scrape the interior walls of the vessel. When the materials are melted they are discharged through a spout 4 having a cut-off valve 5. This outlet communicates with a trough or dough-type mixer 6 having a mixing paddle 7. The solid non-meltable ingredients are admixed in the trough while the melt is being made and then all of the components are admixed together in the trough to form the plastic mass. As previously explained, when liquid, or low melting point, oleaginous components or nitro explosive compositions are to be used in the making of the explosive they are preferably added at this point. The trough 6 is equipped with a jacket 8 so that it can be cooled or heated for the control of temperature.

A spout 9 is arranged for the delivery of the plastic mass from the trough 6 into a grain former and classifier indicated generally at 10. This spout may be equipped with a worm conveyor, as shown, and it may also have an orifice of predetermined diameter at its discharge end for the control of the compaction of the mass, and therefore, the control of the density of it as it is being delivered to the grain former 10.

The grain former may be comprised of a conventional riddle having an interior annular screen or foraminous membrane 11 within which the plastic mass is discharged from the spout. A roller 12 is carried freely within a cradle 13 which is suspended freely from an axle 14. The roller is of relatively heavy weight and it hangs vertically from the axle so that the roller is free to rotate about its own axis as the annular membrane is rotated. When the plastic explosive is introduced into the membrane it comes into contact with the roller; the latter tends to roll against the membrane and thus serves to force the plastic mass through the openings in the screen, to subdivide the mass of material.

Grains being discharged from the annular membrane fall onto the surface of the riddle and travel downwardly. The fines and small sized grains fall through classifying screen 15 into a collecting hopper 17 and are collected in a box 18. Grains of proper size fall through the classifying screen 19 into a hopper 20 from which they are collected in a box 21. Lumps and tailings are discharged from the end of the riddle into a collector 22. As previously explained, the tailings and fines are returned to the trough 6 for admixture with another batch of material.

A detailed example of the employment of the process in the manufacture of an explosive is as follows:

To make, for instance a 40% strength granular explosive, 58 parts of ammonium nitrate, 27 parts of sodium nitrate and 3 parts of sugar are introduced into the melting chamber, steam at a pressure of 5 pounds is introduced into the jacket and the materials are stirred and agitated and heated until they are melted. This operation usually will require about 10 minutes. Meanwhile, 3 parts of sulfur, 7 parts of wood pulp, and 1 part of paraffin are introduced into the trough and admixed. When the melt is completed it is added to the trough and both groups of components are admixed.

The temperature is so controlled that when all of the components are admixed the temperature of the plastic mass is approximately 90° C. It is then discharged gradually into the grain former.

Air at room temperature (120° F.) at relative humidity of 5% is admitted to the riddle. After the material is classified it may be treated with approximately 1% of aluminum powder in a glazing tumbler and it is then ready for use.

The foregoing details are given purely as an example of the typical controls used in making one typical type of explosive, and the invention is in no sense to be limited thereby, but only by the substance of the claims which follow.

Having described my invention, I claim:

1. A method for making granular ammonium nitrate explosives which process comprises dividing the components of which a balanced explosive composition is to be made, into groups comprising respectively, substantially dry meltable components, including ammonium nitrate, and substantially dry non-meltable components, heating the meltable components in the absence of any substantial quantity of water until they reach fluid condition, at a temperature less than the temperature at which they decompose, then mixing the dry non-meltable and melted components thereby obtaining a plastic mass substantially devoid of water, and finally forming the plastic mass into grains.

2. A method for making granular explosives which comprises agitating and heating a substantially dry composition which is meltable when heated and which contains a substantial quantity of ammonium nitrate, to a temperature below the temperature at which the composition will decompose, for a period of time sufficient to melt it, adding to and incorporating with this melt substantially dry non-meltable explosive-making chemicals proportioned in amount relative to the melted composition and to each other to yield a balanced explosive composition thereby obtaining a plastic mass which is substantially devoid of evaporable liquids, and then forming said mass into explosive grains and permitting said grains to cool and harden.

3. A method for making a granular ammonium nitrate explosive composition which process comprises dividing the components of which a balanced ammonium nitrate explosive composition is to be made into groups comprising respectively, substantially dry meltable, oxygen containing components and substantially dry non-meltable components, heating the meltable components at a temperature less than the temperature at which they exothermally decompose, until they reach fluid condition, then mixing the non-meltable and melted components in the absence of any substantial quantity of water thereby ob-

taining a plastic mass of balanced explosive composition which is substantially free of moisture and evaporable liquids, and finally forming the plastic mass into grains by extruding it through a foraminous membrane into an atmosphere sufficiently lower in temperature than the mass, to cause the grains to set and become sufficiently hardened to be sorted as to size.

4. A method for making chemically balanced granular ammonium nitrate explosives, which comprises agitating and heating a substantially dry composition made of meltable explosive-making chemicals, including ammonium nitrate at a temperature lower than that at which the composition decomposes, for a period of time sufficient to melt the composition, then, in the absence of any substantial quantity of water, adding to and incorporating with this melted mass, non-meltable explosive-making substances, which are proportioned in amount relative to the meltable explosive making chemicals to yield a balanced explosive composition, whereby obtaining a plastic mass of balanced explosive composition, then subdividing said plastic mass into discrete explosive grains in an atmosphere sufficiently low in temperature to set the grains to physical hard condition as they are subdivided from said mass.

5. In the art of making a blended explosive the process which comprises melting ammonium nitrate and mixing solid unmelted supplemental explosive making ingredients with it while it is in the melted condition, the said supplemental ingredients being proportioned relative to the ammonium nitrate to yield a substantially balanced explosive composition when mixed with the ammonium nitrate, and in the absence of any substantial quantity of water, then permitting the admixture to solidify by cooling and subdividing it into a granular composition during the period of transition in which solidification is taking place.

6. The method of preparing a detonatable explosive having high sensitivity, which comprises preparing a plastic mass of explosive composition substantially devoid of water and nitroglycerine sensitizer, by preparing a hot fluid mass containing a substantial quantity of ammonium nitrate, adding to and admixing with said mass substantially dry explosive making chemical components proportioned relative thereto to yield a chemically balanced explosive composition, and finally subdividing the plastic mass into grains during a period of transition in which solidification of the mass is taking place.

7. The method of making an ammonium nitrate explosive composition, which method comprises heating a mass consisting primarily of ammonium nitrate, to fluidify the same without the use of any substantial quantity of water, with the heating operation being conducted in the absence of materials which tend to combine with the ammonium nitrate to cause decomposition, then discontinuing the heating and incorporating the ammonium nitrate with other explosive making chemicals proportioned to provide a balanced ammonium nitrate explosive composition, with the incorporating operation being conducted over a period while the temperature is permitted to decrease, the commingling of the fluid ammonium nitrate melt and the other explosive compositions providing a hot plastic mass which is substantially devoid of water, then subdividing this hot plastic mass into grains, the temperature of the mass and the temperature of the atmosphere surrounding the grains as they are formed being controlled to cause setting of the grains to non-tacky consistency as they are formed, whereby the grains become sufficiently set as they are formed to retain their discrete individuality when they are commingled.

8. The method of making an explosive, which method comprises heating a composition comprised of meltable ingredients and containing a substantial quantity of ammonium nitrate to melt the same without the use of any substantial quantity of water and in the absence of materials which tend to combine with the ammonium nitrate to cause decomposition, then discounting the heating and incorporating in said melt other explosive making chemicals proportioned to provide a hot plastic mass which is substantially devoid of water, but with the incorporating operation being conducted over a period while the temperature of the mass is decreasing, then subdividing this mass into grains and controlling the temperature of the mass and the temperature of the atmosphere surrounding the grains as they are formed in such manner that the grains set to a non-tacky consistency as they are formed, thereby producing grains sufficiently hard to retain their discrete individuality when they are commingled.

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