

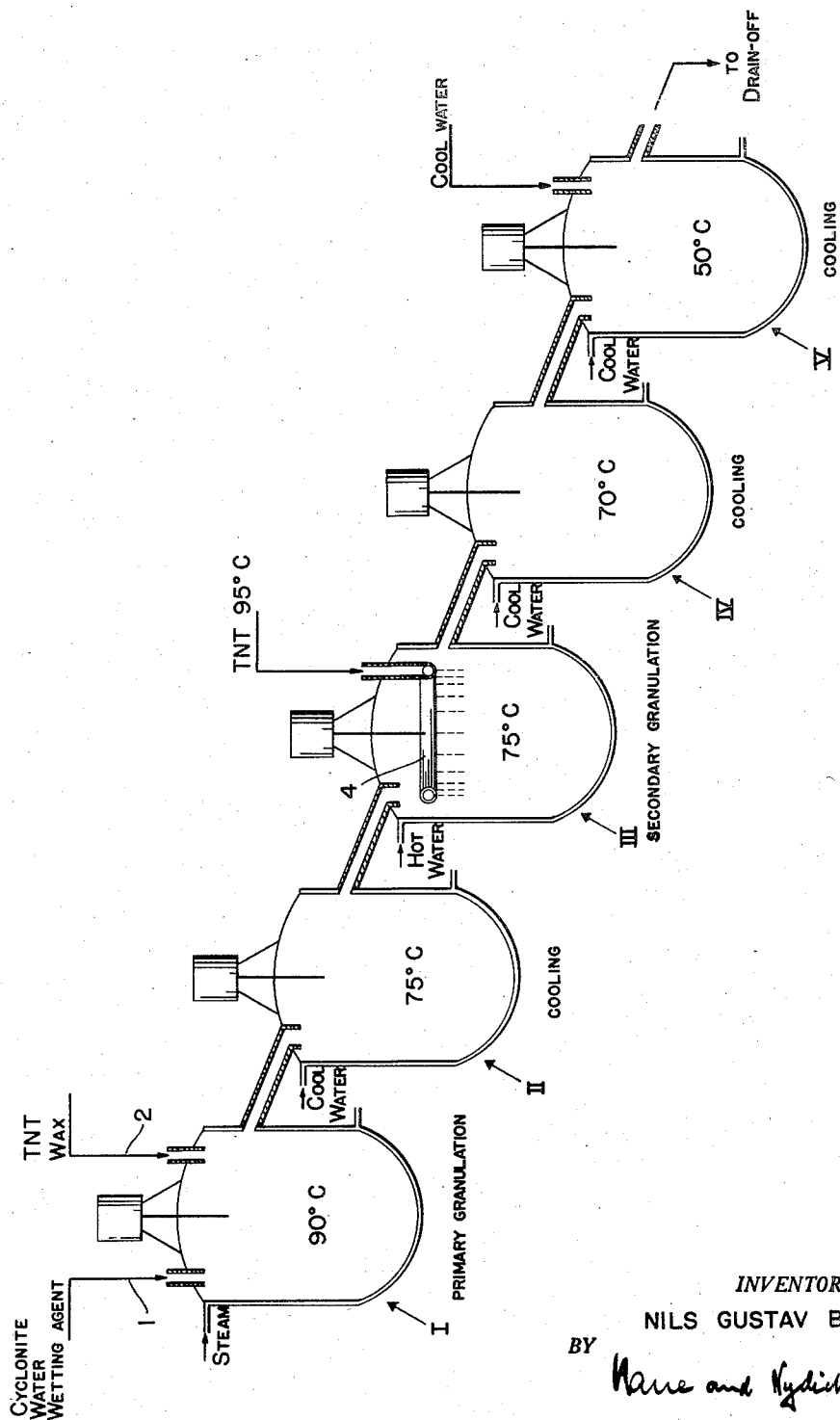
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METHOD OF MANUFACTURING EXPLOSIVES

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## METHOD OF MANUFACTURING EXPLOSIVES

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This invention relates to explosives; and in particular, is directed to a novel process for the manufacture of granulated mixed explosives containing trinitrotoluol.

It is known to manufacture mixed explosives containing TNT (trinitrotoluol) in such way that the explosives other than the TNT, as for example, cyclotrimethylene-trinitramine (cyclonite RDX), 2,4,6-trinitrophenyl-methylnitramine (tetryl), pentaerythritol tetranitrate (PETN), ammonium picrate (explosive D), aluminum, etc. are added to the molten TNT and distributed in the molten TNT by stirring. The mixed explosive thus produced is thereafter subjected to generally known operations for the manufacture of granules, flakes or cakes. It is thus possible to manufacture mixed explosives containing TNT where the explosives are directly brought together. By such manufacture, the mixture will constitute one single coherent unit, whereby the mutual relation between the ingredients can be varied to a very great extent. The most serious disadvantage of this method of manufacturing mixed explosives is the hazard of accidents due to fires or explosions caused by the necessity of working with a considerable coherent quantity of the explosives at one time during the mixing operation.

In order to lessen such hazard of explosion, it is possible to carry out mixing of the explosives in a solution, preferably of water. In the water, the mixed explosives will be produced in the form of grains, which are not in contact with each other. According to this last mentioned method, the mixing is carried out in one step. The disadvantage of the last mentioned method is that the relation between the explosive ingredients in the mixture can only be varied to a very small extent. Thus, the TNT content in the mixed explosive lies between 5% and 20%. Where attempts are made to manufacture mixed explosives by carrying out the intermixing in water, and using TNT in quantities outside the aforesaid range of from 5 to 20 percent, it is found that when the mixed explosive stiffens, granules are obtained but the grains can differ from each other considerably both in composition and size. When the TNT content thereof is comparatively small, very different sizes of grains and crystals are obtained. If the TNT content is high, it is difficult to maintain good distribution in the aqueous phase, and when the mixture cools, a part thereof stiffens and forms a firm cake. It is only when the TNT content is of such an optimum value in the suspension described above that a final result can be achieved wherein the granules exhibit evenness of grain size combined with homogeneity of composition without the separation therefrom of a firm cake of TNT.

According to the present invention, by using two steps, it is possible to vary the mutual relation between the explosive ingredients to the same extent as is possible in the method where the ingredients are mixed directly with each other. Accordingly, it is among the principal objects of the present invention to provide a process to govern the manufacture of granules of mixed explosives containing varying quantities of TNT in such a way

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that the product produced will be granules with evenness of composition and grain size.

I have found that such objective is attained if the manufacture be divided into two separate steps, which may appropriately be designated as the primary and the secondary granulation. When the manufacture is carried out in batches, the primary and secondary granulation may be carried out seriatim in the same vessel. The method may easily be adapted or converted to a continuous operation in which different vessels are used for the primary and secondary granulations. To carry out the primary granulation, a watery suspension of molten TNT is made with such a quantity of the TNT that in each individual case, together with the other component explosives, granules of even or uniform composition and grain size may be obtained. The additional portion of TNT desired to bring the TNT content of the final granules to a desired value is introduced in the subsequent secondary granulation. If a correctly proportioned quantity of TNT be used, granules of the mixed explosive will be produced in the first operation that are characterized by great homogeneity of composition, have an appropriate grain size and are devoid of any tendency to stick together or collect on the walls of the apparatus.

In carrying out the secondary granulation, the granules produced in the primary granulation, together with the mother liquid or together with some other suitable suspending liquid as for example alcohol and/or glycerine is used to which there is added the remaining portion of the TNT in molten condition. This addition can be accomplished by means of an appropriate sprinkling device. While the mass is vigorously stirred, if a correct temperature has been chosen, the TNT will precipitate on the primary granules. It is of great importance that an appropriate temperature be used in the last-mentioned operation. The temperature depends upon the type of mixed explosives (as for example, cyclotol: 60% cyclonite and 40% TNT, tetrytol: 70% tetryl and 30% TNT, pentolite: 50% PETN and 50% TNT, picratol: 50% explosive D and 50% TNT), i. e. on the composition and on the granulating conditions, as for example the form or shape of the vessel and/or the stirring conditions. The temperature is determined empirically in each individual case by a laboratory test; and then this temperature is applied to the full scale operation. Generally the temperature should lie in the approximate range of 70° to 80° C. If the temperature be too high, there is a hazard that a sticky material will be produced. If the temperature be too low, the granules produced will not be even and homogeneous.

The following are illustrative examples of mixed explosives made in accordance with this invention; and the accompanying drawing shows a general organization of apparatus suitable for carrying out such manufacture.

## Example 1

Manufacture in batches of granulated mixed explosive containing about 40% TNT

While stirring well mix at approximately 90° C. 1 weight portion RDX, 0.18 part TNT, 3.3 parts water, 0.02 part wax, as for example, beeswax, Canada wax or carbowax, and a little wetting agent, as for example, a non-ionic material such as a polyglycol ether. After a short time, approx. 10 minutes, cool down to approx. 75° C. To the granules thus obtained in the mother liquid, while stirring well, add 0.48 part TNT in a liquid form (temperature of TNT approx. 95° C.). When all the TNT has been added, cool the mixture, and the granules can be drained off on a vacuum filter and dried.

## Data for final product:

Sieve analyses: 28.3% remains on sieve No. 10  
 U. S. Standard: 71.6% remains between sieve No. 10  
 and sieve No. 20  
 Specific weight: 1.63

It is to be noted that the amount of wax used, as shown by this example or any of the other subsequent examples, can vary in amount of from about 0.5 to 0.005 part by weight. The wax aids in the producing of bodies from the granules.

The amount of wetting agent used is in the order of about 10 cc. of the wetting agent per ton of the explosive. The granulation may be effectuated without use of a wetting agent.

## Example 2

While stirring well, mix at approximately 90° C., 3.3 weight parts of water, 1 weight part of cyclonite and 0.2 part of wax, for example, paraffin wax, a small quantity of wetting agent, as aforesaid and 0.18 part of TNT. The mixing is carried out in a vessel provided with a jacket and a connection at the bottom. Steam is injected directly into the mixture of explosives through the said connection. The steam is used for heating the explosives and the jacket used for cooling. The cooling agent is conducted through the space between the jacket and the vessel. It will be understood of course that steam may also, when desired, be passed therethrough. In the latter case, the explosives will not be heated directly but indirectly. To effectuate an axial flow of the explosives to the vessel, the vessel may be provided with a number of baffles. The stirrer may be provided with obliquely positioned wings. After stirring for about ten minutes, the explosive mixture is cooled to 75° C. To the granules thus produced in the mother liquid and while stirring well, there is added 0.48 weight part of TNT in liquid form, the TNT having a temperature of about 95° C. The TNT is dropped on the mixture from a tube shaped in annular form and provided with holes. When all of the 0.48 part of the TNT has been added, the mixture is cooled to a temperature of 60° C. or even lower. After cooling the granules may be drained off and dried.

## Data for final product:

Sieve analyses: 28.3% remains on sieve No. 10  
 U. S. Standard: 71.6% remains between sieve No. 10 and sieve No. 20  
 Specific weight: 1.63

The procedure just described for carrying out the primary granulation may be varied by first placing the TNT in the mixing vessel, following which the other explosives can be put in, while stirring the TNT.

## Example 3

Continuous manufacture of granulated mixed explosive containing about 40% TNT (cyclitol 60/40)

As shown in the accompanying drawing, there are mixed while in vessel I, per time unit, a water-RDX (cyclonite) suspension containing 1 weight portion of RDX, 3.3 parts of water and a suitable wetting agent through supply conduit 1, 0.18 part of TNT and 0.02 part of a suitable liquefied wax are introduced in the vessel through supply pipe 2. The temperature is maintained at approximately 90° C. The primary granules thus formed in vessel I together with the suspending liquid are then transferred through cooling vessel II to vessel III. In vessel III, secondary granulation is carried out by stirring the suspension of the primary granules at a temperature of about 75° C. and spraying the same through the annular sprinkler 4 with molten TNT having a temperature of approximately 95° C. so that, per time unit, 0.48 part of TNT will be added as by coating to the primary granules. The suspension of the thus coated (secondary) granules may then be transferred to vessel IV where the temperature is reduced to about 70° C.; and thence from

vessel IV to vessel V where the temperature is further reduced to about 50° C. After this last cooling, the mass is discharged and drained off as by means of a vacuum filter and the secondary granules dried.

When using vessels having a cubic capacity of 4 cubic meters, the mixed explosive can be manufactured with a throughput of about 3 tons per hour.

## Data for final product in accordance with this example:

Sieve analyses: 25.0% remains on sieve No. 10  
 U. S. Standard: 74.8% remains between sieve No. 10 and sieve No. 20  
 Specific weight: 1.63.

It will be understood that the foregoing description of the invention and the examples set forth are merely illustrative of the principles thereof. Accordingly, the appended claims are to be construed as defining the invention within the full spirit and scope thereof.

## I claim:

1. A method of manufacturing granulated mixed explosive containing trinitrotoluol in excess of 20% which comprises stirring a suspension of at least one explosive selected from the group consisting of cyclotrimethylene-trinitramine, 2,4,6-trinitro phenylmethylnitramine, pentaerythritol tetranitrate and ammonium picrate and a portion of the TNT, about one third of the total TNT, in the fluid state in a liquid, cooling the said mixture to a temperature whereby homogeneous, uniform, non-sticking granules are produced, followed by the step of suspending the aforesaid granules in water, stirring the same, and adding thereto the remainder of molten TNT thereby to produce a coating of TNT on the granules first produced.

2. A method of manufacturing granulated mixed explosives containing trinitrotoluol in excess of 20% characterized by the feature that the granules are made in two stages, the first stage being one in which the components of the mixed explosives selected from the group consisting of cyclotrimethylenetrinitramine, 2,4,6-trinitro phenylmethylnitramine, pentaerythritol tetranitrate and ammonium picrate are suspended in water and stirred at a temperature exceeding the melting point of the TNT, adding to said stirred suspension a portion of the TNT, about one third of the total TNT and cooling the said mixture to a temperature whereby homogeneous, similar, non-sticking primary granules are produced, followed by a second stage, wherein said primary granules are suspended in water and while being stirred, there is added thereto the remainder of molten TNT, thereby to produce a coating of TNT on the said primary granules.

3. A method of manufacturing granulated mixed explosives containing trinitrotoluol in excess of 20% which comprises suspending the explosives selected from the group consisting of cyclotrimethylenetrinitramine, 2,4,6-trinitro phenylmethylnitramine, pentaerythritol tetranitrate and ammonium picrate in water, stirring the same at a temperature exceeding the melting point of the TNT adding to said stirred suspension a portion of the TNT, about one third of the total TNT and cooling the said mixture to a temperature whereby homogeneous, uniform, non-sticking granules are produced, followed by the step of suspending the aforesaid granules in water, stirring the same, and adding thereto the remainder of molten TNT thereby to produce a coating of TNT on the granules first produced.

4. A method of manufacturing a granulated mixed explosive containing trinitrotoluol in excess of 20% and RDX which comprises, suspending the RDX in water and stirring the same at a temperature exceeding the melting point of the TNT, adding to such stirred suspension a portion of the TNT, about one third of the total TNT cooling said mixture to a temperature whereby homogeneous, uniform, non-sticking granules of a mixture of RDX and TNT are produced, suspending said granules

in water, stirring the same and adding thereto the remainder of molten TNT, thereby to produce a coating of TNT on the granules first produced.

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