UNITED STATES PATENT OFFICE.

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COOLING EXPLOSIVE SHELLS.

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To all whom it may concern:

Be it known that I, ARTHUR J. MOXHAM, a subject of the King of Great Britain, residing at New York city, county of New York and State of New York, have invented a new and useful Improvement in Cooling Explosive Shells, of which the following is a full, clear, and exact description.

In explosive shells loaded with trinitrotoluol, picric acid and other of the crystalline high explosive, one of the difficulties experienced during the cooling is the development of piping or cavitation in the explosive material. The ordinary method of cooling is such that the outside layer of the explosive charge cools first below the point of crystallization. Hence, a thin band of crystallized material forms in contact with the metallic part of the inside of the shell. This thin band, which incloses a body of explosive material still molten, acts as a non-conductor and retards the cooling of the interior. Even after the crystallization has reached well within the body of explosive material, the center core remains not only liquid, but very liquid. The final result of this method of cooling is, as above stated, piping or cavitation, as it leaves a core or cavity in the center of the shell.

The object of my invention is to avoid this piping or cavitation. To this end I subject a shell, loaded with explosive material having a well defined melting point, to two successive cooling operations. In the first operation the shell is subjected to such a temperature that the entire body of explosive material, from its outer edge to its center, will be cooled to a point closely approximating, but safely above, that of crystallization. After the entire mass of explosive material which, although it is still liquid, has been thus uniformly cooled to nearly its freezing point, the shell is subjected to the second cooling operation, in which it is exposed to a temperature below the freezing point of the explosive material, thus effecting the uniform crystallization or solidification of the entire body of explosive material. The second cooling operation should be preferably a rapid one, because the molten charge will have so increased in density that the contraction upon further cooling will not develop piping or cavities.

The following specific example illustrates one preferred way of carrying out my process as applied to a shell of given size loaded with a given explosive material.

An ordinary 155 millimeter shell (which is approximately a six inch shell) is loaded with about fifteen and one-half pounds of trinitrotoluol. This explosive has a melting point varying from 76° C. to 81° C, according to the specifications under which it is manufactured. The shell, after the molten charge of trinitrotoluol is poured in, is inserted in a container and subjected to a temperature a very few degrees above the melting point of the trinitrotoluol; say about 85° C. Suitable provision should be made for carrying off the heat given up by the shell during the cooling operation. This may be effectively done by employing, as a container, a tunnel of considerable length, the shell being kept traveling therethrough slowly and a current of air of a temperature of about 85° C. caused to circulate through the tunnel to carry off the abstracted heat.

After the molten charge of trinitrotoluol has been reduced, by passage through the tunnel, to a uniform temperature of (say) 85° C., the shell is immediately transferred to another cooling chamber in which is maintained a temperature below the point of crystallization of the trinitrotoluol. The result is that crystallization of the central core will take place contemporaneously or nearly so with the crystallization in the outer band and the action will be substantially uniform throughout the mass, which uniformity of action prevents the development of piping or cavitation.

It will be understood that the example given is illustrative only, and that the process is not dependent for its successful execution upon the employment of any particular cooling apparatus. Thus it may be found practicable to cool the explosive material down to nearly its freezing point before charging it into the shell and to subject the shell itself to only the second of the two cooling operations described.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. The process of treating high explosive material of shells to effect cooling or solidification while preventing piping or cavitation, which consists in reducing the temperature of the entire body of explosive material to a point approximating, but above,

its point of crystallization, and then cooling the entire body of explosive material to a temperature below its point of crystallization.

2. The process of treating explosive material of shells to effect cooling or solidification while preventing piping or cavitation, which consists in subjecting said material to a temperature approximating, but above, its point of crystallization to effect a substantially uniform reduction of its temperature and contraction of its volume, and then subjecting the material to a temperature below its point of crystallization, thereby effecting the cooling or solidification of the entire mass.

3. The process of treating explosive material of shells to effect crystallization while preventing piping or cavitation, which consists in cooling the material at a temperature above the point of solidification until the entire body thereof has been subjected to a substantial contraction of volume and reduction of temperature while maintaining in a liquid condition the entire body of the explosive and then cooling the material comparatively quickly to effect the solidification of substantially the entire body of explosive material.

4. The process of treating shells containing high explosive material which consists in loading the shells with the high explosive in a liquid condition, then subjecting the loaded shells to a temperature substantially below that of the explosive when charged until the entire body of the explosive is reduced to a temperature approximating, but above, its freezing point, and then subjecting the loaded and cooled shells to a temperature substantially below the freezing point of the explosive, whereby the formation of a band of crystallin explosive material surrounding a molten interior is avoided and the solidification of the entire body of explosive effected with substantial thoroughness and uniformity.

5. The process of treating high explosive material of shells to effect crystallization while preventing piping or cavitation, which consists in reducing the temperature of the entire mass of explosive material until the entire mass approximates, but does not reach, the temperature at which it crystallizes, and then uniformly and simultaneously crystallizing the mass throughout by subjecting it to a temperature below its temperature of crystallization.

In testimony of which invention I have hereunto set my hand at New York, N. Y., on this 7th day of January, 1918.

ARTHUR J. MOXHAM