(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 634 193 A1**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number: **94110481.2**

(51) Int. Cl.[6]: **A62D 3/00**

(22) Date of filing: **06.07.94**

(30) Priority: **13.07.93 US 90459**

(43) Date of publication of application:
**18.01.95 Bulletin 95/03**

(84) Designated Contracting States:
**BE DE ES FR GB IT NL SE**

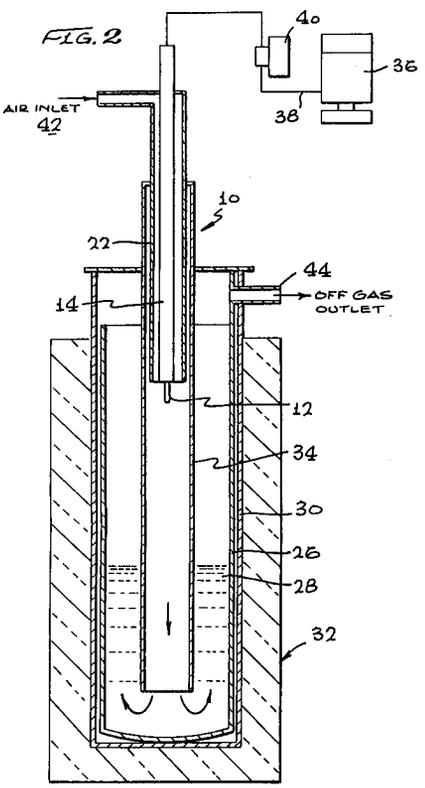
(71) Applicant: **ROCKWELL INTERNATIONAL CORPORATION**
**2201 Seal Beach Boulevard,**
**P.O. Box 4250**
**Seal Beach, CA 90740-8250 (US)**

(72) Inventor: **Gay, Richard Leslie**
**10012 Hanna Avenue**
**Chatsworth, CA 91311 (US)**
Inventor: **Guon, Jerold**
**23824 Aetna Street**
**Woodland Hills, CA 91367 (US)**
Inventor: **Newcomb, John Charles**
**1366 Los Amigos**
**Simi Valley, CA 93065 (US)**

(74) Representative: **Wächtershäuser, Günter, Prof. Dr.**
**Patentanwalt**
**Tal 29**
**D-80331 München (DE)**

## (54) Method and system for feeding propellant slurry.

(57) A method and system are provided for feeding a slurry of energetic wastes, such as propellants or explosives, dissolved in a volatile solvent such as acetone, for introduction into a molten salt for destruction of such waste, without vaporization of the solvent in the feeding device or injector, and without deposition of explosive residue on the inside surface of such injector. This is achieved by introducing carbon dioxide liquid into the slurry feeding device or injector, and into heat exchange relation with the feed slurry to cool the slurry and prevent vaporization of the volatile solvent, and to thereby prevent deposition of explosive solid residue in the feed injector. The injector is mounted on the vessel which contains the molten salt and such vessel is positioned in a furnace for heating the molten salt to reaction temperature. Although the injector for feeding the propellant slurry is heated by the furnace, sufficient cooling is achieved by the liquid carbon dioxide within the injector to prevent vaporization of the volatile solvent.




EP 0 634 193 A1

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to the destruction of explosives and propellants, and is particularly directed to an improved process for feeding a slurry of energetic wastes, such as a propellant or explosive, dissolved in a volatile solvent into a waste destruction system, while preventing vaporization of the solvent and leaving an explosive solid residue on the feeding device.

### 2. Description of the Prior Art

Propellants and explosives are energetic systems containing energetic groups such as nitrate and azide groups, and finely-divided metal particles. The problem is to dispose of these materials as a waste. The use of a molten salt bath containing alyali metal carbonate for destroying propellant and explosive wastes has been developed. Because these materials are so sensitive as solids to potential detonation, the practice has been to dissolve them in an organic solvent such as ketones (e.g. acetone),ethers and acetates, to make a pumpable slurry. However, since ketones, ethers and acetates used to form the slurry are very volatile, where a feed injector is located within a heated vessel in a molten salt waste destruction system, the heat transferred to the feed injector is such that it is likely to vaporize the organic solvent and leave a solid residue on the inside of the injector piping and which may potentially detonate.

## SUMMARY OF THE INVENTION

The present invention provides a method and system for actively cooling the injector for feeding the energetic waste slurry of a propellant or explosive containing a volatile organic solvent such as acetone, while the slurry is being heated, so that the solvent in the slurry does not evaporate and no explosive residue forms and the slurry is discharged from the feed injector for passage to the waste destruction system, such as a molten salt bath.

According to the invention, such cooling of the energetic waste is achieved using carbon dioxide liquid. The carbon dioxide liquid is introduced into an annulus of the injector for heat exchange with the waste slurry passing through a central tube in the injector. Since the feed injector is normally mounted within a furnace containing a molten salt waste destruction bath, common aqueous coolants such as water could not be employed because if a leak developed in the injector, water would be introduced into the molten salt bath which could result in a steam explosion. Where carbon dioxide liquid is employed according to the present invention, it will vaporize during heat exchange cooling with the waste slurry in the injector, and no steam or other explosion potential is presented. Common cooling gases such as air or helium cannot be used because insufficient heat can be removed in the gas phase.

## OBJECTS OF THE INVENTION

It is accordingly an object of the present invention to provide an improved process for feeding a waste slurry of a propellant or explosive dissolved in a volatile solvent to a waste destruction system.

Another object is the provision of a process for feeding a waste slurry of a propellant or explosive dissolved in acetone or other volatile organic solvent through a feeding device into a molten salt bath for destruction of the propellant or explosive, without vaporization of the acetone or other volatile organic solvent during passage of the waste slurry through the feed system.

Yet another object is the provision of a system for carrying out the invention process.

Other objects and advantages of the invention will be apparent or made obvious by the description below of a preferred embodiment of the invention.

## DESCRIPTION OF THE DRAWINGS

Fig. 1 is an elevational view of an actively-cooled slurry injector for carrying out the invention process; and

Fig. 2 shows the slurry injector of Fig. 1 positioned within an electric furnace containing a molten salt bath for discharge of the feed slurry into such bath.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring to Fig. 1 of the drawing, the actively cooled slurry injector according to the invention, indicated at 10, is comprised of a central tube 12 for passage of the feed slurry, and which is open at both ends. A second larger diameter tube 14 is positioned around tube 12 concentrically therewith. The bottom of tube 14 is sealed at 16 but is open at its upper end. A third small diameter tube 18 is positioned in the annulus 20 between tubes 12 and 14, and extends downwardly into the annulus close to the bottom thereof. Carbon dioxide liquid is fed downwardly through the small tube 18 and is discharged from the bottom thereof into the annulus 20 and passes in heat exchange relation with the feed slurry in the central tube 12, cooling same

and causing vaporization of the $CO_2$. The liquid carbon dioxide fed to tube 18 and into annulus 20 is usually under pressure, e.g. 800 psi, and at a temperature of the order of about 0 °C or below. The $CO_2$ gas is discharged from the top of tube 14 since it is sealed at the bottom. In this process it flows around the outside of the central tube 12 and removes heat therefrom.

While the slurry injector is normally positioned inside a furnace, as shown in Fig. 2 and described below, so that it is subjected to heating from the outside, the cooling capacity of the carbon dioxide liquid is still sufficient to maintain the feed slurry sufficiently cooled so that the volatile solvent therein, such as acetone, does not evaporate.

A fourth tube 22 having a diameter greater than tube 14 is positioned concentrically around tubes 12 and 14. Tube 22 is open at both ends and functions for passage of air downwardly in the annulus 24 between tubes 14 and 22 and exits at the bottom of tube 22. The air passing through annulus 24 and discharging at the bottom thereof functions as process air for passage to the molten salt bath as shown in Fig. 2, and also aids to a minor extent in cooling of the central feed tube 12.

Referring now to Fig. 2, it is seen that the slurry injector 10 of Fig. 1 is mounted within the upper end of a containment vessel 26 containing a molten salt bath 28 at the bottom. The slurry injector 10 is mounted within the upper end of a downcomer 34 which communicates at its lower end with the molten salt bath 28. The molten salt bath 28 contains an alkali metal carbonate such as sodium carbonate, or an alkali metal chloride such as sodium chloride or mixtures thereof. In preferred practice a mixture of sodium carbonate and sodium chloride chiefly sodium carbonate, is employed. Temperature of the molten salt bath 28 can be maintained from about 300 to about 1,000 °C for submerged reactive contact of the waste feed with the molten salt and decomposition of the waste propellant or explosive feed to form essentially $CO_2$, nitrogen and water vapor, which can be vented. Such molten salt compositions are well known in the art and described, for example, in U. S. Patent 3,778,320.

To maintain the above noted molten salt temperatures, the containment vessel 26 is positioned within a retainer vessel 30 and the entire assembly including the molten salt 28, the slurry injector 10 and downcomer 34 is positioned within an electric furnace 32.

Waste feed slurry containing volatile solvent such as acetone is fed from the supply tank 36 via line 38 and a pump 40 to the central tube 12 of the slurry injector 10. Process air is fed from an air inlet 42 into the outer tube 22 and the annulus 24. The feed slurry and the process air are discharged from the lower end of the injector 10 through the downcomer 34 and forced through the salt bath 28 for reaction therewith. Reactive off-gas containing $CO_2$, $N_2$ and water vapor are discharged from an off-gas outlet 44 at the upper end of the retainer vessel 30.

It will be noted that although the injector 10 mounted within the electric furnace 32 is being heated therein, the cooling effect of the carbon dioxide liquid on the feed slurry within the central tube 12 of the injector is sufficient to maintain the volatile organic solvent such as acetone in the feed slurry in liquid form without vaporization thereof, so that no explosive or propellant residue is deposited within the central tube 12, and the slurry which is fed into the upper end of the central tube 12 of the slurry injector, remains as a slurry throughout its passage through the injector and is discharged as a slurry from the bottom of the slurry injector without vaporization of the acetone therein.

It is understood that although acetone is a preferred organic solvent for the energetic waste slurry, other ketones, ethers or acetates, and mixtures thereof, and which are volatile can be used, such as methyl ethyl ketone, diethyl ether, tetrahydrofuran, ethyl acetate, and mixtures thereof.

From the foregoing, it is seen that the invention provides an improved method and system for feeding a slurry of energetic waste solids dissolved in a volatile solvent such as acetone, to a molten salt for destruction of such waste, without evaporation of the solvent in the feeding device or injector, and without depositing an explosive solid residue on the inside surface of the injector.

It is to be understood that what has been described is merely illustrative of the principles of the invention and that numerous arrangements in accordance with this invention may be devised by one skilled in the art without departing from the spirit and scope thereof.

## Claims

1. In the process of feeding a slurry of a propellant or explosive dissolved in a volatile solvent through a feeding device and into a molten salt system for destruction of said propellant or explosive, the improvement for preventing vaporization of said solvent and preventing formation of an explosive residue in the feeding device, comprising passing carbon dioxide liquid into heat exchange relation with said slurry to cool same and to maintain said solvent in liquid form.

2. The process of claim 1, wherein said solvent is selected from the group consisting of ketones, ethers, acetates, and mixtures thereof.

3. The process of claim 1, wherein said solvent is acetone.

4. The process of claim 1, wherein said feeding device feed is an actively-cooled injector having a central passage, and including passing carbon dioxide liquid into an annulus of the injector around said feed passage to cool the slurry therein, and vaporizing said carbon dioxide liquid and discharging the resulting carbon dioxide gas from said annulus.

5. The process of claim 4, and including passing air through a second annulus around said annulus containing said carbon dioxide liquid and gas.

6. The process of claim 5, wherein said solvent is selected from the group consisting of ketones, ethers, acetates, and mixtures thereof.

7. The process of claim 5, therein said solvent is acetone.

8. The process of feeding a slurry of a propellant or explosive dissolved in a volatile solvent into a molten salt system for destruction of said propellant or explosive while preventing vaporization of said solvent and preventing formation of an explosive residue, comprising

passing said feed slurry through a central feed passage in an injector disposed within a furnace containing a molten salt bath,

passing carbon dioxide liquid downwardly through a tube and into an annulus around said feed passage to cool said slurry and to maintain said solvent in liquid form and prevent formation of a residue in said feed passage, vaporizing said carbon dioxide liquid, said annulus being closed at the lower end of said injector,

discharging the resulting carbon dioxide gas from the upper end of said injector, and

discharging said slurry from the lower end of said feed passage into said molten salt bath.

9. The process of claim 8, wherein said volatile solvent is acetone.

10. The process of claim 8, and including passing air downwardly through a second annulus around said annulus containing said carbon dioxide liquid and gas, and discharging said air from the lower end of said second annulus, into said molten salt bath.

11. A system for feeding a slurry of a propellant or explosive dissolved in a volatile solvent into a molten salt system for destruction of said propellant or explosive while preventing vaporization of said solvent and preventing formation of an explosive residue, which comprises

an injector,

a molten salt system,

a containment vessel for said molten salt system,

said injector mounted at the upper end of said vessel, said injector comprising

a central tube for passage of a feed slurry of a propellant or explosive dissolved in a volatile solvent, the lower end of said central tube being open and communicating with said molten salt system,

a second tube disposed around and concentric with said central tube and forming an annulus between said tubes, said second tube being closed at its lower end and open at its upper end,

a third small diameter tube extending into said annulus and open at its lower end for communication with said annulus, and

means for feeding carbon dioxide liquid into the upper end of said third tube for passage at its lower end into said annulus and into heat exchange relation with the feed slurry in said central tube to cool said slurry and for discharge of the resulting carbon dioxide gas from the upper end of said annulus.

12. The system of claim 11, and including a fourth tube around and concentric with said second tube and forming a second annulus between said second and fourth tubes, said fourth tube being open at opposite ends for passage of air through said injector and into said molten salt system.

13. The system of claim 12, and including a downcomer for passage of cooled feed slurry and air from the lower end of said injector and through said molten salt system.

14. The system of claim 13, said molten salt system, said containment vessel, said injector and said downcomer being mounted in an electric furnace.

FIG. 2

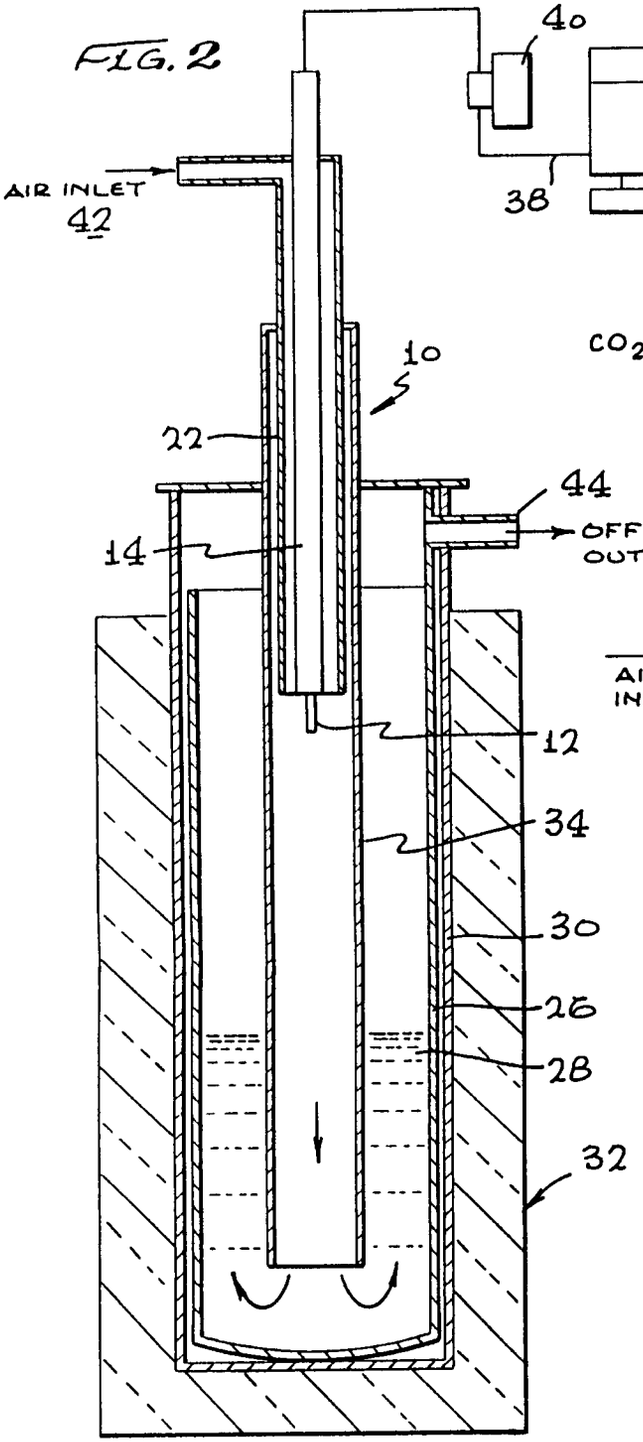
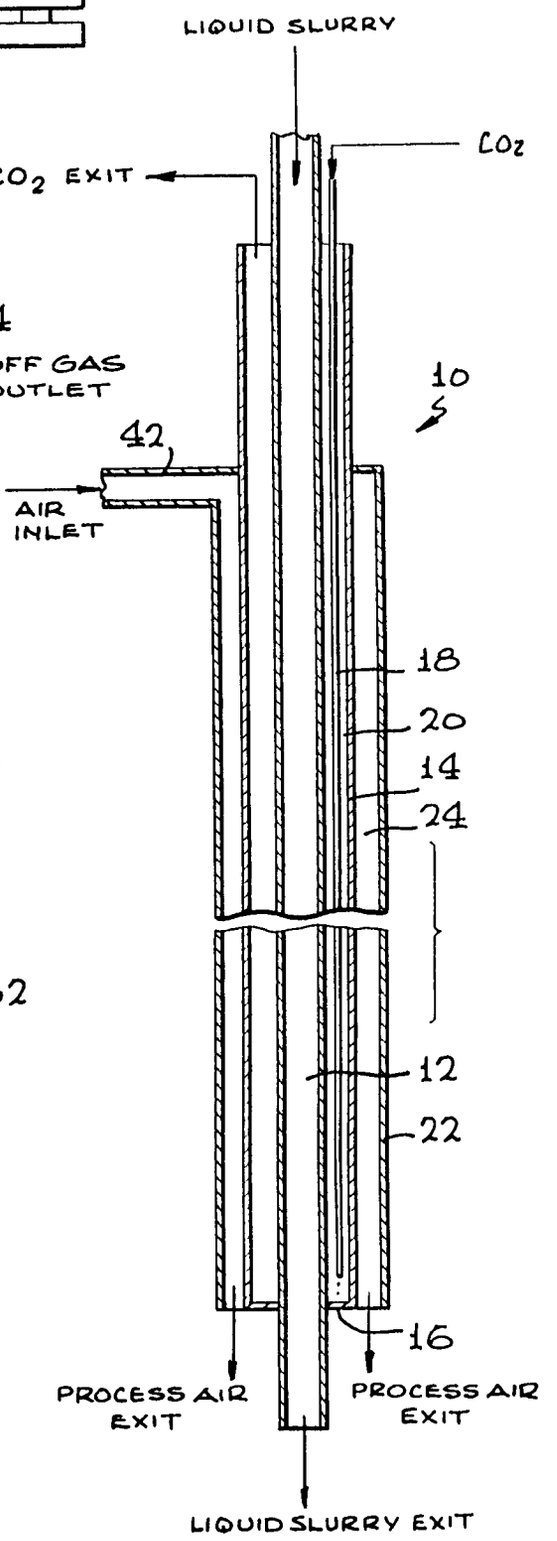

40
36
38
AIR INLET
42
10
22
44
OFF GAS
OUTLET
14
12
34
30
26
28
32

FIG. 1


LIQUID SLURRY
$CO_2$
$CO_2$ EXIT
10
42
AIR
INLET
18
20
14
24
12
22
16
PROCESS AIR
EXIT
PROCESS AIR
EXIT
LIQUID SLURRY EXIT

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 94 11 0481

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X | WO-A-93 02751 (MOLTEN METAL TECHNOLOGY)<br>* page 1, line 7 *<br>* page 7, line 30 - page 8, line 29 *<br>* page 15, line 8-15 * | 1-14 | A62D3/00 |
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 7, no. 135 (C-170)<br>& JP-A-58 048 616 (KAWASAKI SEITETSU) 22 March 1983<br>* abstract * | 1-14 | |
| A | US-A-4 602 574 (R.D.BACH)<br>* column 5, line 8-13 * | 1-14 | |
| A | US-A-3 778 320 (S.J.YOSIM ET AL.) | | |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

A62D

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 30 August 1994 | Dalkafouki, A |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)