The invention described herein may be manufactured and used by or for the Government, for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to the stabilization of Levinstein mustard. The most important chemical warfare vesicant agent known to date is the agent known as "mustard gas." Chemically, pure mustard gas or mustard is bis-[(beta-chloroethyl) sulfide. Although there are several processes for manufacturing mustard, the most important method in this country is the so-called "Levinstein process." The product of the Levinstein process is commonly known to those skilled in the art as "Levinstein mustard."

Levinstein mustard is a relatively impure product, and the dichloroethyl sulfide content thereof is in the neighborhood of 75%. The impurities in Levinstein mustard are of a complex nature and have not been completely determined to this date, but are essentially poly-sulfides of the composition (CICH₂CH₂)ₙSₙ.

Although Levinstein mustard has very effective vesicant properties, and is substantially equivalent to pure mustard from the vesicant standpoint, it does have the serious objection of being unstable over long periods of storage in steel containers, especially at temperatures of 110° to 150° F. The exact reasons for the degradation of Levinstein mustard in storage have not been fully determined in all respects. However, it is known that the instability is due to certain impurities present, since the pure product is not unstable under normal storage conditions. A number of theories have been advanced from various sources as to the causes of the instability of Levinstein mustard. Corrosion of steel containers by the mustard molecule is probably due to its "inner salt" nature, and in the case of Levinstein mustard this is enhanced by presence of polysulfides containing labile sulfur. Because of these polysulfides, iron actually dissolves in Levinstein mustard at slightly elevated temperature. Levinstein mustard is very stable in glass containers, or in steel containers coated with a properly baked-on suitable lacquer.

Regardless of the exact reasons for the instability of Levinstein mustard, the problem is fully recognized and is extremely serious during time of war and national emergency when it becomes necessary to build up a very great strategic reserve of this chemical warfare agent in contemplation of the fact that chemical warfare may, at any time, be resorted to.

From a practical standpoint it is necessary to store the bulk of the stock pile of Levinstein mustard in steel drums. Logistical reasons make it necessary to have a stable portion of Levinstein mustard supply located in tropical, or near tropical, regions. The high temperatures in such regions greatly hasten the deterioration or degradation of the Levinstein mustard stored in such regions. During the spoilage or deterioration of Levinstein mustard, pressures develop in the steel drums, and, eventually, if the product is not used, the deterioration is carried to the point where it is necessary to destroy the portion of the supply which has so deteriorated.

Although the above outlined problem has been known since World War I, when Levinstein mustard was produced and stored on a large scale, there has been hitherto no satisfactory method or means of stabilizing Levinstein mustard with respect to chemical decomposition and development of pressure. A great amount of research effort has been devoted to the problem. However, prior to this invention, the net results of such previous research and investigation of the problem only indicated that ammonia was a partially effective stabilizer for Levinstein mustard, and that partial stabilization could be obtained by the use of small amounts of strong bases. However, none of these methods or means of stabilization were at all satisfactory from a practical standpoint.

Accordingly, the object of this invention is to provide a practical and effective means of stabilizing Levinstein mustard so as to prevent to a large degree its deterioration in storage. Briefly stated, the means of stabilizing Levinstein mustard provided by this invention, consists in adding thereto small amounts of certain amines which have been found effective for this purpose. The amines, which are presently preferred as stabilizers of Levinstein mustard, are: morpholine, hexamethylenetetramine, dimethyl amine, triethylene tetramine, and tetrachloroethylene pentamine.

Specifically, 0.5% hexamethylenetetramine, 1% of dimethyl amine, and 1% of morpholine have been found to be effective.

The nature of this invention having been broadly outlined above, and preferred embodiments of the invention having been described, it will be apparent that certain modifications and additional formulations will suggest themselves to those skilled in the art. Accordingly, it is intended that the foregoing descriptive material
shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A stabilized mixture consisting essentially of bis-(beta chlorethyl) sulphide and sulphides having the formula (CICH₂CH₂)₂S₅ and morpholine, said morpholine constituting by weight 1% of said mixture.

2. The method of stabilizing a mixture consisting essentially of bis-(beta chlorethyl) sulphide and sulphides having the composition (CICH₂CH₂)₂S₅, said method consisting essentially in adding morpholine to said mixture in an amount constituting, by weight, 1% of the weight of said mixture.

RUDOLPH MACY.