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CONTOUR PACKAGING OF FIELD CLOTHING ITEMS

Interim Report
June 1962

QUARTERMASTER FOOD AND CONTAINER INSTITUTE FOR THE ARMED FORCES
QUARTERMASTER RESEARCH AND ENGINEERING COMMAND, U.S. ARMY
CHICAGO 9, ILLINOIS

QMFCIAF Report No. 18-62

PROJECT: 7-91-03-015 Container Development

SUBTASK: Development of contour and compression packaging techniques to increase protection, permit unitization and facilitate distribution to using tactical units.

CONTOUR PACKAGING OF FIELD CLOTHING ITEMS

by

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Development and Standards Branch
Container Division

Interim Report
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ABSTRACT

The concept of contour packaging is being studied as a possible means of providing an economical method of compression packaging of clothing and textile items without sacrificing unit quantity flexibility needed for today's mobile army.

Ten barrier materials, including four unsupported materials, and six laminated materials were included in this phase of the study.

It was found that heat-shrinkable polyethylene provided better protection against damage from rough handling than the other materials tested. The high gas transmission rate of this material, however, makes it unsatisfactory for contour packaging.

The best over-all performance was obtained from those materials containing a cloth backing as the outer ply of the lamination.

CONTOUR PACKAGING OF FIELD CLOTHING ITEMS

INTRODUCTION

The concept of contour packaging of field clothing items was conceived as a possible means of providing an economical method of packaging these items while maintaining unit quantity flexibility needed for today's mobile army. In the past, large units of men have been successfully supplied from central supply points with items of clothing packaged in compressed or semi-compressed bales. Unit quantities of a particular item contained in bale packs, however, cannot be efficiently utilized by the small widely dispersed units of today's army.

Packaging uncompressed clothing items in fiberboard shipping containers is a method of solving the unit quantity problem. However, the cube efficiency of the bale pack cannot be realized by this method, resulting in greater storage space requirements for a given quantity of items and less efficient utilization of transportation facilities.

Contour packaging, which entails packaging of field clothing items in flexible containers under vacuum compression (Figures 1 to 5), is an effort to combine the cube efficiency obtained by the bale pack with the unit quantity flexibility of the fiberboard pack. In addition to the savings in tare weight and cube, the vacuum-compressed contour packages also provide protection against damage from moisture and insects. The absence of oxygen and moisture within the package will also eliminate or retard damage of clothing due to fungus growth.

Preparation of Contour Packages

Experimental contour packages of clothing items have been prepared by the following methods: (1) vacuum chamber, (2) modified vacuum forming machine, (3) extraction of air by means of a tube inserted through an opening in the package. A detailed discussion of each of these methods of preparing contour packages is contained in QMFCIAF Report No. 29-59, Contour Packaging of Clothing Items, October 1959.

The tube extraction method was used for preparing all test packages covered by this report. This method best simulates the packaging methods used commercially to produce similar types of packages in the meat and dairy products industries. A packaging method employing the tube extraction principle would probably be used by industry for contour packaging of clothing items, at least during the early stages of production.

PREVIOUS STUDIES

During the early phases of studies on contour packaging, various thicknesses of the common packaging barrier materials and a few recommended laminates were considered. From these tests, it was found that a combination of 0.002-inch polyethylene and 0.001-inch polyester provided better protection than the other transparent materials tested. Rough handling tests which simulate the rough handling normally encountered in the military supply system were successfully passed by the polyethylene-polyester combination, indicating that this combination was the best candidate, of the materials available at that time, for contour packaging applications.

Based on these studies, limited quantities of selected field clothing items were prepared for engineering tests. These tests were designed to obtain information on the acceptability of contour packages by supply and using personnel as well as the ability of the barrier material to withstand the hazards of transportation, storage, and issue.

Contour packaged clothing was found to be more desirable, with respect to handling and issuing, than loose items from bale packs. Receiving personnel also preferred the contour packaged clothing because of its cleanliness and more desirable appearance than loose items. It was found, however, that a relatively high percentage of packages had failed to maintain the vacuum under which they were originally packaged.

Analysis of Defective Packages (0.002-inch Polyethylene - 0.001-inch Polyester)

Examination of contour packages which had failed to maintain vacuum showed that failure was not due to defective heat seals as had previously been suspected. Microscopic examination of holes found in the barrier indicated that most failure was caused by abrasion damage. It was also noted that most failure occurred in the wrinkled areas around the edges and near the package corners.

Comparative tests were conducted on fresh packages (packaged 24 hours before testing) and aged packages (packaged approximately nine months before testing), using identical barrier material which had been obtained from the same source to determine the effect of aging on the barrier material. It was found that the fresh packages were capable of withstanding nearly twice as much rough handling before failure than the aged packages.

Based on the findings discussed above, it was determined that studies should be conducted on methods of reducing abrasion damage, including the use of cushioning materials to reduce damage to the intermediate contour packages, forming packages to prevent loose fit in the shipping container after movement, and the effect of a reduction in vacuum on the performance of the packages. In addition, it was felt that investigation of the performance of many recently developed barrier materials and combinations of materials was warranted, in view of the recent advancements in the barrier material field.

Cushioning Materials Used to Reduce Abrasion Damage

Experimentation with various types and thicknesses of cellulous cushioning materials around the packages indicated a significant improvement in the package performance occurred only when a sufficient quantity of cushioning material was used to completely immobilize the package. The use of this quantity of cushioning material results in a loss of some of the cube efficiency obtained by contour packaging. Other types of abrasion resistant cushioning materials are being investigated for this application.

Partial Vacuum

Experimental packages prepared with reduced vacuum showed a slight decrease in the amount of damage after one cycle of rough handling tests as described below. It was found that the reduced vacuum packages were not rigid enough to maintain their original size and shape. This allowed a considerable amount of re-distribution of contents during movement of the boxes during test, causing the contour packages to become loose within the shipping container. Continued rough handling caused considerable movement of the packages within the boxes, resulting in a sharp increase in abrasion damage. Reducing the vacuum to the point where continued handling will not cause the packages to re-shape and become loose is not considered practical since one of the main objectives of contour packaging, that of cube reduction, would not then be fully realized.

Formed Packages

The necessity of immobilizing the intermediate packages, as borne out by the partial vacuum and cushioned package experimentation, indicated the need for a technique which would eliminate the "thinning out" of material around the edges of the packages. The thin areas are less rigid, even under full vacuum, than the thicker portion of the package. After movement and handling of the shipping containers, the thin areas tend to flatten against the thicker, more rigid body of the package. The smaller package is then free to move within the shipping container, greatly increasing the possibility of abrasion damage (see Figure 6).

A hand-operated frame device has been developed to allow pressure to be applied to all sides of the package during the air extraction operation. This device compresses the thin areas, resulting in a package which is more rectangular in shape than packages prepared in the normal manner. In addition, packages prepared in this manner are more uniform in density which greatly decreases the possibility of further compression of edges and the resulting loose fit within the shipping container.

A decrease in failure rate was found in some barrier materials when packaged with the use of the described forming device. The additional creasing of the barrier material caused by this operation was found to increase failure rate in other materials such as combinations containing high-density polyethylene.

Accelerated Climatic Storage and Rough Handling Tests

Storage tests are currently being conducted under accelerated adverse climatic conditions. The storage areas being used include: (1) 100°F./90% R.H.; (2) -20°F.; and (3) 110°F./uncontrolled humidity.

Rough handling tests have been conducted at -20°F. on those barrier materials which showed favorable performance under standard conditions. No significant decrease in rough handling endurance has been found when tested at -20°F.

Barrier Material Tests

All packages included in this phase of the test program were prepared by the tube extraction method (i.e. placing the folded item or items in a bag, sealing the bag except for a small opening through which an air extraction tube is inserted, extracting the air and sealing the opening). The forming device described above was not used and the packages were tested without the use of cushioning materials. Test packages were placed in fiberboard shipping containers conforming to Type I, Class 2, Grade 3, Style RSC of Specification PPP-B-636. Each container was provided with a top and bottom pad made of the same material from which the box was fabricated.

Rough handling tests were conducted on field clothing items contour packaged in each of the following barrier materials:

Control 0.002-inch polyethylene, 0.001-inch polyester.

a. 0.004-inch heat-shrinkable polyethylene (0.002-inch double wound).

b. 0.002-inch polyethylene, 0.0005-inch polyester, 0.001-inch polyethylene-cloth backing.

c. 0.0025-inch polyethylene, 0.0005-inch aluminum foil, 0.001-inch polyethylene-cloth backing.

d. 0.008-inch polyethylene (treated for skin packaging).

e. 0.005-inch fluorohalocarbon film (Type I).

f. 0.010-inch polyethylene, 0.0005-inch polyester.

g. 0.004-inch high density polyethylene, polyvinylidene chloride coating.

h. 0.005-inch fluorohalocarbon film (Type II).

i. 0.004-inch polyethylene, 0.001-inch polyester.

j. 0.001-inch polyethylene, 0.005-inch polyester, 0.001-inch polyethylene.

The rough handling tests to which the test packages were subjected consisted of:

a. Vibration - Two hours at 245 cycles per minute.

b. Drop-test (30-inch drop) - A series of 10 corner, edge, and flat-drop tests.

c. Hexagonal drum - Thirty (30) revolutions (180 impacts).

Results and Discussion

The percentage of contour packages failing to maintain vacuum after rough handling tests is shown graphically in Figure 7. A relatively high failure rate is shown for all barrier materials. The rough handling test was designed to produce a failure rate higher than that experienced by the control material (0.002-inch polyethylene, 0.001-inch polyester) during field tests. This was done in an effort to determine the most durable barrier material available at this time. Future work will include studies on cost reduction and a determination of minimum thicknesses of materials which will perform satisfactorily. A rough handling test which will provide a realistic prediction of field performance of barrier materials for contour packaging will be developed when more data from laboratory studies and field tests is available.

It is apparent from Figure 7 that the best rough handling endurance has been obtained from 0.004-inch heat-shrinkable polyethylene. Packages made with this material are prepared by the tube extraction method described above. After the vacuum operation, heat is applied to the package, shrinking the edges into contact with the body of the package and eliminating wrinkles from the surfaces and corners of the package. Elimination of the protruding edges, which result from excess package material caused by compression of the contents, and removal of wrinkles greatly reduces the chances of damage from flexing of the edges and from abrasion on the surfaces and corners of the packages.

Although satisfactory rough handling test results were obtained with 0.004-inch heat-shrinkable polyethylene, the high gas transmission rate of this material makes it unsatisfactory for contour packaging. Storage tests showed that a complete loss of vacuum occurred after 29 days storage at 100°F. Vacuum loss at 72°F. and 50 percent relative humidity was considerably less than at 100°F., but was still intolerably high.

As shown by the above storage tests, heat-shrinkable polyethylene is unsatisfactory as a contour packaging barrier material. It is apparent, however, that rough handling endurance is greatly increased by shrinking the edges and corners and eliminating wrinkles from the packages. Work is currently being conducted by industry to develop heat-shrinkable barrier materials having low water vapor and gas transmission rates. Further studies will be conducted on these heat-shrinkable materials as sufficient samples become available.

Of the barrier materials listed above, the lamination consisting of 0.002-inch polyethylene, 0.0005-inch polyester, 0.001-inch polyethylene, cloth backing, has shown the best performance in rough handling and storage tests. Variations in package arrangement and packaging techniques are currently being studied to further reduce the failure rate with this material.

Future Work

Laboratory studies will be conducted in the following areas:

1. Evaluate new barrier materials, including heat-shrinkable materials, as they become available.

2. Continue accelerated climatic storage tests with candidate barrier materials.

3. Conduct further studies on the use of thin, abrasion resistant cushioning materials such as extruded polystyrene foam.

4. Continue development of improved packaging techniques to improve performance of contour packages.

Figure 1

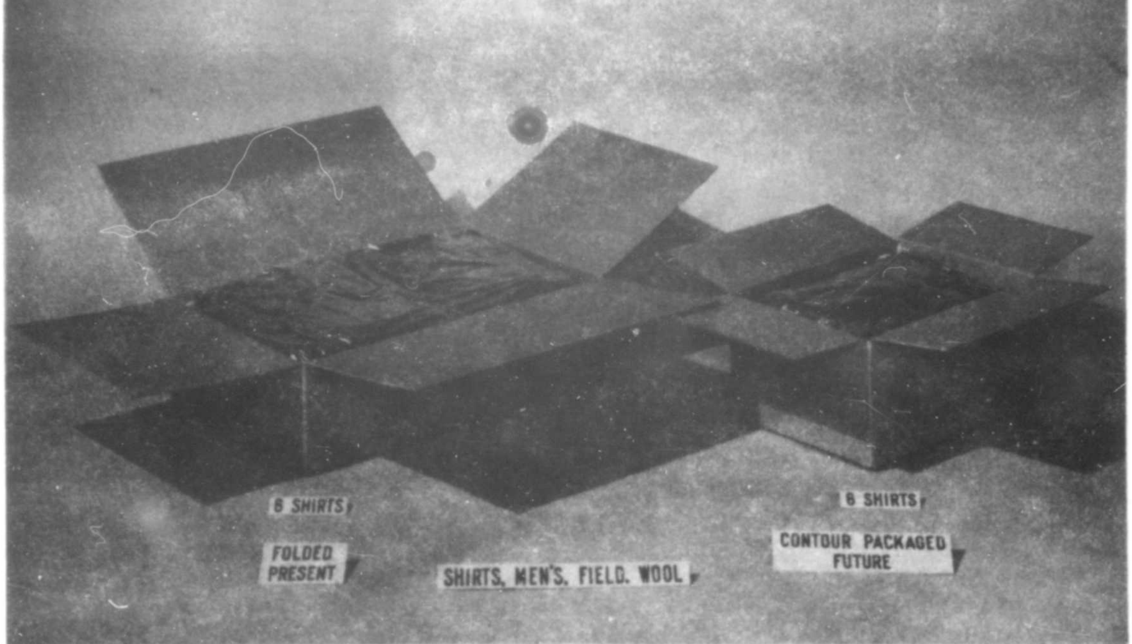
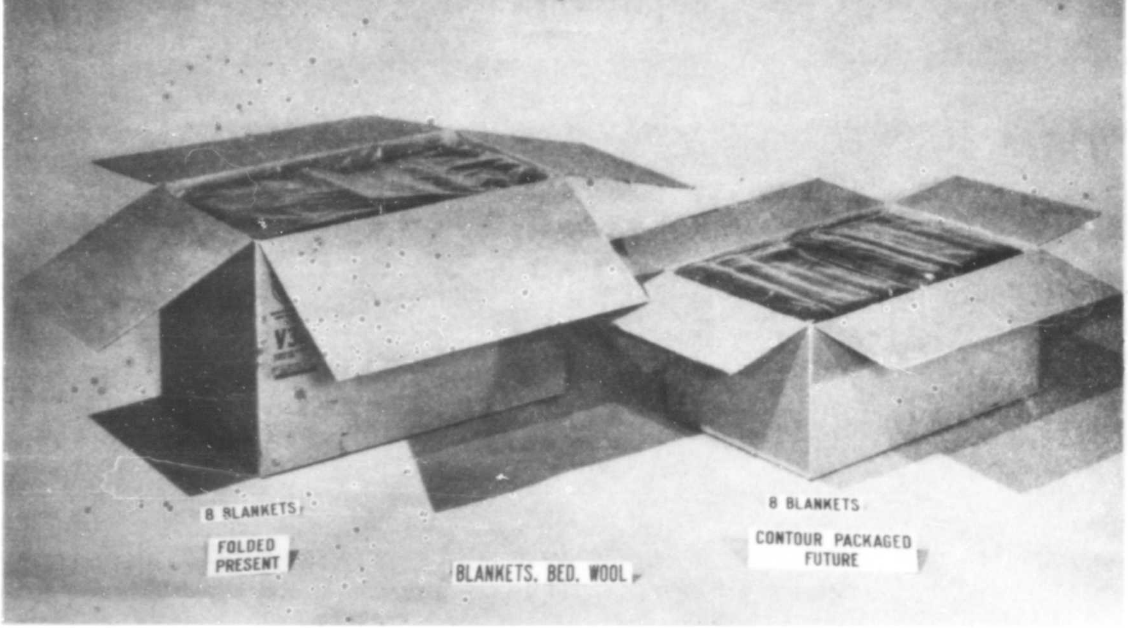


Figure 2



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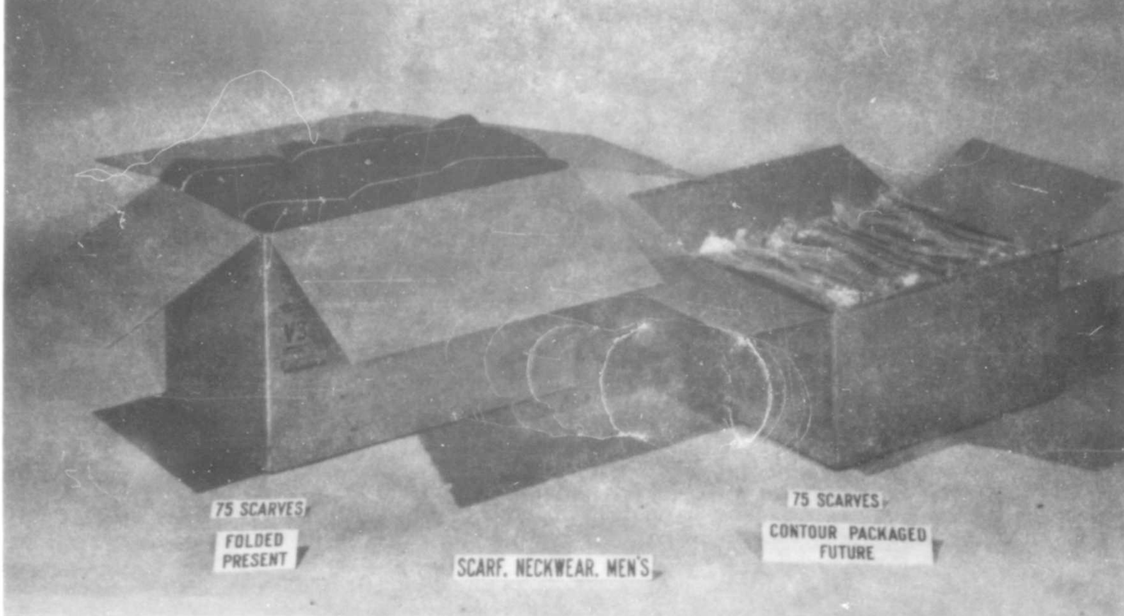
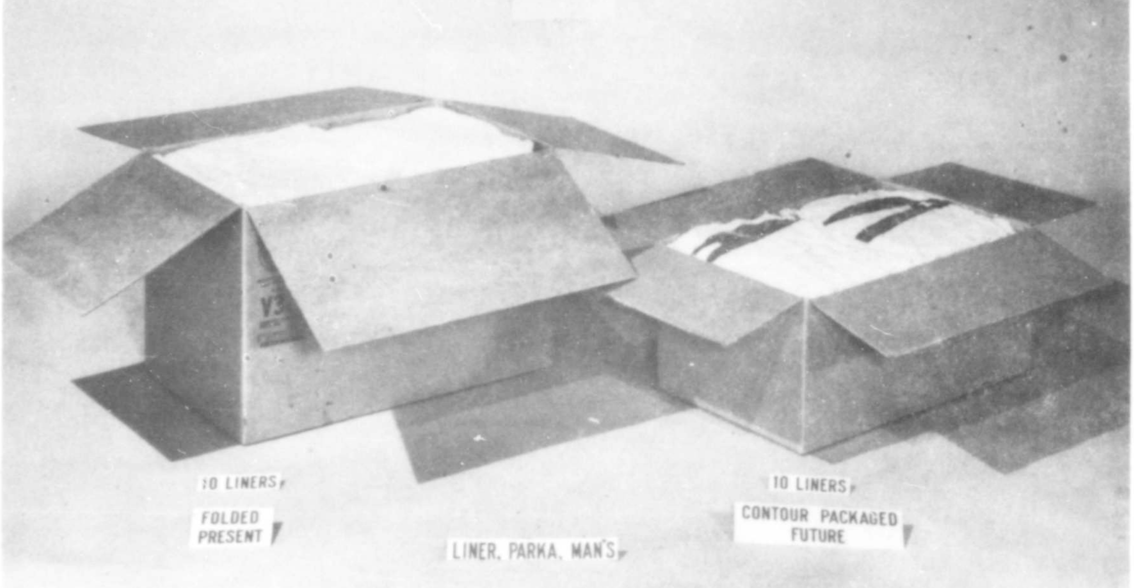


Figure 4



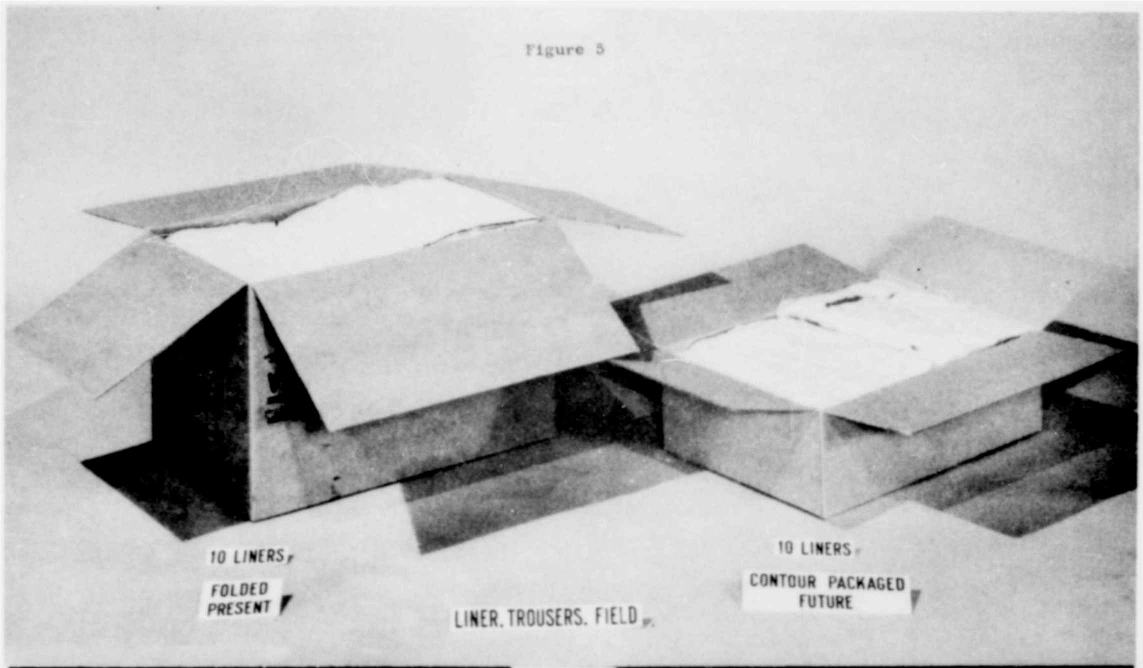


Figure 5

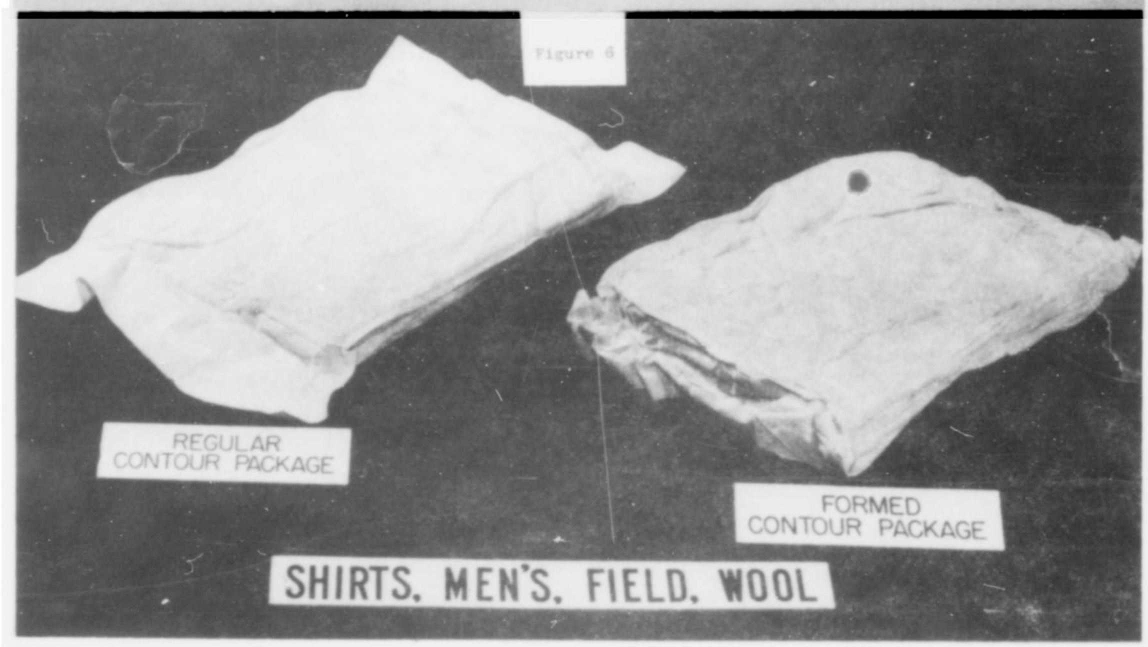
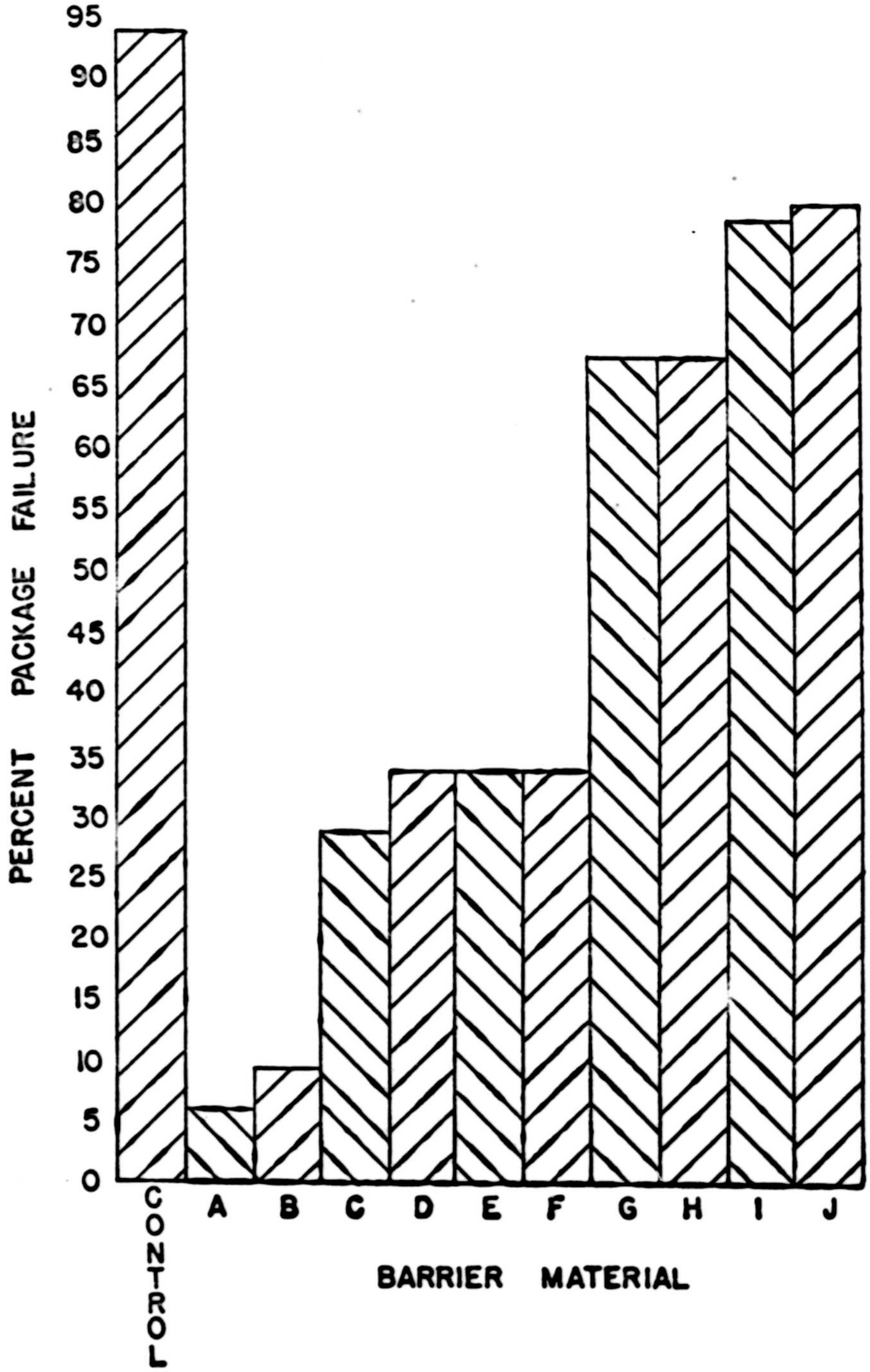


Figure 6

FIGURE 7

VACUUM LOSS IN CONTOUR PACKAGES



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