2912

DEVELOPMENT OF A DISHWASHING RACK FOR MESS TRAYS

DEPARTMENT OF THE NAVY
BUREAU OF SUPPLIES AND ACCOUNTS
WASHINGTON 25, D.C.

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TECHNICAL REPORT REVIEW

CONDENSED REPORT

DEVELOPMENT OF A DISHWASHING RACK FOR MESS TRAYS

Task NT-F015-13-004
Sub-Task 13-004-156-2

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U. S. NAVAL SUPPLY RESEARCH AND DEVELOPMENT FACILITY
BAYONNE, NEW JERSEY

CONDENSED REPORT

DEVELOPMENT OF A DISHWASHING RACK FOR MESS TRAYS

Task NT-F015-13-004
Sub-Task 13-004-156-2

by

M. L. Mayer
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4 August 1961

ABSTRACT

Previously reported masking effects caused by close positioning of mess trays in the Navy 12-tray, stainless-steel dishwashing rack have been remedied by altering the rack design to reduce the number of trays from twelve to six. In addition, a weight reduction was accomplished by fabricating the rack from aluminum alloy. A newly designed 6-tray dishwashing rack, fabricated from aluminum alloy was found to weigh only 74% as much as the present aluminum rack; its corrosion resistance under Navy dishwashing machine conditions was satisfactory; it was much easier to load; and its service life is estimated to be four times that of the present rack.

SUMMARY

PROBLEM

To develop a rack of optimum weight, strength, ease of loading, and corrosion resistance for the machine-washing of compartmented mess trays.

CONCLUSIONS

The prototype 6-tray rack is a significant improvement over the Navy stock rack because of lighter weight, ease of handling and loading, and greater strength.

RECOMMENDATIONS

It is recommended that a 1-year field test be conducted of the prototype aluminum alloy, 6-tray dishwashing racks at Navy messes.

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INTRODUCTION

At the request of the Bureau of Ships, the Bureau of Supplies and Accounts authorized the U. S. Naval Supply Research and Development Facility to study and develop dishwashing racks for the purpose of improving present Navy models.*

The need for improvement of the Navy 12-tray dishwashing rack was recognized from field experiences and tray washing studies conducted at NAVSUPRANDFAC and the National Sanitation Foundation, which indicated that the masking effects from close positioning of the trays prevented the soil from being removed satisfactorily. The results of the study further indicated that soil removal was significantly improved when the space between trays was increased by loading only 6 trays per rack and positioning the trays parallel to the spray arms of the dishwashing machine.**

In addition to improving the tray-washing capabilities of the tray rack, NAVSUPRANDFAC recognized that the weight of the rack could be reduced considerably by designing a rack to be fabricated out of aluminum alloy. In the meantime, BUSHIPS made some improvements by altering the design of the conventional tray rack to reduce the number of trays from twelve to six and by fabricating the rack from aluminum alloy.

This report is concerned with the study of the suitability for Navy use of a prototype aluminum dishwashing rack designed to handle 6 trays with modifications in the structural components to lengthen the service life of the tray rack currently in use.

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*BUSANDA ltr SS A11/2 of 27 March 1958.

**NAVSUPRANDFAC ltr CR A11-156L(MER:lp) ot 20 June 1958.

DESCRIPTION OF EQUIPMENT

The prototype dishwashing rack, weighing 3.7 lbs. (Fig. 1, page 3), is a welded rack designed to handle six Navy mess trays. A guidance drawing of the rack is shown in Fig. 2, page 4. The component parts of the rack, fabricated from 6061 aluminum alloy, with a T-6 temper,* are:

1. Frame - The frame, rectangular in form, is composed of 3/4" x 3/4" x 1/8" aluminum alloy angle. The dimensions of the frame are 20-1/4" x 17-1/2" to fit the shipboard washing machines.

2. Handles - Two curved handles, formed of aluminum alloy tubing, 1/2" diameter OD, are welded to the frame to facilitate handling of the rack. The handles also serve as the sides of the rack and are intended to prevent the trays from sliding out of the rack.

3. Tray Supports - Two tray supports, made from 3/16" aluminum alloy sheet, are welded to the frame. The supports are designed to allow seating of the mess trays at an angle of 18^{o} from the vertical, with a distance between trays of approximately 2-1/2".

4. Stiffeners - Two 1/8" diameter stiffener rods are welded between the frame and the tray supports to give added rigidity to the assembly.

5. Stacking Features - Three design features are incorporated to permit stacking of the racks:

a. Stacking Lug - The stacking lug is designed as a protrusion positioned at the top center of the tray supports.

b. Stacking Lug Recess - Semi-circular recesses are formed in the bottom center of the tray supports to accept the stacking lug of the rack below when the racks are stacked vertically. This arrangement is intended to prevent movement between stacked racks in a direction parallel to the handles.

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*Federal Specification QQ-A-270a, dated 6 Nov 1957.

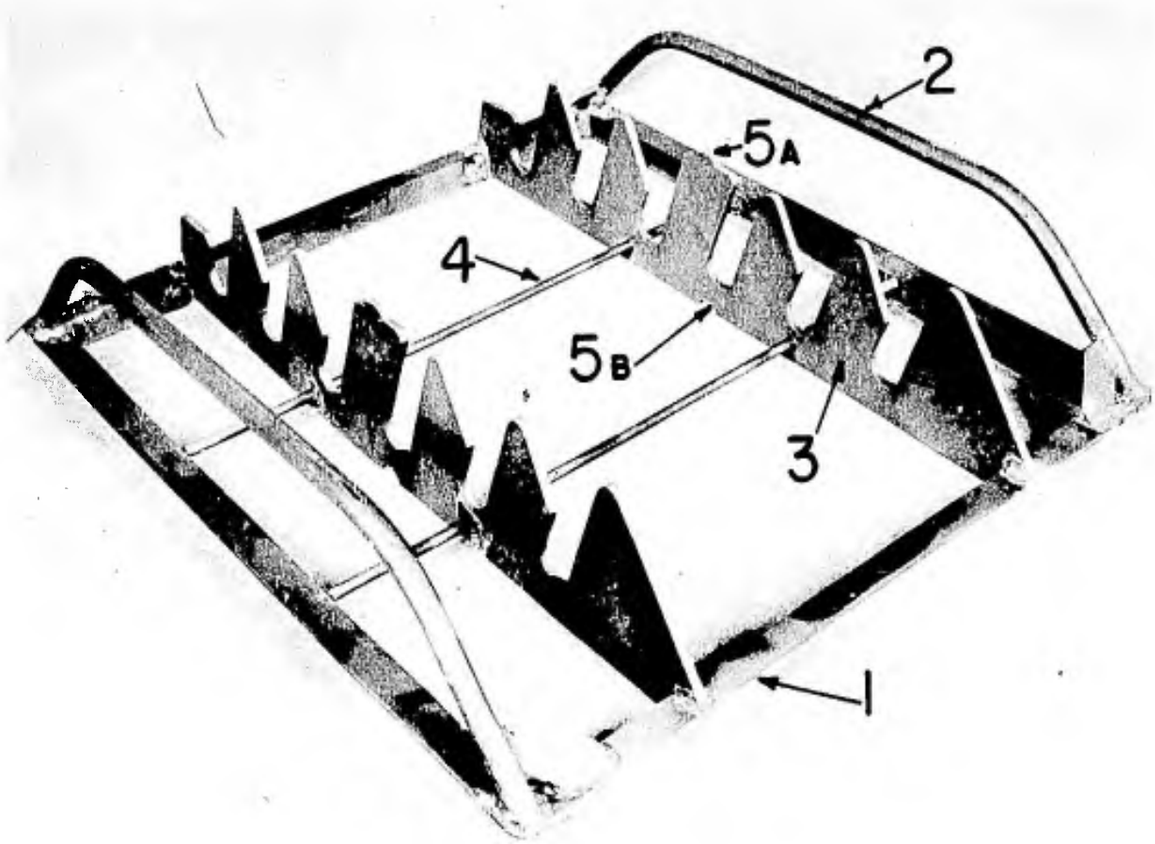
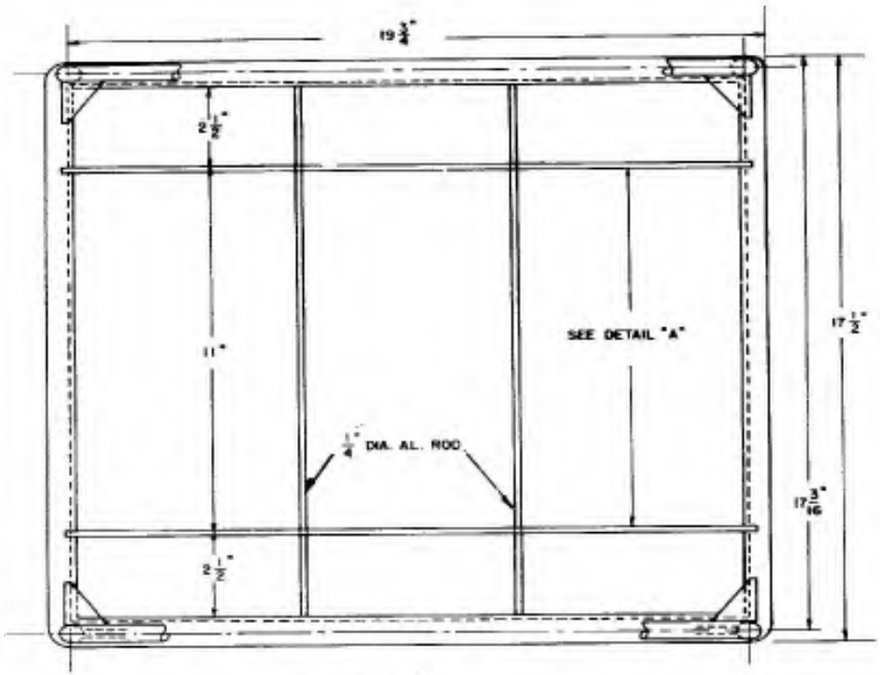
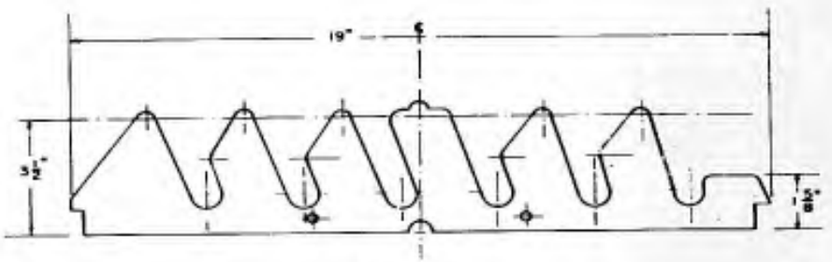


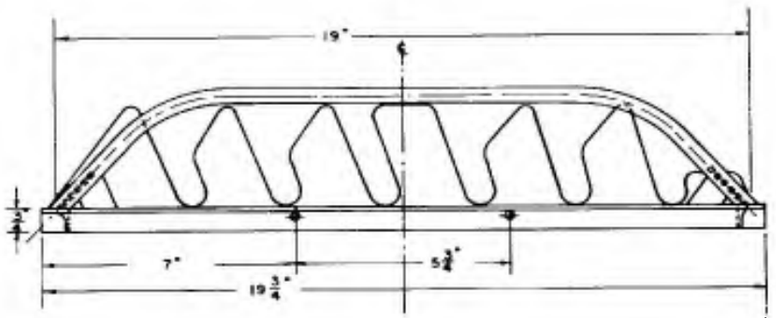
Fig. 1. - Prototype aluminum alloy tray rack showing: (1) frame, (2) handles, (3) tray supports, (4) stiffeners, (5A) stacking lug, and (5B) stacking lug recess.



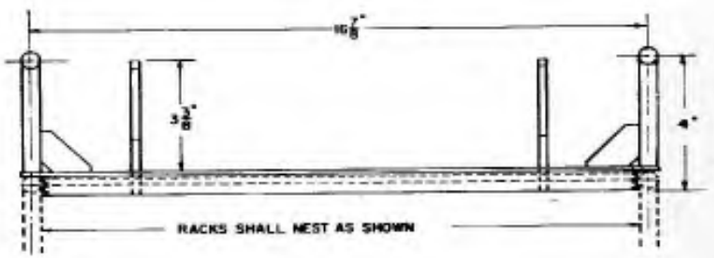
PLAN



DETAIL "A"



ELEVATION



SIDE

FIG. 2 - GUIDANCE DRAWING OF PROTOTYPE 6-TRAY DISHWASHING RACK

c. Frame Angle - The frame angle fits over the handles of the rack below when the racks are stacked vertically. This arrangement is intended to prevent lateral movement between stacked racks.

PROCEDURES

The study of the prototype aluminum 6-tray rack was divided into four parts: (1) corrosion studies of the aluminum alloy, (2) comparative soil removal studies by washing trays in both the prototype dishwashing rack and the Navy stock rack, (3) comparative impact studies in a revolving drum using both the prototype and Navy stock tray rack, and (4) general observations including comparative loading studies and physical data on the two types of tray racks.

Corrosion Study

In order to determine the effects of Navy dishwashing conditions on the 6061 aluminum alloy tray rack, corrosion studies were conducted on a prototype rack fabricated of this material.

The prototype was placed in a Navy dishwashing machine and subjected to a continuous spray of wash water with a detergent concentration of type II detergent of approximately 0.27% by weight. Wash water temperature and pressure were maintained at 140°F. + 5°F., and 3-5 psig, respectively. The study was conducted for 456 hours.

The rack was removed from the machine, rinsed with fresh water, and dried. The rack was examined visually for discoloration, etching, and formation of a white film on the surface of the metal.

Comparative Tray-Washing Study

Clean, 6-compartmented standard Navy mess trays* were soiled by spraying a modified Hucker soil** uniformly over the entire front surface of each tray. The trays were baked in a rotary

*Navy stock number G7350-634-1376 (Spec. MIL-T-46).

**See Appendix A for description of modified Hucker soil and method of preparation.

bake oven* for 30 minutes at 325°F. The trays were allowed to cool for a period of at least 48 hours. Each tray was weighed and coded prior to the tray-washing study. The trays were weighed after soil application and after washing. Trays were always positioned in the racks with the largest compartment at the top of the rack.

Three and one-half ounces of type II dishwashing machine compound were added for each 10 gallons of wash water,** making the detergent concentration approximately 0.27%. The detergent was added before the start of each set of three washing runs.

A conveyor-type, double-tank, Navy model DA-85*** dishwashing machine was used in the washing studies. The temperature of the recirculating wash water was maintained between 145°F. and 165°F. The temperature of the recirculating rinse water was maintained at 180°F. The final rinse valve was maintained between 180°F. and 190°F. Pressure at both the wash spray and rinse spray manifolds was maintained at 4.5 psig. The conveyor was operated at full speed which, in turn, exposed racks to the wash spray for 56 seconds, the rinse spray for 53 seconds, and the final rinse spray for 33 seconds.

Six soiled trays were placed in the prototype rack and six soiled trays were placed in the Navy stock rack. To approximate field conditions, the placement schedule for one run of 4-1/2 minutes through the dishwashing machine consisted of one dummy rack, fully loaded with dinnerware, one prototype rack loaded with six soiled trays, one Navy stock rack fully loaded with six soiled trays, followed by one dummy rack loaded with dinnerware. Each of the four racks completed one cycle.§ Three runs were made through the double-tank dishwashing machine. The washed trays were removed from the racks, allowed to dry, and were weighed. Fig. 3, page 7, shows the prototype tray rack entering the DA-85 dishwashing machine.

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*Middleby-Marshall Rotary Oven, Model R, Size 907B, ser #59219.

**Fed. Spec. P-D-425a, paragraph 3.13.2.

***See Appendix B for description of DA-85 dishwashing machine.

§One cycle consists of wash, rinse, and final rinse.

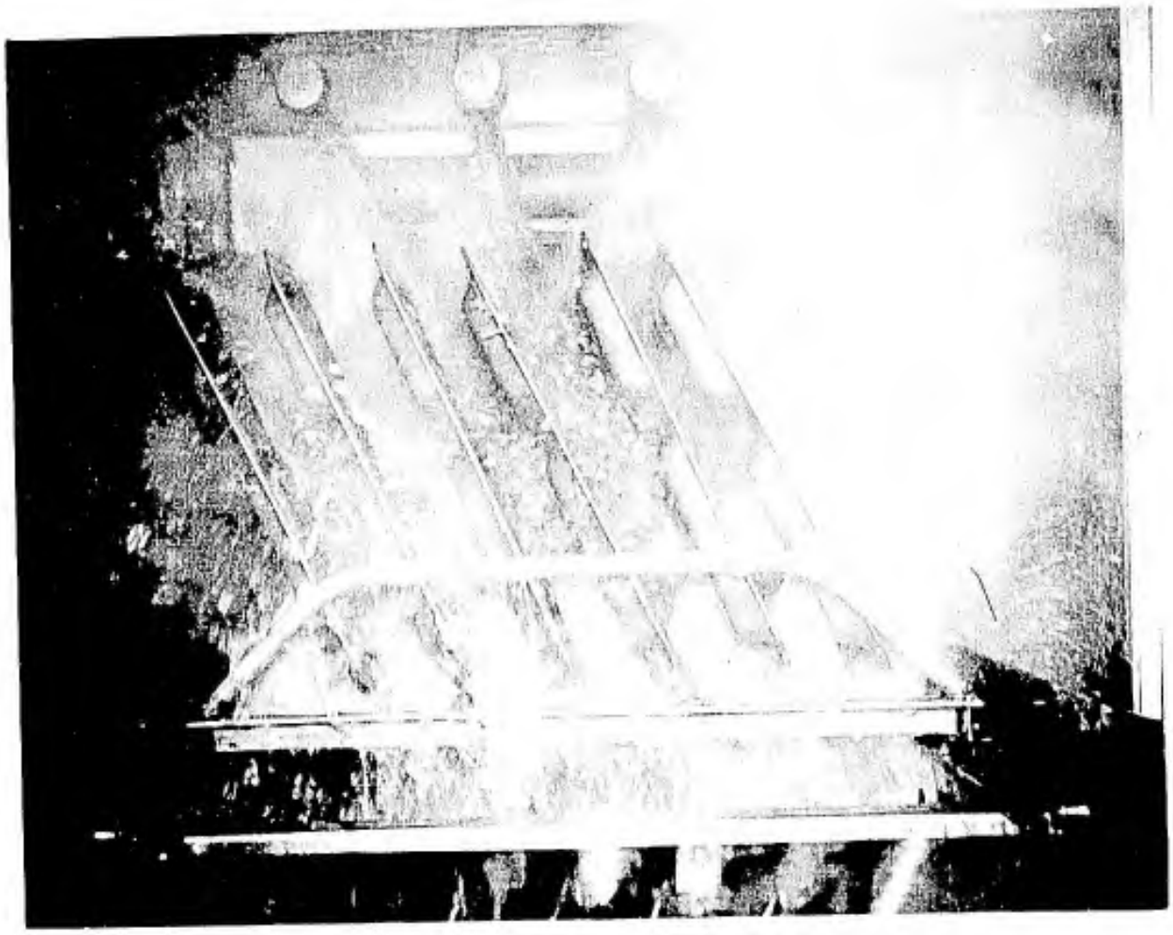

Fig. 3. - Shows the prototype 6-tray rack passing through the wasn spray of a Navy Model DA-85 dishwashing machine. Note that the 20-1/4" dimension positions the trays parallel to the axis of the machine. The 17" dimension will not fit on the chain drive.

Comparative Impact Study

For this study, the prototype tray rack and the Navy stock rack were subjected to a controlled cycle of drops simulating rough handling. The testing machine used was a 14-foot hexagonal revolving drum* built in accordance to ASTM Designation: D782-47.

Twelve prototype tray racks and 12 Navy stock tray racks were studied according to the following procedure:

One tray rack was placed in the testing drum. The revolution counter was set at the zero mark. The drum was started and allowed to run for 10 revolutions. The drum was then stopped and the tray rack under study was examined visually for structural failure. The same procedure was followed for consecutive 5-minute runs. If during a run a failure in the rack (broken part, weld separation, distortion) was observed visually or by sound, the drum was stopped and the type of failure and location of failure was noted, as well as the number of impacts sustained by the rack. Each rack was tested until at least two failures occurred.

Tray-Loading Study

To determine the comparative ease of loading trays into the prototype and Navy stock racks, the following procedure was followed: Six empty prototype racks were stacked on the deck adjacent to the operator. Thirty-six (36) trays were placed in two stacks of 18 each on a dresser in front of the operator. The trays were stacked so that they did not nest. The length of time required to load six racks was determined by timing the operator from an initial starting time to a final time of the placement of the 36th tray into the tray rack. This procedure was repeated two times, with each type of rack comprising one run. Five different operators conducted this study.

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*See Appendix C for complete description of hexagonal revolving drum.

Physical Characteristics Comparison

Physical comparisons of both the prototype and Navy stock rack were made by measuring and by observing the following characteristics: length, width, height, weight, height of 5 racks stacked, tray capacity, material of construction, type of welds, number of welds, number of pieces necessary to fabricate rack, number of different shaped pieces required to fabricate rack, method of unloading, and cost.

FINDINGS

Corrosion Study

A gun-metal gray discoloration was found to be uniformly distributed over the entire prototype aluminum tray rack. Fillet welds appeared darker. No pitting, etching, or white film formation was found on the prototype rack.

Comparative Tray-Washing Study

The results of the comparative tray-washing study are summarized below.

RACK TYPE	PER CENT SOIL REMOVAL (BY WEIGHT)
Prototype	100
Navy Stock	100

Comparative Impact Study

The results of the impact study are summarized below. It can be seen from the table that the prototype rack withstood approximately 3.2 times the number of impacts of the Navy stock rack.

RACK TYPE	NO. OF RACKS TESTED	AVG. NO. OF IMPACTS TO CAUSE FAILURE	RANGE OF IMPACTS TO CAUSE FAILURE
Prototype	12	464	220-943
Navy Stock	12	141	76-228

Tray-Loading Study

The results of the tray-loading study are summarized below. It can be seen from the table that it took 26.4% less time to load the prototype rack than the Navy stock rack.

RACK TYPE	RUN NUMBER					
	1	2	3	4	5	Avg.
	TIME TO LOAD 6 RACKS (MIN.)					
Navy Stock	9.86	7.15	6.91	7.79	8.28	8.00
Prototype	8.29	5.27	4.73	6.13	5.03	5.89

Physical Characteristics Comparison

The results of the physical comparison of the prototype and the Navy stock tray racks are shown in the following table. It can be seen from the table that the prototype tray rack weighs less, takes up less space, and requires fewer parts to fabricate than the Navy stock rack.

FEATURES	NAVY STOCK*	PROTOTYPE**
Length	20-1/4"	19-3/4"
Width	16-5/8"	17-1/2"
Height	6-1/2"	4-1/4"
Area of Rack Open to Spray***	72.56%	95.07%
Weight (Approx.)	5 lbs. 0 oz.	3 lbs. 11 oz.
Height of Stack of 5 Racks	29-1/2"	18-1/4"
Capacity (Trays)	6	6
Material	AL 6063-T6	AL 6061-T6
Type of Welds	Fillet and Spot	Fillet
Number of Welds	Spot 48) 56 Fillet 8)	28
Number of Pieces Required to Fabricate	22	14
Number of Different Pieces	7	6
Pieces Requiring Fabrication Other Than End Cuts	16	6
Unload by Dumping	No	Yes
Load - Pre-positioning Necessary	Yes	No
Cost	$10.40§	$11.95¶

*Stock No. G7320-647-3865.
**NAVSUPRANDFAC Dwg. No. FS 156(2)-E-120-A.
***Does not include frame.
§Navy Stock List of General Stores, Standard Price Supplement, Effective Period: 1 Dec 1960 to 31 May 1961.
¶Quote from Spotweld Division of The Otto Konigslow Mfg. Co., Cleveland, Ohio.

CONCLUSIONS

1. 6061-T-6 aluminum alloy appears to be a satisfactory material for Navy dishwashing machine racks.

2. The new design of 6-tray prototype aluminum tray rack has significant improvements in lower weight, easier loading and longer life.

APPENDIX A

MODIFIED HUCKER SOIL FORMULATION

Ingredients	Parts by Weight
Peanut Butter	1
Butter	1
Lard	1
Flour	1
Dried Egg Powder	1
Cornstarch	1
Evaporated Milk	1
Printer's Ink	0.2
Corn Oil	0.4
Water	750 ml.*

METHOD OF PREPARATION

1. Mix peanut butter, butter, lard, corn oil, 300 ml. water in Waring blender - 30 seconds low speed.

2. Add flour, egg powder, cornstarch, evaporated milk, 300 ml. water - mix 30 seconds low speed.

3. Add printer's ink, 150 ml. water - mix 60 seconds low speed.

4. Water may be added to the Hucker soil as required to make the mixture thin enough to allow passage through a spray gun.

5. Before spraying, mix thoroughly.

*This volume of water sufficient when one part equals 150 grams.

APPENDIX B

DESCRIPTION OF NAVY MODEL DA-85 DISHWASHING MACHINE

This machine is equipped with a variable speed, adjustable-type conveyor fitted with a control lever which may be set at half speed or full speed as desired.

The tank capacity for both the wash tank and rinse tank is 33 gallons each to the overflow line.

A final steam rinse is fitted to the machine. The final rinse water is mechanically controlled as to temperature by an automatic mixing valve (Power's Mixer). Separate valves are mounted on the machine for the entrance of steam and hot water into the mixer.

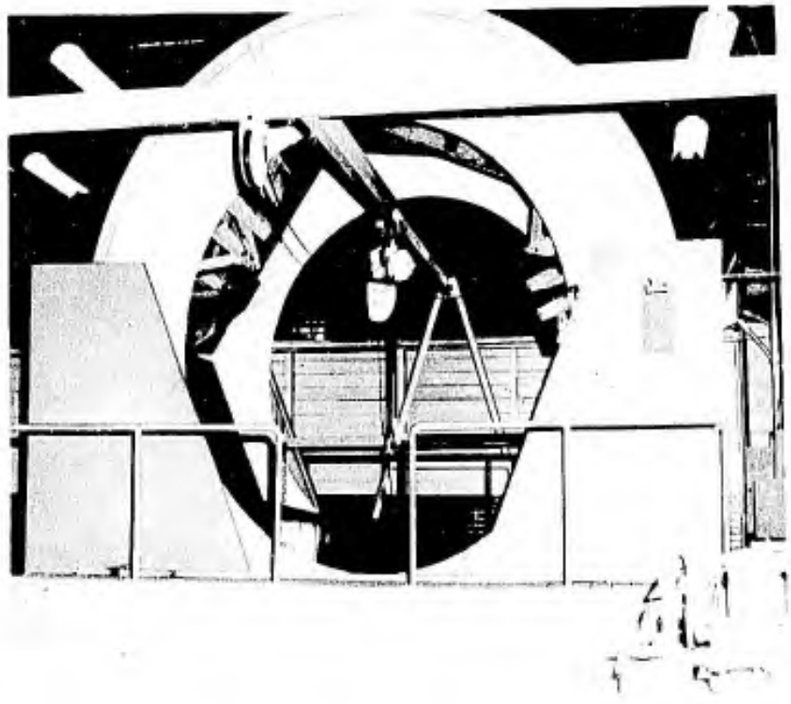
The rinse tank is fitted with a thermostatic cutoff which automatically shuts off the machine in the event the temperature of the water in the rinse tank falls below $180^{o}F$.

Thermometers are mounted to show the temperature of the water in the wash tank, rinse tank, and final rinse line.

Each tank is fitted with a pressure gauge to show the pressure of the pump circulating sprays.

APPENDIX C

DRUM, REVOLVING HEXAGONAL, 14 FOOT (FOR CONTAINER TESTING)



FUNCTION

To simulate the rough manual handling of shipping containers by placing these containers inside the revolving hexagonal faced drum with certain type obstacles attached to each face.

The drum subjects a loaded container to a fairly well-controlled cycle of drops simulating rough handling. It is a good method for determining the shock absorbent qualities of a box and of finding out its weakest factor.

OPERATIONAL REQUIREMENTS

1. Source of 220 Volts A.C. power.

2. Lifting hooks for overhead traveling crane or fork truck for handling the numerous containers.

3. Revolution counter.

MANUFACTURER

Wisconsin Foundry & Machine Company
Madison, Wisconsin

MANUFACTURER'S INFORMATION (ON MOTOR)

Horse Power	- 10	Cycles	- 60
Volts	- 220 A.C.	Rev. Per Min.	- 1,750 reduced to 1 per minute on drum
Phase	- 3		
		Current	- 26 Amps

OPERATIONAL INFORMATION

The Revolving Hexagonal Drum is a testing machine used to give an indication of the ability of a shipping container to withstand various shocks and impact stresses simulating those which may be expected in handling or shipment, to protect its contents when subjected to such shocks and stresses, and to obtain average results permitting a comparison of different designs of containers of the same size and carrying the same load. The test permits a visual observation of the progressive destruction or failure of the package through which means of improving the design may be determined.

The testing machine measures 14 feet in diameter, 8 feet wide inside, and tests containers weighing 600 lbs. maximum at one revolution per minute.

The revolving drum forms a geometrical prism whose bases are regular hexagons and whose lateral faces are rectangles. Baffles or hazards are fixed on the inside of the drum and constructed of hard maple and 1/4-inch steel plate to protect the wooden edges. The bases are formed by cast iron segments with total weight of 15,000 lbs. or more to absorb all the shock of the dropping container without showing the continuous speed of the drum.

Inside the drum are six faces, eight feet square, on which baffles, guides, and obstructions are so arranged as to cause a package to slide, turn and fall on its faces, edges, and corners as the drum slowly revolves at one revolution per minute.

The test specimens are packed and sealed in the same manner as they would be in actual shipment. They are then labeled, mailed, conditioned (according to ASTM Designation D782-47), and tested (according to ASTM Designation D641).

Naval Supply Research & Development Facility, Bayonne, N. J.

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II. Ryberg, M. E.
III. Title: Dishwashing rack for...
IV. NT-F015-13-004
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1. Dishwashers—Equipment
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II. Ryberg, M. E.
III. Title: Dishwashing rack for...
IV. NT-F015-13-004
V. Sub-Task 13-004-156-2

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