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ADC TECHNICAL REPORT 52-324 ✓

DEVELOPMENT OF A METAL SHIPPING CONTAINER
FOR HELICOPTER ROTOR BLADES

W. S. Eubanks, Jr., 2d Lt, USAF
Propeller Laboratory

December 1952 ✓

SEO 582-210

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NAVY

FOREWORD

The container described in this report was developed for the Air Force by Kellett Aircraft Corporation of Camden, New Jersey under Contract No. AF 33(038)-12757. The project was initiated and initially monitored by Captain D. D. Ziegler as project engineer under Propeller Laboratory SEO 562-210. The project was later monitored by Lt. W. S. Eubanks, Jr., Pottery Wing Branch, Propeller Laboratory, as project engineer. Acknowledgment is made for the assistance and helpful suggestions given by the personnel of the Packaging Branch, Materials Laboratory, WADC.

ABSTRACT

The design and development of an all metal, demountable, extensible, shipping container which is easily assembled and disassembled is described. In addition, a description of another type of container which was not developed under an Air Force contract is included for information and comparison.

It is concluded that the container developed under Air Force Contract AF 33(038)-12757 and described herein meets the requirements of the subject contract and development program. The subject container passed a series of drop tests and a shipping service test during which an actual set of blades was installed in the container and the container shipped to various points in the continental United States. With minor modifications the subject container should be suitable for shipping rotor blades in varying lengths from 6 ft. to 36 ft.

The Honold container, which is described for additional information, appears adequate for utilization in the shipment of small rotor blades, although minor modifications may be necessary to insure that this container could be used in continuous service.

PUBLICATION REVIEW

This report has been reviewed and is approved.


L. M. TAYLOR
Colonel, USAF
Chief, Propeller Laboratory
Directorate of Laboratories

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DEVELOPMENT OF A METAL SHIPPING CONTAINER

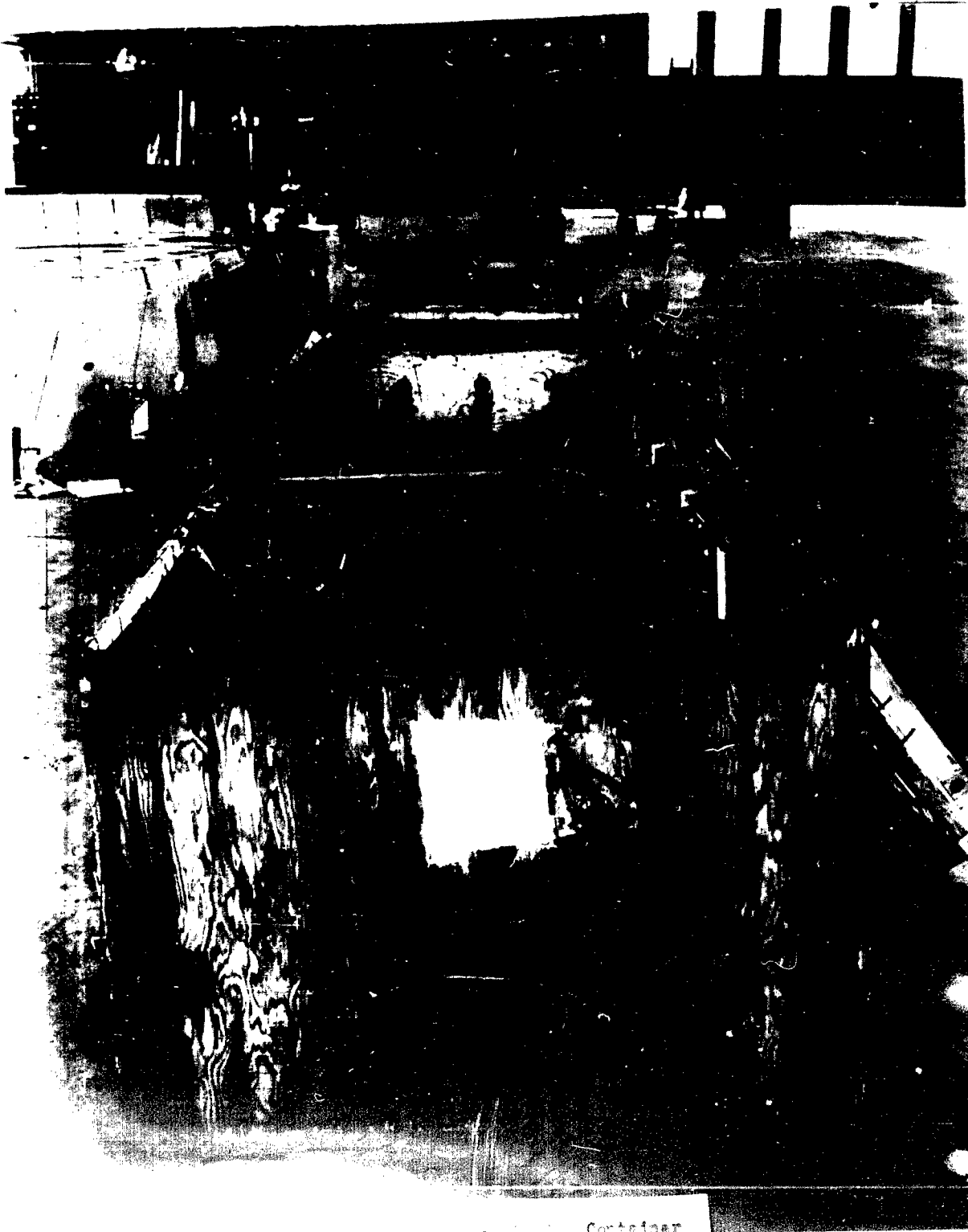
FOR HELICOPTER ROTOR BLADES

INTRODUCTION

Helicopter rotor blades, by the nature of their design and construction, are difficult to package properly. A helicopter rotor blade is usually a long, slender, vane-like wing that features light, flexible construction. The extreme length of a container to house a set of rotor blades as compared to its width and height necessitates a stronger, normally heavier, construction to give the required rigidity. Due to the type of construction necessary to assure that a rotor blade weighs as little as possible, the majority of the helicopter rotor blade designs now in use or contemplated for future use have low impact resistance. It is necessary then to provide some means of packaging these blades so that they will be isolated from any shock loads which might be imposed by an accidental dropping of the container. When rotor blades are packaged, careful attention must be paid to the provisions for mounting the blades so that the inherent flexibility of these blades will not allow them to strike the walls of the container or blade supports and thus damage the blades.

To date, the containers used for shipping rotor blades have been constructed primarily of wood. These containers are extremely heavy as compared to the weight of the blades being shipped. An example of this is a wooden container weighing 1200 pounds which is used to ship a set of helicopter blades weighing 360 pounds. It has been found that it is difficult not to damage the wooden containers during disassembly since the wood splinters and cracks if force is used to pry off the top, (see Figs. 1, 2, and 3). Often, if there are no blades to return from the field, the wooden containers are destroyed or disassembled for another purpose. Shipping cubature is the same whether the containers are empty or full. For this type of container, it requires a different size container for each size of rotor blade. Normally, when an activity receives a shipment of helicopter blades, the blades are removed from the container and stored in racks. If the activity maintains a large supply of helicopter blades, the problem of storage for the empty blade shipping containers presents itself.

It was with these problems in mind that the Propeller Laboratory initiated Project R-582-210 and Purchase Request No. 99994 for the development of a metal shipping container for helicopter rotor blades which would be demountable, extensible, and easily assembled and disassembled. The Purchase Request No. 99994, and the subsequent proposals and bids received, are attached hereto for information.



Container

814-10-23 103-1
MAIN MOTOR BLADES
QTY 3 PCS
DATE PKD 2 / 28 1973
SER NBS-55M-1012
WT 1590 1069
CU 202 1073
L- 26 FT 5 IN
W- 3 FT 2 IN
D- 2 FT 5 IN

Fig. 2 - Damaged Wooden Container



Fig. 3 - Damaged Wooden Container

BACKGROUND OF THE PROJECT

On 24 June 1947, the Packaging Branch of Materials Laboratory let a contract to East Coast Aeronautics, Inc., New York, New York, for the development of two types of lightweight containers for the shipment of helicopter rotor blades. The Type I container (Fig. 4) was to be of all metal construction and the Type II (Fig. 5) was to be of combined materials. Inside clear dimensions were to be 18 ft. (length) by 30 in. (width) by 33 in. (depth). This size container would accommodate the main rotor blades of the R-6 helicopter, which were taken as a typical load for the purposes of this development. The load was 174 pounds, of which 125 pounds was carried at one end of the container, and 49 pounds at the other end. The load was supported by and attached to reinforced floor members located 14 in. and 30 in., respectively, from the ends of the container. Both types of containers were assembled by means of bolts and fixed nuts, and could be completely disassembled and bundled for shipment when empty. The Type I container was made of corrugated, 0.04 in. aluminum sheet with stiffening ribs and two full-length wood skids. The Type II container was made of three-eighths inch plywood with wood skids. Alignment and closure along the junctions of sides, ends and top were accomplished by means of a continuous metal section consisting of a semi-circular channel and fin. The fins were riveted to the edge face of one panel and the channel fitted over the edge of the adjacent panel. The channels were lined with a rubber gasket to provide a tight closure. The top panel of each container carried four lifting rings, one at each corner. The net weight of the metal container was 283 pounds. The plywood container weighed 352 pounds. The contract with East Coast Aeronautics, Inc. was successfully completed 19 February 1948 with the acceptance of a wooden and metal container. The test data are recorded in References 1 and 2.

Although these designs proved successful and met the requirements of the Air Force, it was not felt that they were completely satisfactory for the following reasons:

- (1) Although they were designed to be demountable, there was a large number of fasteners and considerable time was required to assemble and disassemble these containers.
- (2) These containers were not extensible so that a different size container was required for each different size rotor blade.

This project was closed out 26 March 1952 in Memorandum Report No. WORTG-M-5533, Reference 3.

In 1947, the Packaging Branch of Materials Laboratory let a contract to East Coast Aeronautics, Inc., New York, New York, for the development of two types of lightweight containers for the shipment of helicopter rotor blades. The Type I container (Fig. 4) was to be of all metal construction and the Type II (Fig. 5) was to be of combined materials. Inside clear dimensions were to be 18 ft. (length) by 30 in. (width) by 33 in. (depth). This size container would accommodate the main rotor blades of the R-6 helicopter, which were taken as a typical load for the purposes of this development. The load was 174 pounds, of which 125 pounds was carried at one end of the container, and 49 pounds at the other end. The load was supported by and attached to reinforced floor members located 14 in. and 30 in., respectively, from the ends of the container. Both types of containers were assembled by means of bolts and fixed nuts, and could be completely disassembled and bundled for shipment when empty. The Type I container was made of corrugated, 0.04 in. aluminum sheet with stiffening ribs and two full-length wood skids. The Type II container was made of three-eighths inch plywood with wood skids. Alignment and closure along the junctions of sides, ends and top were accomplished by means of a continuous metal section consisting of a semi-circular channel and fin. The fins were riveted to the edge face of one panel and the channel fitted over the edge of the adjacent panel. The channels were lined with a rubber gasket to provide a tight closure. The top panel of each container carried four lifting rings, one at each corner. The net weight of the metal container was 283 pounds. The plywood container weighed 352 pounds. The contract with East Coast Aeronautics, Inc. was successfully completed 19 February 1948 with the acceptance of a wooden and metal container. The test data are recorded in References 1 and 2.



Fig. 4 - Metal Container Developed by Materials Laboratory, WADC

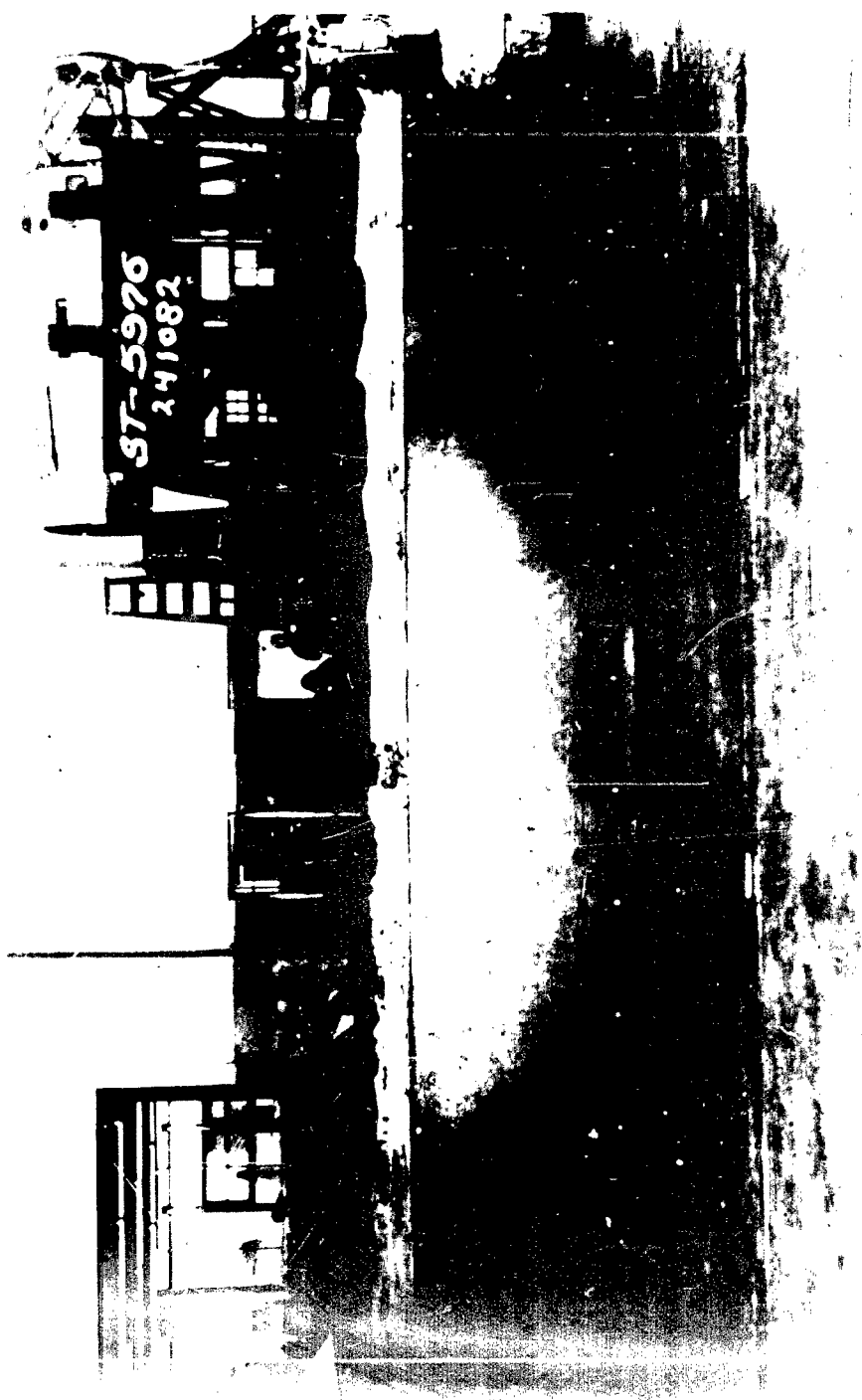


fig. 5 - Combination Wood-Metal Container Developed by Materials Laboratory. WADC

sizes of rotor blades. The reasons given were as follows:

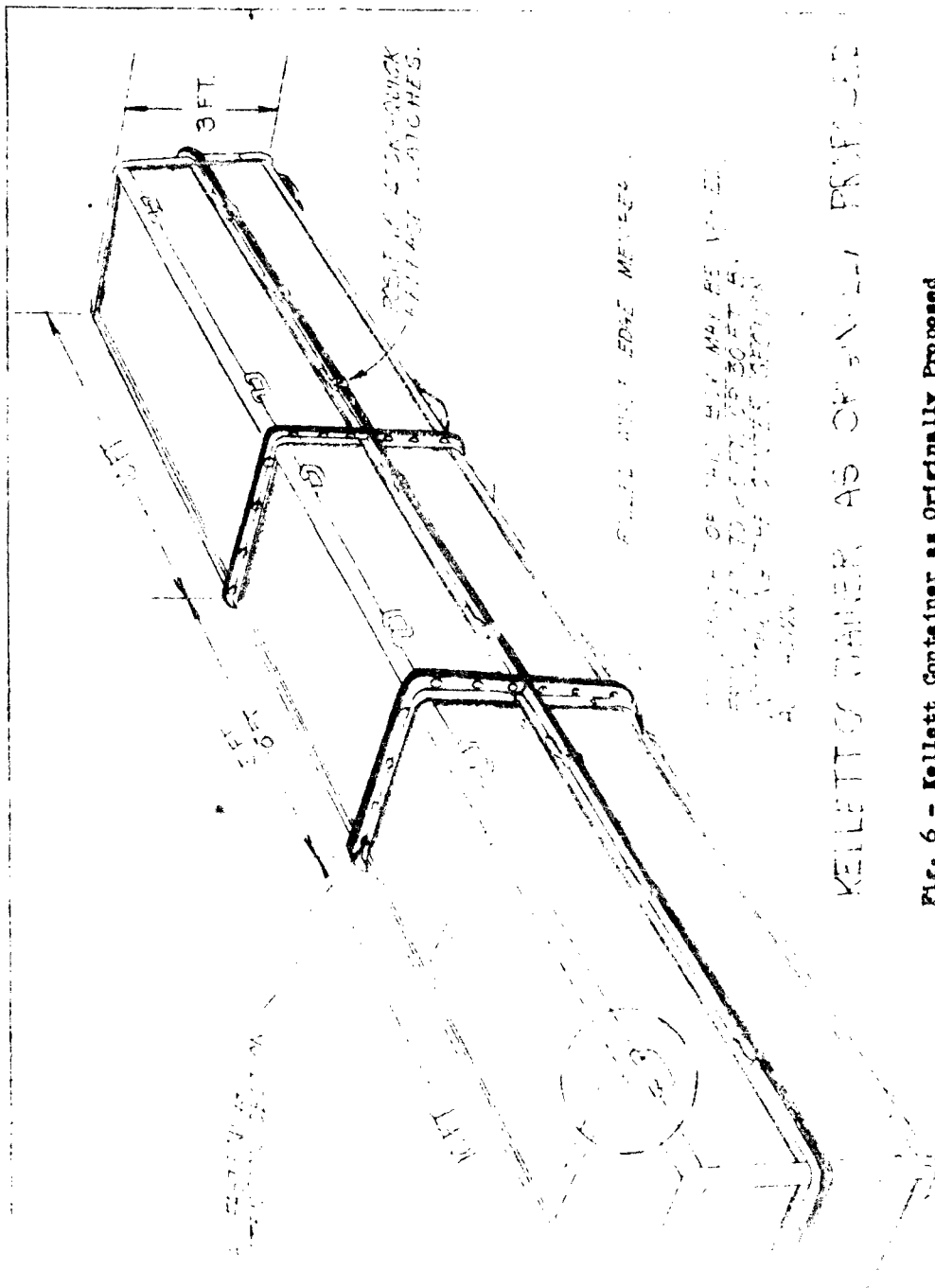
- (1) In the past, no specification or standardization for packaging rotor blades was available to the manufacturers of rotor blades. As a result of this condition, each manufacturer has used his own packaging procedures and fabricated the boxes which are used for shipment of commercial rotor blades. In some instances, the boxes have proved to be unsatisfactory and blades have been damaged.
- (2) The boxes used for shipment of rotor blades have all been fabricated of wood. Due to the extreme length of the box compared to the cross sectional area, heavy pieces of timber are required to obtain the required rigidity. It would appear feasible that a metal box could be fabricated to accomplish the desired rigidity with a weight saving of approximately 50 per cent. This would reduce the problem of handling as well as the freight costs for shipment.
- (3) The length of the boxes required to package the rotor blades presently in use and those contemplated in the future vary to such an extent that the design of several types of wood boxes would be required. It would appear feasible that a metal box could be built in sections and by removal or addition of sections, be adequate for packaging a variety of rotor blades. Also, it would appear more practical from a standpoint of re-using the box. Damage would be considerably less and the box could be disassembled and shipped in a very small package.

The requirements for a container as set up for this project are given below. The Kellett Aircraft Corporation was selected as the prime contractor on the basis of its proposal and Contract AF 33(038)-12757 was awarded to this company for the development of a suitable container, (Figs. 6 and 7).

REQUIREMENTS

MATERIAL AND WORKMANSHIP

The metal container assembly will form a finished product capable of meeting the requirements of the military and commercial aircraft industry with industrial



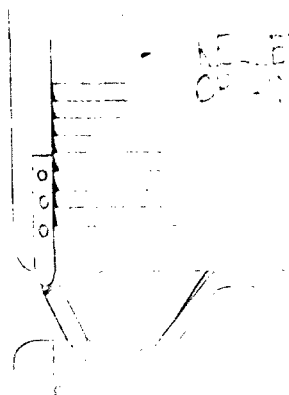
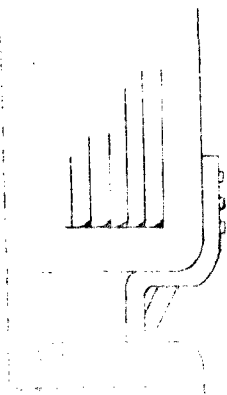
PLYWOOD BLADE LEAFLES
LINED WITH FOAM
RUBBER OF EQUIV. TO BE
SUPPLIED BY BLADE
MANUFACTURER.

QUICK RELEASE LATCH

INTERNAL CHANNEL

SECTION
SHOWING TYPICAL BLADE CRACKS
ISOLATED FROM TOP AND SIDES.

NE-LETT ONCE ON AL
OF RALLY UNNOCES



the deletion of one section. The length of the sections will be determined from the following data:

<u>Model</u>	<u>Rotor Diameter (ft.)</u>	<u>Chord (in.)</u>	<u>No. of Blades</u>	<u>Weight (lb.)</u>
H-5	48	24	3	400
H-13, H-15	37	16	2	200
H-12	48	21	2	500
H-18	33	11	3	120
H-19	53	17	3	400
HRP	35	--	3	220
HRP	41	14	3	330

WEIGHT

Consideration shall be given in the design so that the container will be as light as possible without sacrificing rigidity and ruggedness.

ASSEMBLY AND CLOSURE

The container shall be capable of disassembly, assembly, and closure with the aid of ordinary tools. The assembly and closure devices shall be capable of repeated re-use.

DETAIL REQUIREMENTS

MATERIALS

The panel material shall have a puncture resistance corresponding to that of one-quarter inch, three-ply softwood, plywood, or greater.

CONSTRUCTION

Skids

The base section shall be equipped with skids in a position approximately flush with the sides of the container. The vertical clearance between the bottom of the container and the bottom of the skids shall be a minimum of three inches.

Hardware

The container shall be designed to be opened and closed by hand on the top and bottom.

Load Carrying Members

Load carrying members shall be provided as an integral part of the base of the container to support a directly applied load fastened to and supported only by the base.

Mounting Provisions

Provisions shall be made for mounting adequate blade saddles. Provisions shall be made for anchoring the root end of the rotor blades to the bottom of the container.

Finish

All exposed surfaces subject to corrosion shall be finished with an olive drab paint.

Rigidity

When loaded with a test load and when suspended at the ends as described in Tests, the maximum deflection of the container shall not exceed one-quarter inch. After being subjected to the drop described in Tests, the maximum deflection of the container, similarly loaded and suspended, shall not exceed three-quarters inch. After being subjected to the drop test and to the superimposed loading test, the container shall reveal no significant structural weakness and no deformation shall have occurred which will not permit the ready reassembly of the container following complete disassembly, and the fasteners shall be intact and in a condition for re-use.

TESTS

TEST LOAD

The container shall be loaded for testing, with a dummy load attached firmly to the bottom or base of the container. The dummy load shall be equivalent to the weight of the blades given in Dimensions, above, and the length container required. Of this load, 60 per cent of the weight shall be applied to an area of three inches the width of the container, crosswise of the bottom of the container, and located $1\frac{1}{4}$ inches from one end. The remaining 40 per cent of the dummy load shall be applied to a similar bearing area located 30 inches from the opposite end.

DROP TESTS

Edge Edgewise Test

The container shall be supported at one end of the base on a vertical rod 1/4 inch in diameter in height placed at right angles to the base of the container. The container shall be raised and allowed to fall from a height of 30 inches to the base of the support.

DEFLECTION TESTS

The container shall be freely suspended in a horizontal position by four of the lifting rings, attached to the top, nearest the ends of the container.

SUPERIMPOSED LOAD TEST

A load of 100 pounds per square foot, without intervening dunnage or other supports, shall be applied over the entire top area of the container.

THE KELLETT CONTAINER

After a study of the problem, Kellett decided that the design as originally proposed was not adequate for the job to be done and a complete redesign of the container was made. This redesign was presented to Propeller Laboratory personnel who deemed that it could meet the requirements and was satisfactory. The redesigned container as submitted (see Figs. 8, 9, and 10) has overall dimensions of 26 ft. 4 in. (length), 3 ft. (height), and 2 ft. 8 in. (width). It is constructed of 14 panels made of a square, aluminum tube frame, and aluminum honeycomb filler covered by two parallel aluminum sheets. Initially the panels were assembled with fasteners known as "Roto-Locks" which incorporate a toothed cam and eccentric. These fasteners were replaced by a better type lock when tests proved the "Roto-Locks" unsatisfactory. The container is so designed that by varying the number of panels, lengths of 10 ft., 16 ft., and 26 ft. can be attained. When disassembled and packaged for shipment, its cubature is approximately 140 cubic feet.

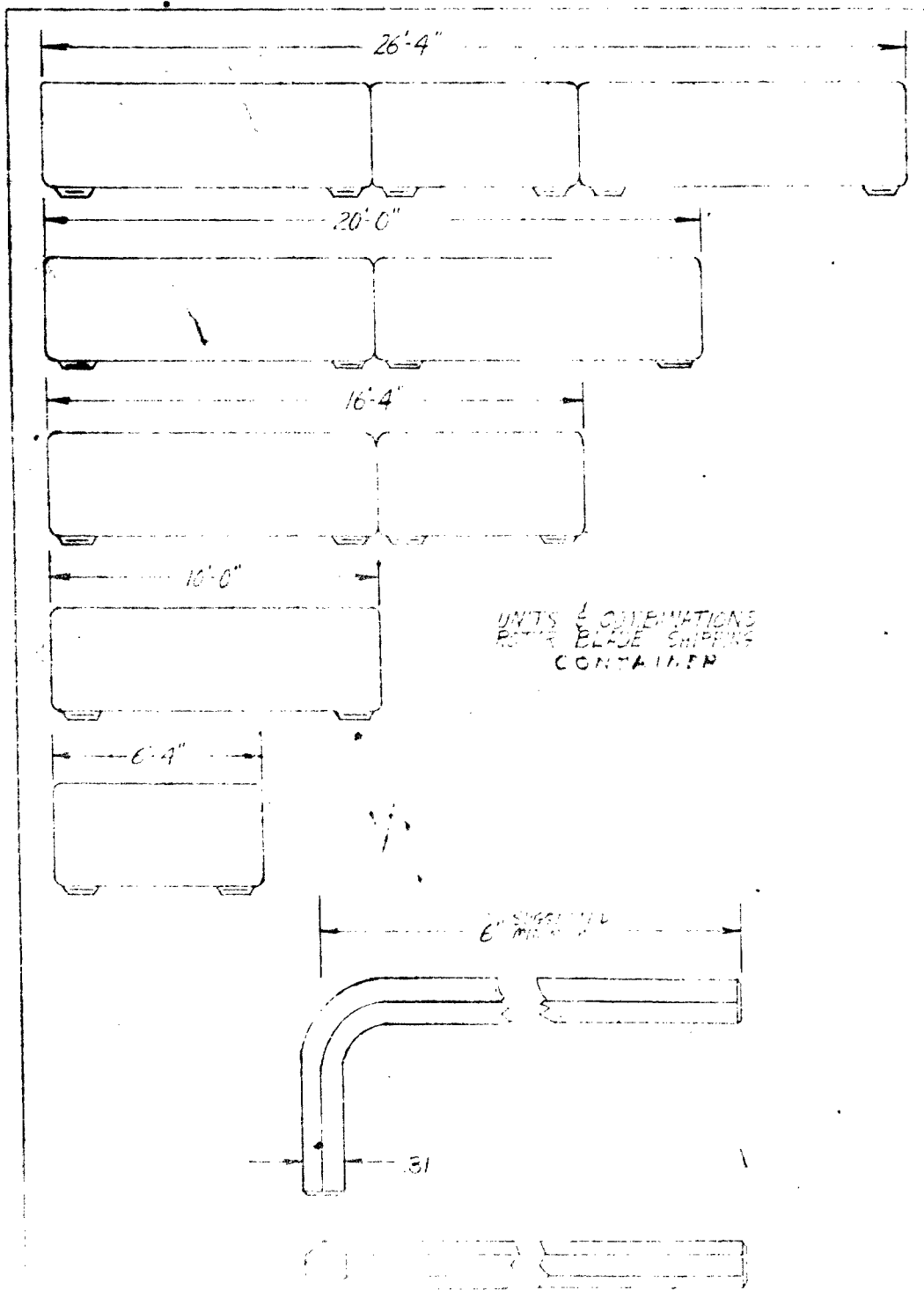
When first submitted on 11 May 1952, the Kellett container successfully passed all of the required tests except the drop tests during which the locks and the flooring under the load failed. The container was returned to the contractor's facilities for redesign and repair. It was resubmitted 8 November 1951 but again the locks and flooring failed during the drop tests. After a new type fastener had been installed and a redesign of the floor panels completed, the container was again submitted 10 March 1952 and successfully completed the drop tests. A detail description of the container and the development program follows:

PANELS

The panels for the Kellett container are of two basic lengths, 10 ft. and 6 ft., and weigh 63 pounds and 38 pounds, respectively. These panels may be used in various combinations to give lengths varying up to 26 ft. (see Figs. 9, 10, and 11). The panel itself is constructed with a frame of .06 in. 24ST3 aluminum alloy tubing, 1 1/2 in. square. This frame is covered with 0.02 in. aluminum sheet. The lock housings are



Fig. 1 - View of building



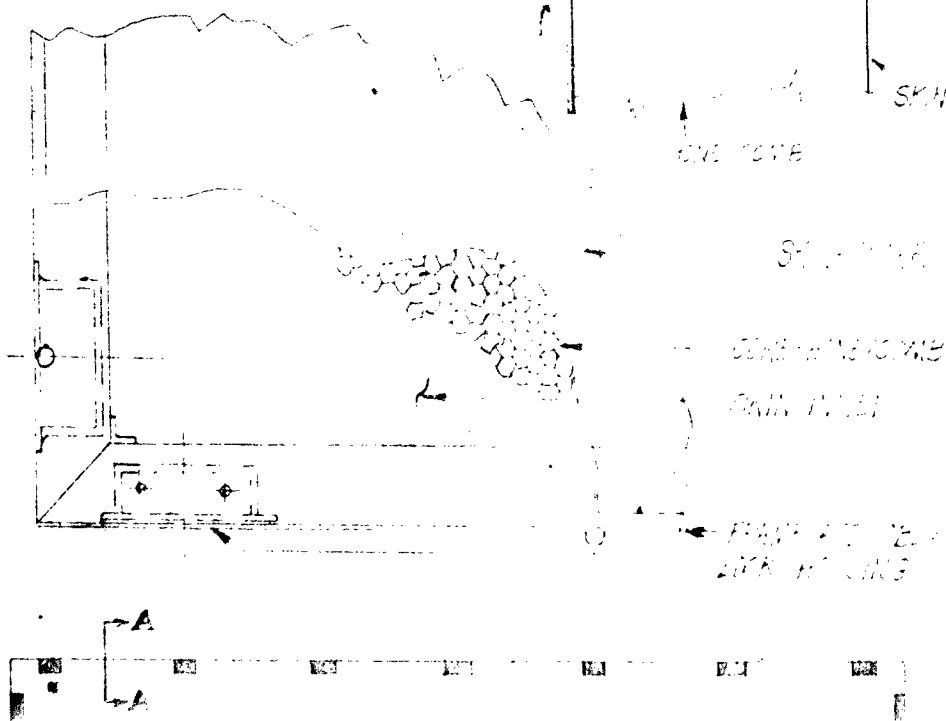
BLEND SHARP CORNER OF
SKIN WITH CORNER RADII
OF TUBE. (7, 8, 9, 10)

SECTION A-A

FULL SCALE

GLUE BOND

Fig. 10 - Details Kellett Container



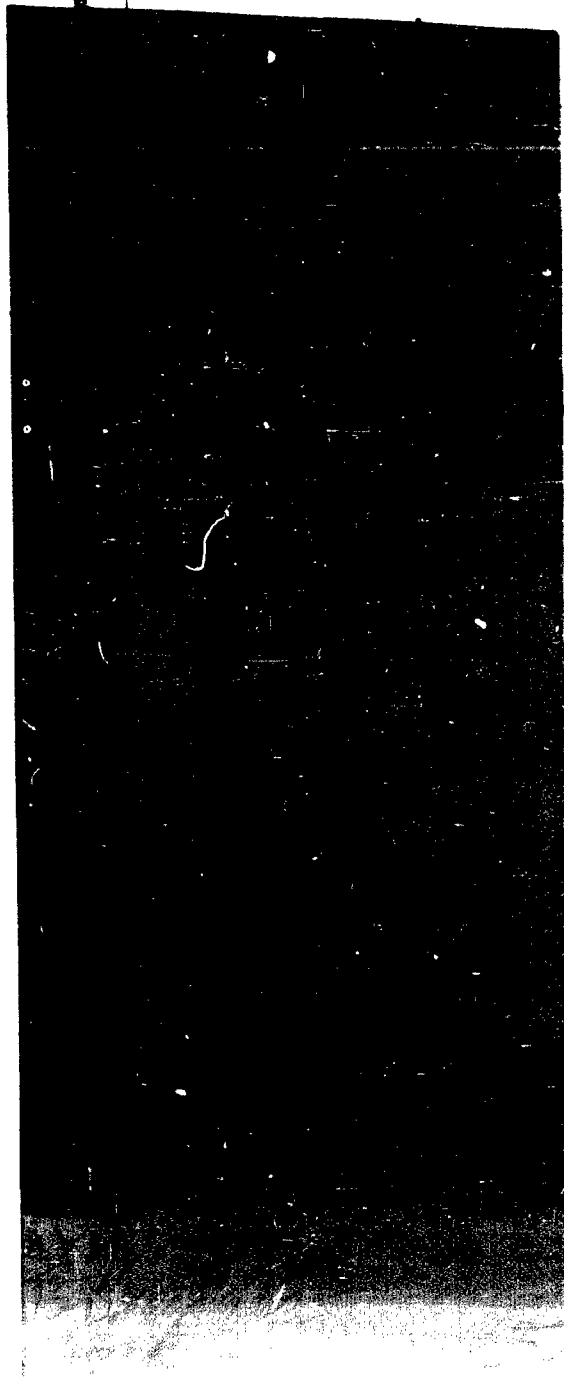


Fig. 11 - Panel - Kellett Container

located every 18.5 in. along the top and bottom of the panel. Three lock housings are located on each end of the panel (see Fig. 12). All panels have tapered floating studs around the periphery to assure positive alignment. Attached to the top panels are four lifting rings, two inches inside diameter, made of 5/16 diameter 1020 steel. The end panels contain two helicoil inserts for attachment of the blade root retaining frames.

The lower panels are designed to carry all of the load. As stated in the Requirements, this load must be distributed over an area which is three inches wide and extends across the width of the panel. In the original design, this load was absorbed by a frame cross member which was attached to the edge tubing by a clip and two rivets. This failed in the first drop test (Ref. 4). When the container was returned to Kellett for modifications, the clips were replaced, using "Hi-Shear" rivets. This failed during the second drop test, (Ref. 5) so the flooring was further strengthened by inserting a hard maple block in the ends of the supporting cross member and fastening it and the supporting clips with four one-quarter inch diameter bolts. The clips were fastened to the side framing with rivets and ends of the Esna Roll Ring, which are used to secure the lock housings at this point. In addition to strengthening the bottom panel for the third series of drop tests, a strip of one-half inch rubber was placed in the bottom of the blade retaining channel to cushion the load. The bottom panel as modified did not fail during the third series of tests.

FASTENERS

The fasteners used to lock the panels of the container are manufactured by the Simmons Fastener Corporation. The fastener first used in the container has the trade name "Roto-Lock" (Fig. 13) and consists primarily of a circular cam with a "T" shaped cross section in the male housing which contacts the extended ears of lips of the female housing. When the cam is rotated by a conventional "hex" or Allen type wrench, the two housings are forced together by the action of the cam on the female ears.

The housings of these early locks were made of cold rolled low carbon steel and the cams were made of brass. This type of lock failed during the 18 in. drop endwise test (Ref. 4). It was found that the lips of the female housings which were stamped were failing either by spreading and allowing the cam to slip or by cracking near the edge of the stamped depression.

After the failure of the locks during the initial acceptance tests, Kellett initiated a development program on the fasteners. It was found that the "Roto-Lock" would withstand an average tensile load of 10,000 pounds. It was also indicated that by utilizing 4130 steel heat treated to a minimum tensile strength of 100,000 pounds for the housings and 4130 steel heat treated to a minimum tensile strength of 100,000 pounds for the cams, the locks would withstand a tensile load of 10,000 pounds.



decided to utilize the 4130 steel housings and brass cams for the second series of acceptance tests. These "Roto-Locks" failed generally in the lips of the cams during the 24 in. drop endwise test (Ref. 5).

After the second failure of the "Roto-Lock" type of fastener, Kellett tested several "Dual-Locks," a new type of fastener recently developed by Simmons Fastener Corporation (see Fig. 14). It was found that it was possible to obtain tensile loads up to 7200 pounds with the newer type lock.

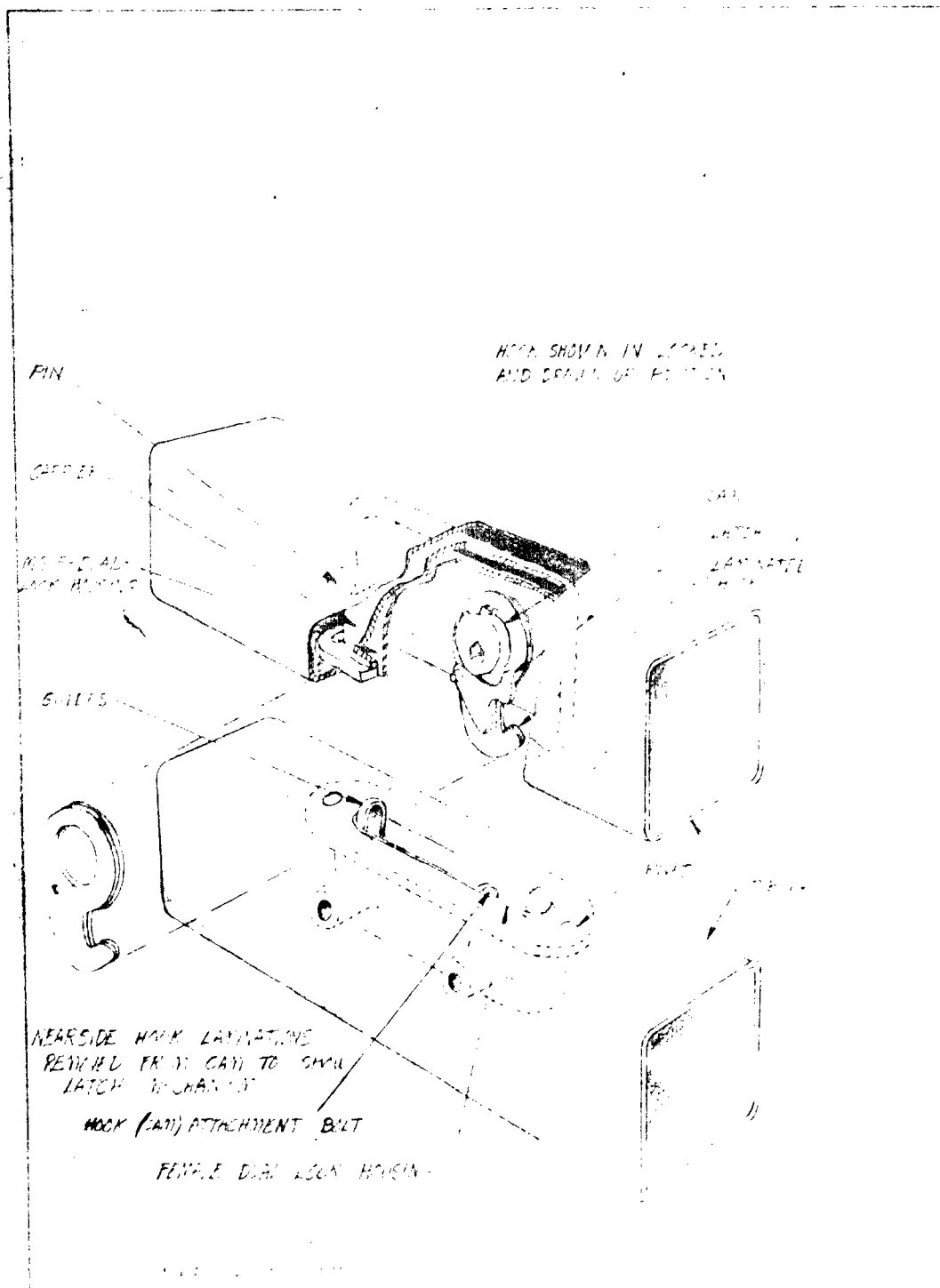
The "Dual-Lock" consists primarily of a hook made of four pieces of 4130 sheet steel heat treated to 160,000 UTS mounted on an eccentric which is operated by a standard Allen "hex" wrench, and a pin located in the female housing. When the wrench is turned, the hook turns with the eccentric until it engages the pin. As the wrench is turned further, the eccentric continues to rotate, forcing the hook into the male housing, pulling the two housings together (see Fig. 12). By reversing the direction of rotation of the wrench, the locking action is reversed.

Sixty-nine "Roto-Locks" were replaced by "Dual-Locks" in all lock housings located below the neutral axis of the container. With the new "Dual-Locks," the Kellett container passed the drop tests, thus meeting the requirements and therefore became acceptable (Ref. 6).

The "Dual-Lock" type of fastener works well in this type of application, for it gives a positive locking action. Also, the "Roll-Pins" which are used to hold the lock housings in the panels appear to work well. These "Roll-Pins" may be plugged or left open as breathers for the container.

SADDLE RETAINING CHANNELS

Another feature of this container is the removable blade support saddle retaining channels (see Fig. 15). These retaining channels are made of .064 in. 24ST aluminum alloy sheet bent into a "U" shape and drilled to accommodate four Simmons one-quarter inch diameter Spring-Lock studs which are used to fasten the channel to the panels. The bottom and side panels contain matching holes near the ends in the frame cross members so that the channels may be quickly attached or detached to the panels. Experience gained during the shipping tests indicates that it would be better if all of the frame cross members were drilled to accommodate the saddle retaining channels so that the channels, and thus the blade supporting saddles, could be shifted back and forth more easily to accommodate the various lengths of blades which are in use. This retaining channel appears to work well for it can be quickly attached and detached and it provides adequate retention of the blade.



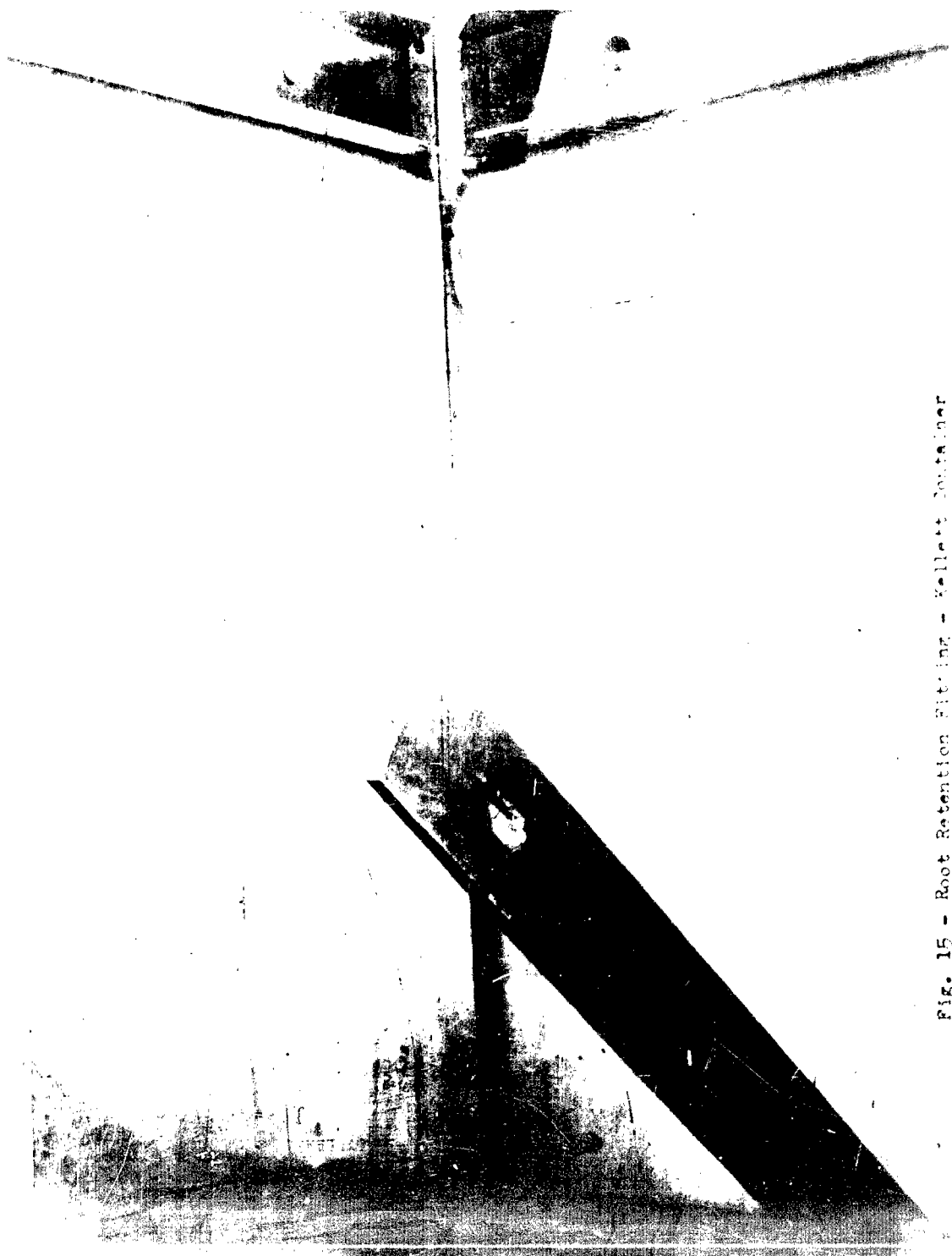


Fig. 15 - Root Retention Fitting - Kallott Container

the container's adequacy. This service test consisted of packing a set of helicopter rotor blades in the container and shipping the container to various points in the continental United States to ascertain if the container would perform its function of protecting the rotor blades from damage.

As stated, this program has been primarily concerned with the development of the actual container and not with the blade mounting provisions, since it was felt that the blade mounting provisions should be left up to the individual blade manufacturer. As a result of this, no saddle design was available and blade supporting saddles had to be designed for this shipping test. It is imperative that the blades be properly supported in the container to prevent damage to the blades. Experience has shown that a large percentage of the damage incurred by rotor blades during shipment is due to improper mounting. For this reason, careful attention was given to the design of the blade supporting saddles for this test in order to assure that these supports would not be a contributing factor to any damage which the test blades might incur.

A set of R-6 wood, fabric, and metal blades was used for the test shipment (see Fig. 16). It was decided to use R-6 blades because the type of construction utilized in these blades rendered them more susceptible to damage than any other available blade. Also, the R-6 blade approximates the length and weight of the blade for an HUP or H-25 helicopter for which another type of container has been fabricated. This use of comparable size blades and containers will enable a comparison to be made between the Kellett container developed by the Air Force and Honold container developed for use with the Navy HUP blades. Only the two 10 ft. sections of the container were needed to ship these blades.

The saddle designs used for this test were the result of the combination of the best features of blade saddle designs which have proved most successful in the past. The blades were not only isolated from the supporting saddles by foam rubber as shown in Figs. 17, 18, 19, and 20, but the saddles were isolated from the container proper by a one-half inch strip of rubber. The blades were securely mounted both by locking the saddle halves securely and by securing the root ends of the blades to the ends of the container.

The blades and the container were thoroughly inspected prior to shipment and all damaged areas were noted and tabulated. A silver dot was painted on one end of the container to aid in the location of the damaged areas for future reference.

The itinerary of the test was as follows:

W-PAFB, Ohio, via rail to Mather AFB, Calif.
Mather AFB, Calif., via truck to Kelly AFB, Texas
Kelly AFB, Texas
Bolling AFB, D.C.
Bolling AFB, D.C.



Fig. 16 - R-2 Blade - Kellett Container

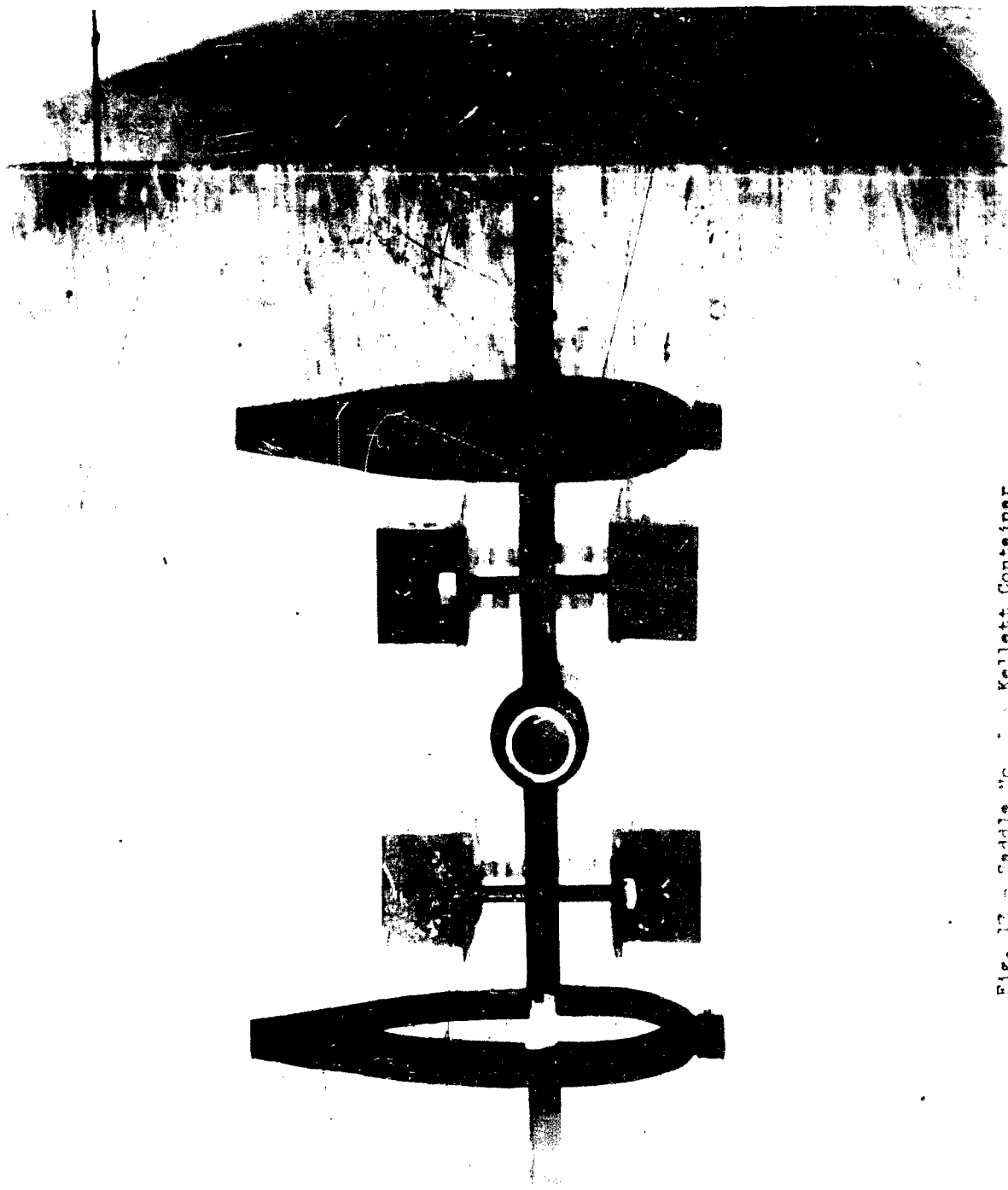
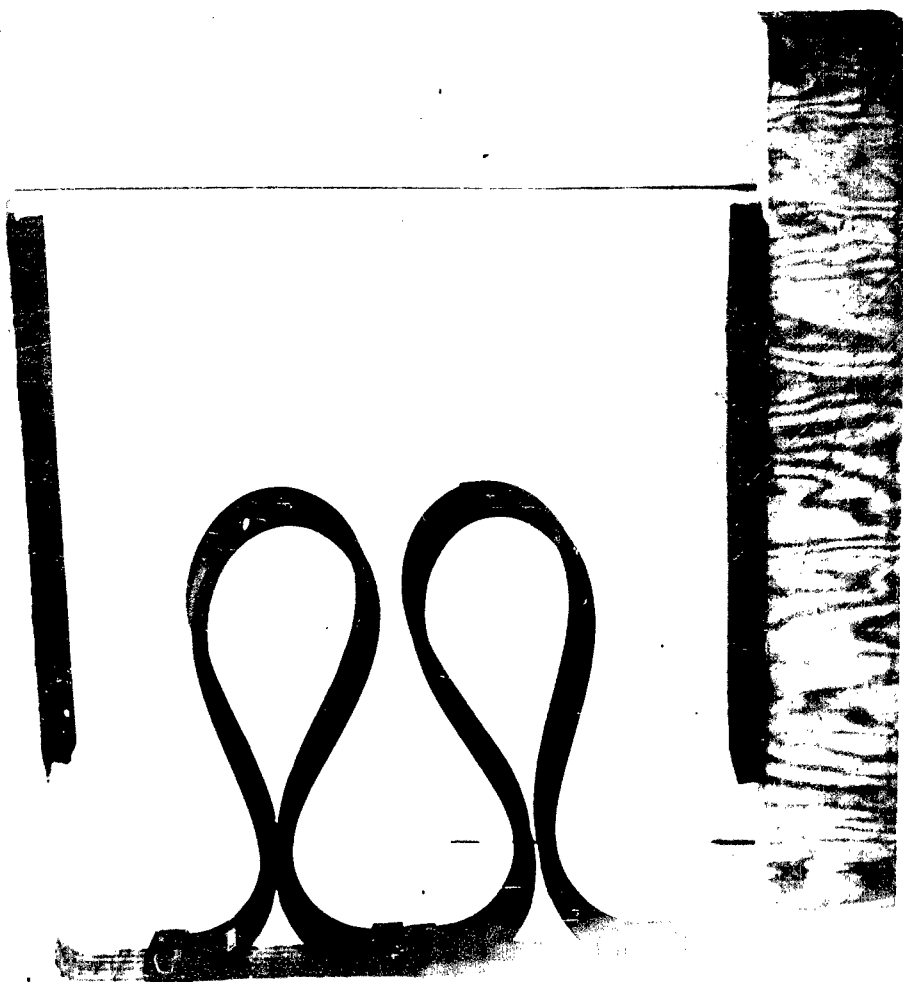
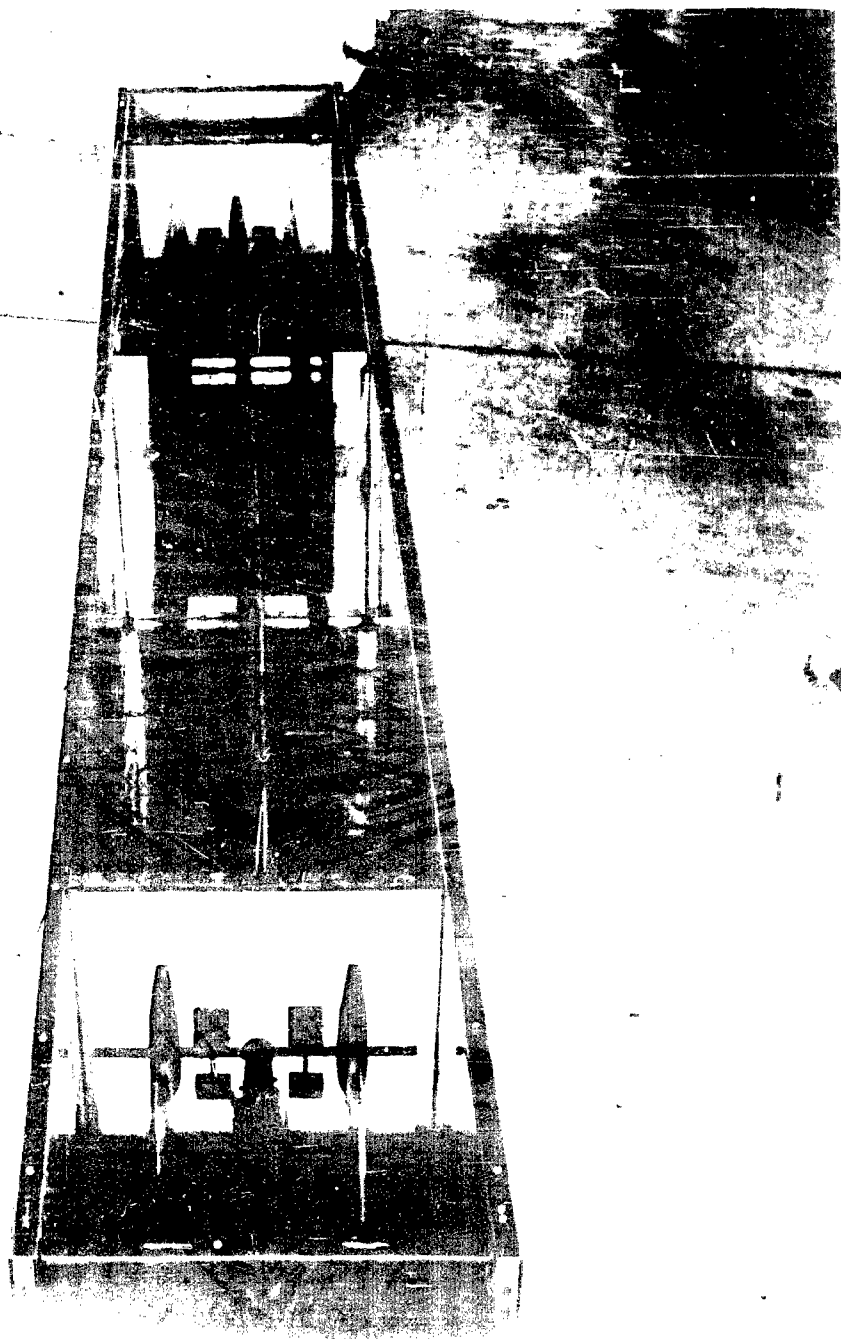


Fig. 17 - Caddle "No. 1" - Kellett Container







and the supply officers at each base were requested to report on the condition of the container as it arrived from the last station. The majority of the damage incurred by the container (see Figs. 21, 22, 23, 24, and 25) occurred during transit from Mather AFB to Kelly AFB. With the exception of several small punctures and the skin tear on the bottom of the container as shown in Fig. 22, the damage incurred in shipment was a continuation of the damage previously incurred by the container during the drop tests. Bond failures and skin separations continued to enlarge as shown in Fig. 24. Neither the R-6 rotor blades nor the interior of the container suffered any damage during the shipping test.

THE HONOLD CONTAINER

BACKGROUND

During the same period that Kellett was developing its container under contract to the Air Force, the Ludlow Honold Manufacturing Company of Solersbt, Pennsylvania, under contract to the Blawie Helicopter Corporation, was developing an all metal shipping container for the Navy HUP helicopter rotor blades. The Propeller Laboratory working with Materials Laboratory tested this container on 20 May 1952.

DESCRIPTION

The Honold container measures approximately 20-1/2 in. by 22-1/2 in. by 17 ft. long. The containing cylinder is 18 in. in diameter. The container tested at WADC weighed 194 pounds. The skin is of .064 in. 61ST aluminum and the blade support saddles are of cast aluminum with the blade profile surrounded by rubber. The two halves of the container are fastened together by hand operated "C" clamps and the saddle halves are fastened together with eye-bolts and wing nuts (see Figs. 26, 27, 28, and 29).

TESTS

The Honold container was tested in accordance with the Requirements of Contract AF 33(038)-18757. It was decided to omit the superimposed load test and the deflection tests since it was felt that primary concern of the Air Force tests was to determine the merit of the aluminum channel (Fig. 29) skids and the shock-mounted blade retaining saddles (Fig. 27). The dummy load consisted of three steel pipes loaded with shot-bags to simulate the weight (224 pounds) of three HUP or R-25 type blades (Fig. 30), distributed so that 60 percent of the load rested on one blade saddle and the remainder on the other saddle.

Fig. 01 - Damage Incurred During Shipping Tests - Kellogg Container

12 MAY 1964

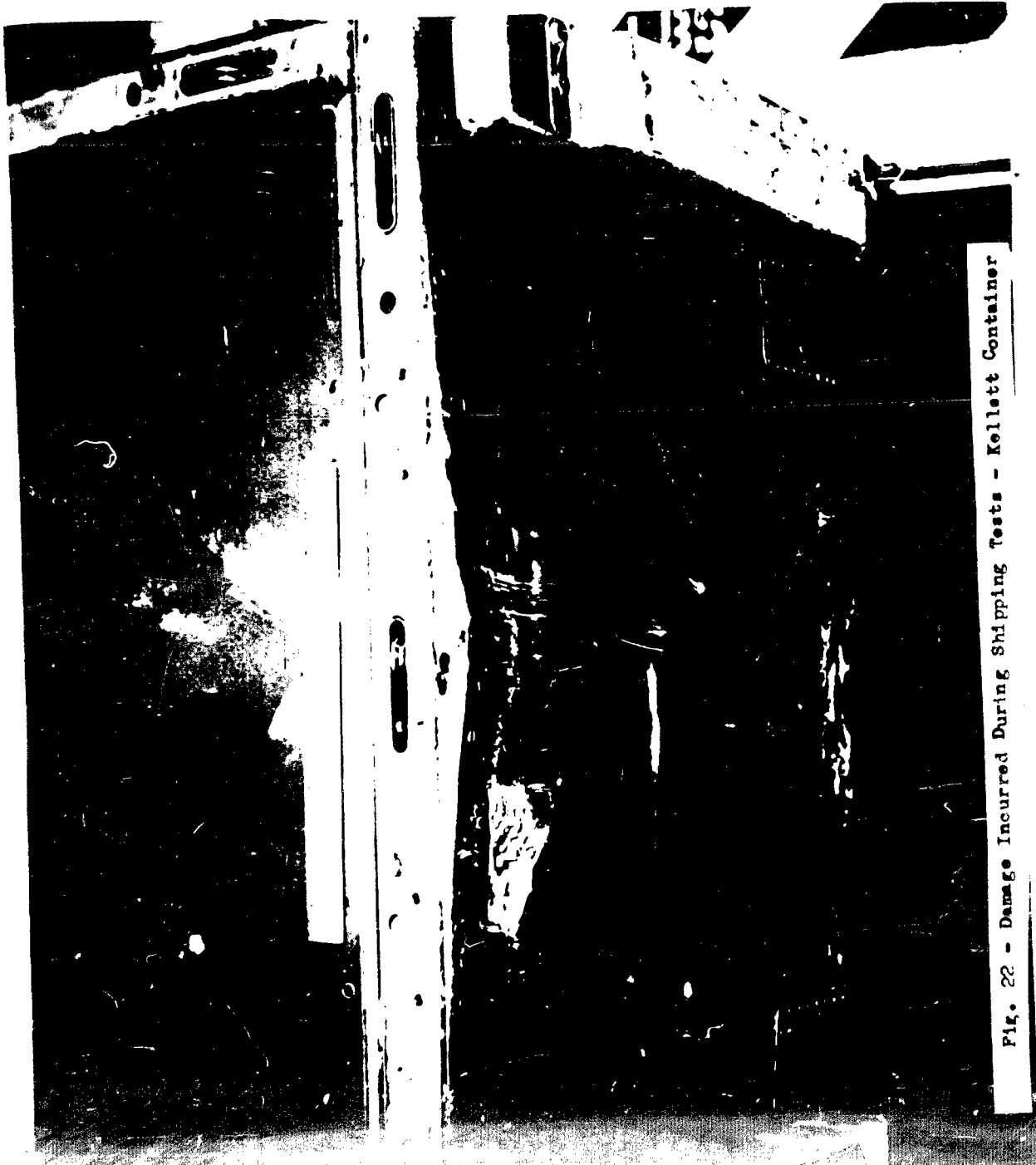


Fig. 22 - Damage Incurred During Shipping Tests - Kellett Container

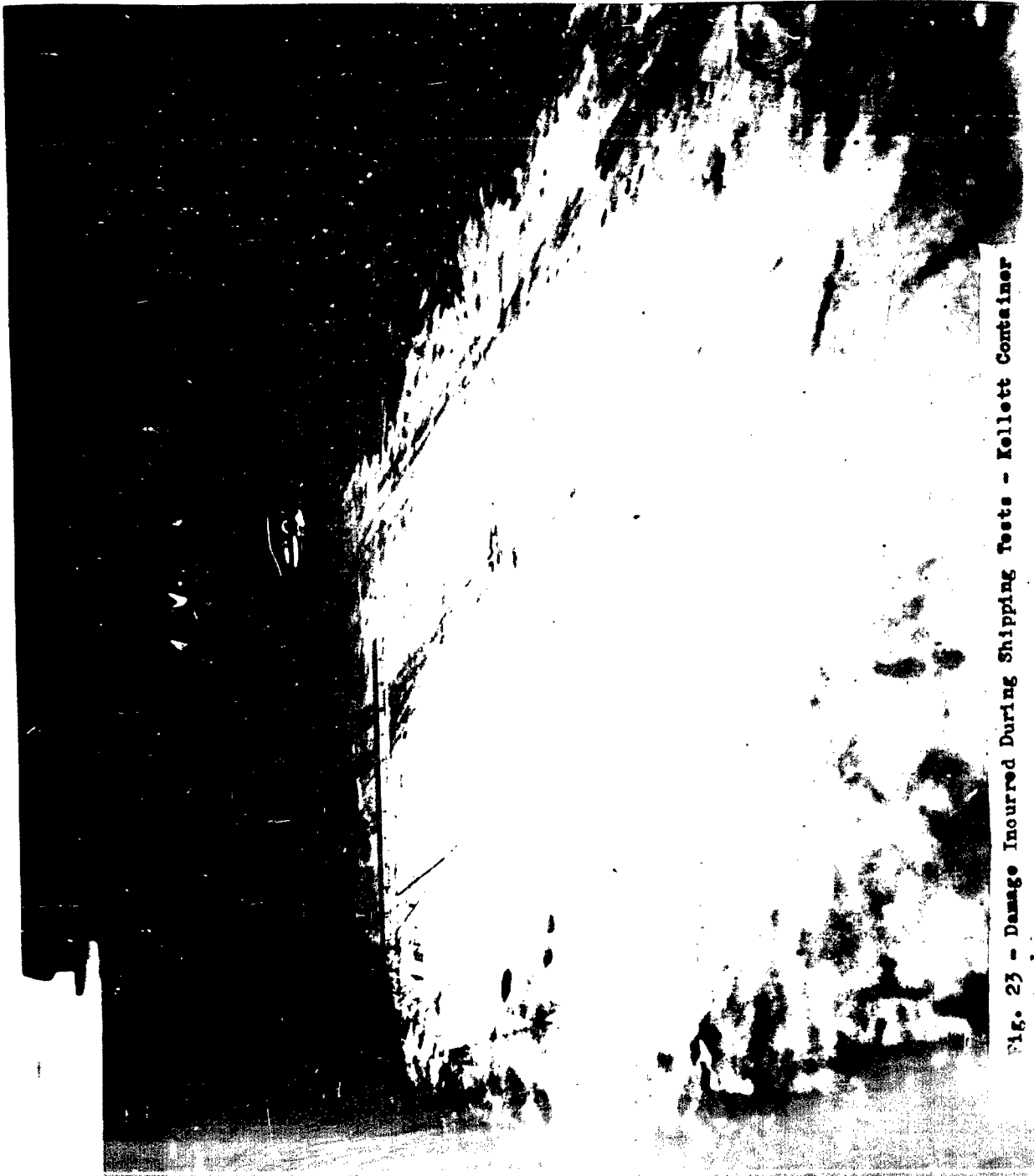


Fig. 23 - Damage Incurred During Shipping Tests - Kellett Container



Fig. 4. - Reducing Gas - Kellogg Container

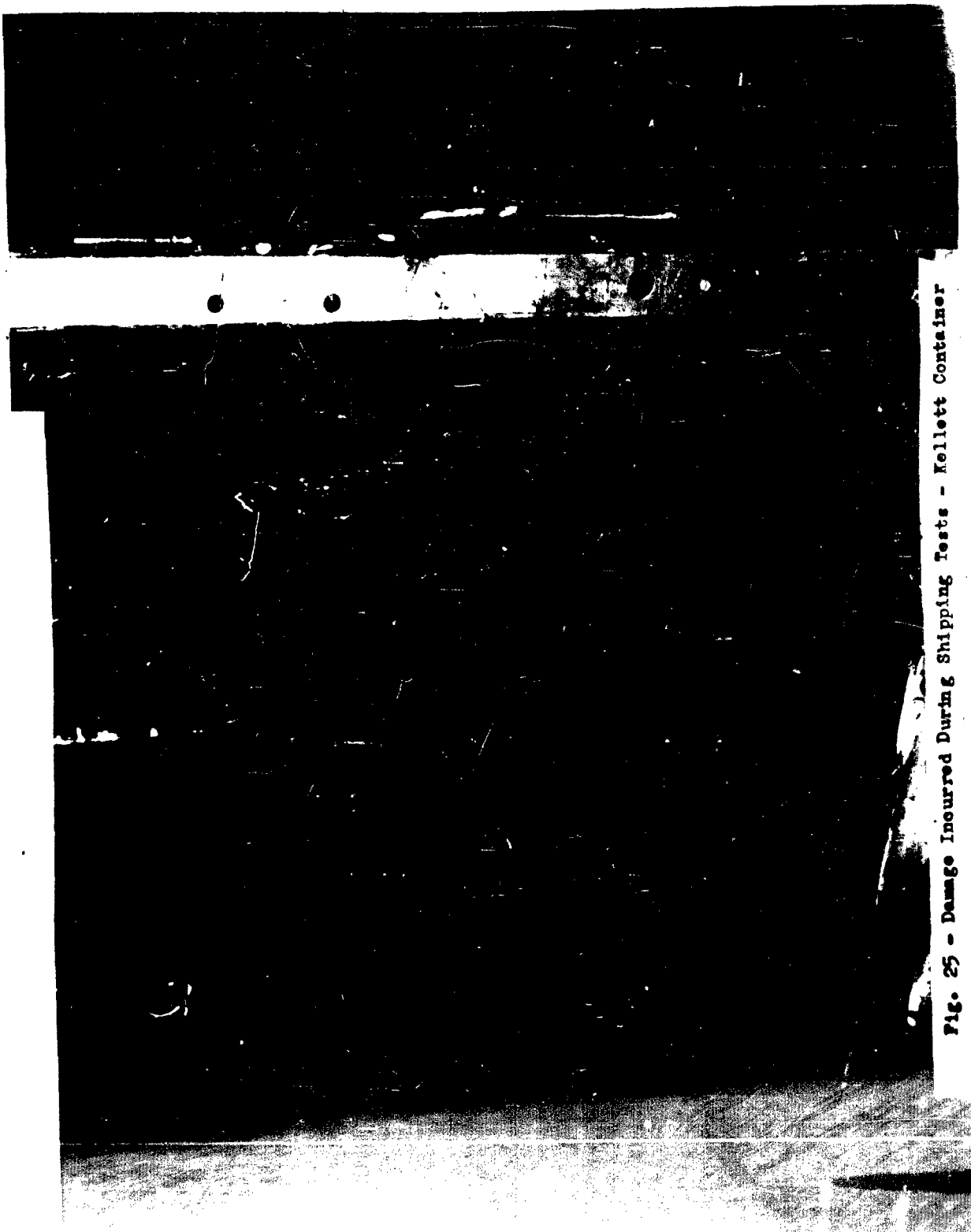
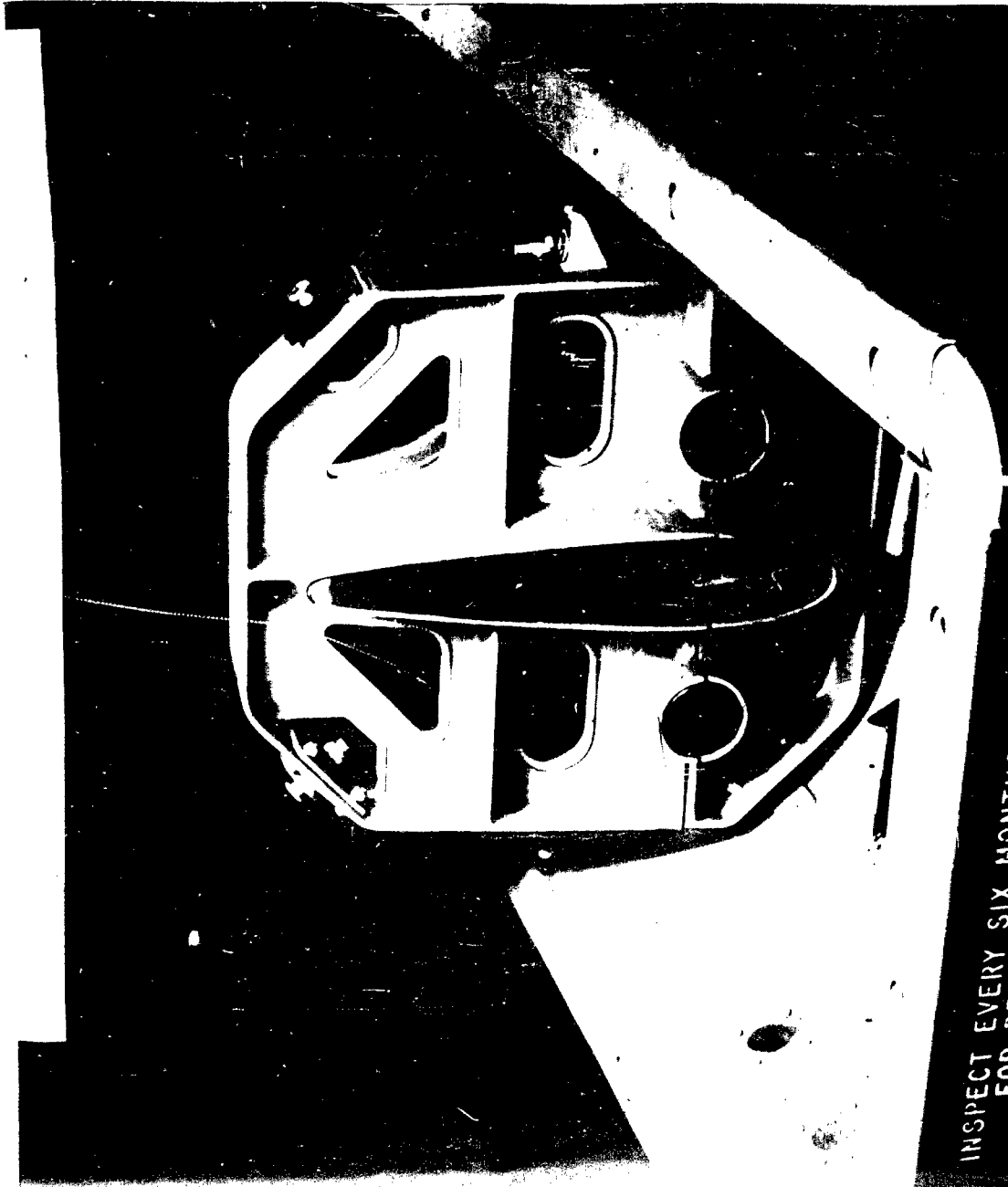


Fig. 25 - Damage Incurred During Shipping Tests - Kellett Container



Fig. 26 - HonoId Container Assembled



INSPECT EVERY SIX MONTHS
FOR DETERIORATION

ORIGINAL INSPEC
SUBSEQUENT INSPE

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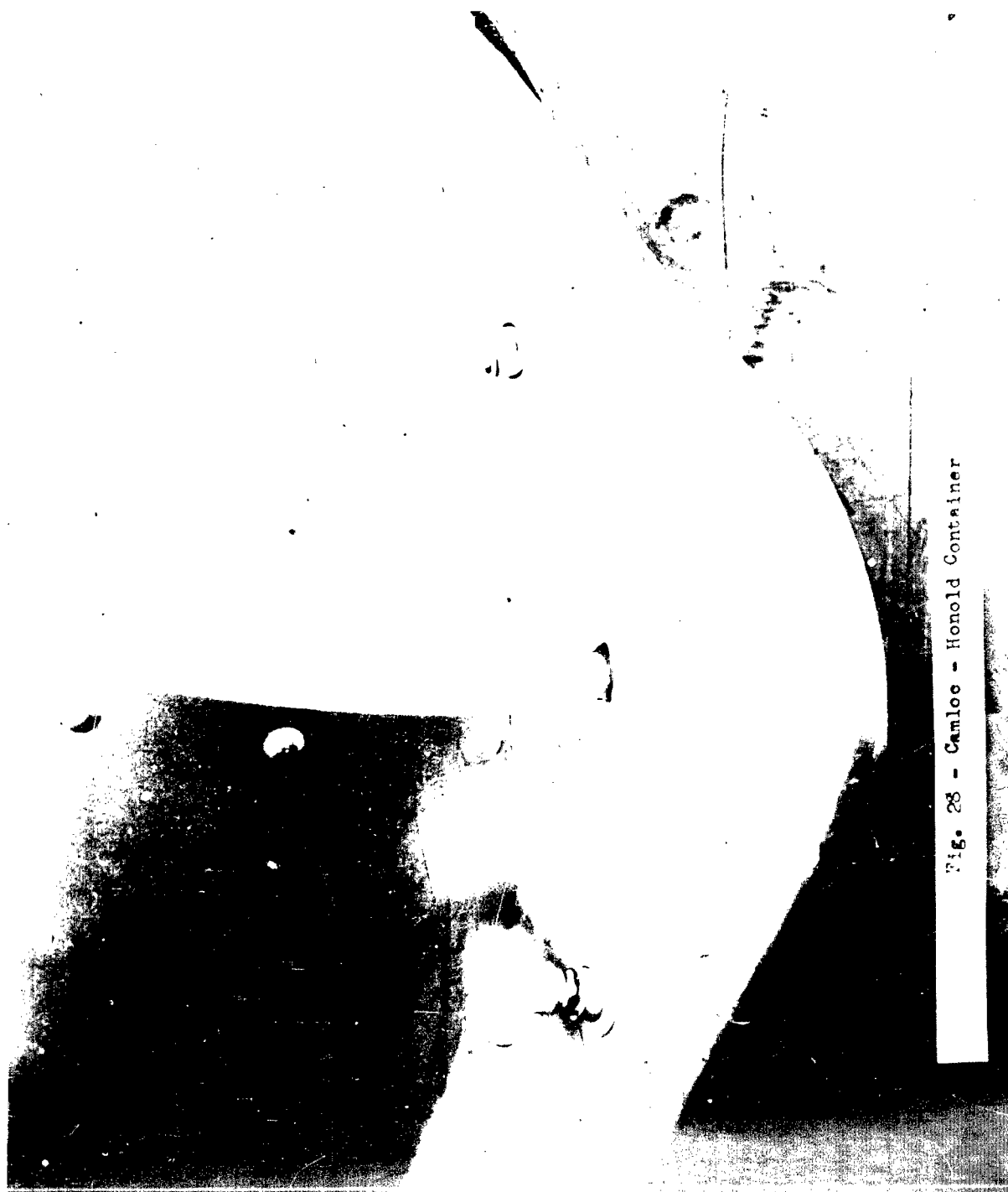
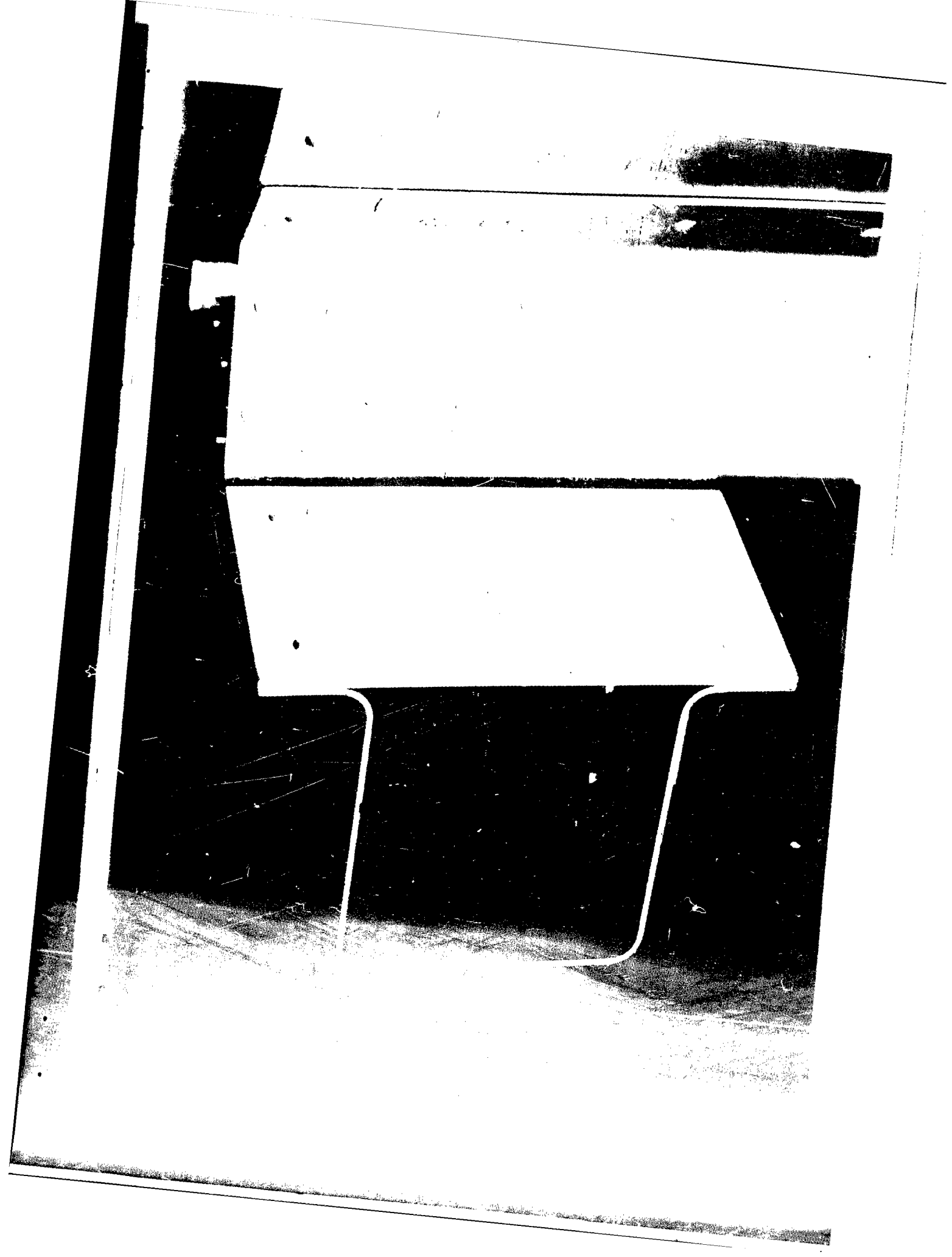


Fig. 28 - Camloo - Honold Container



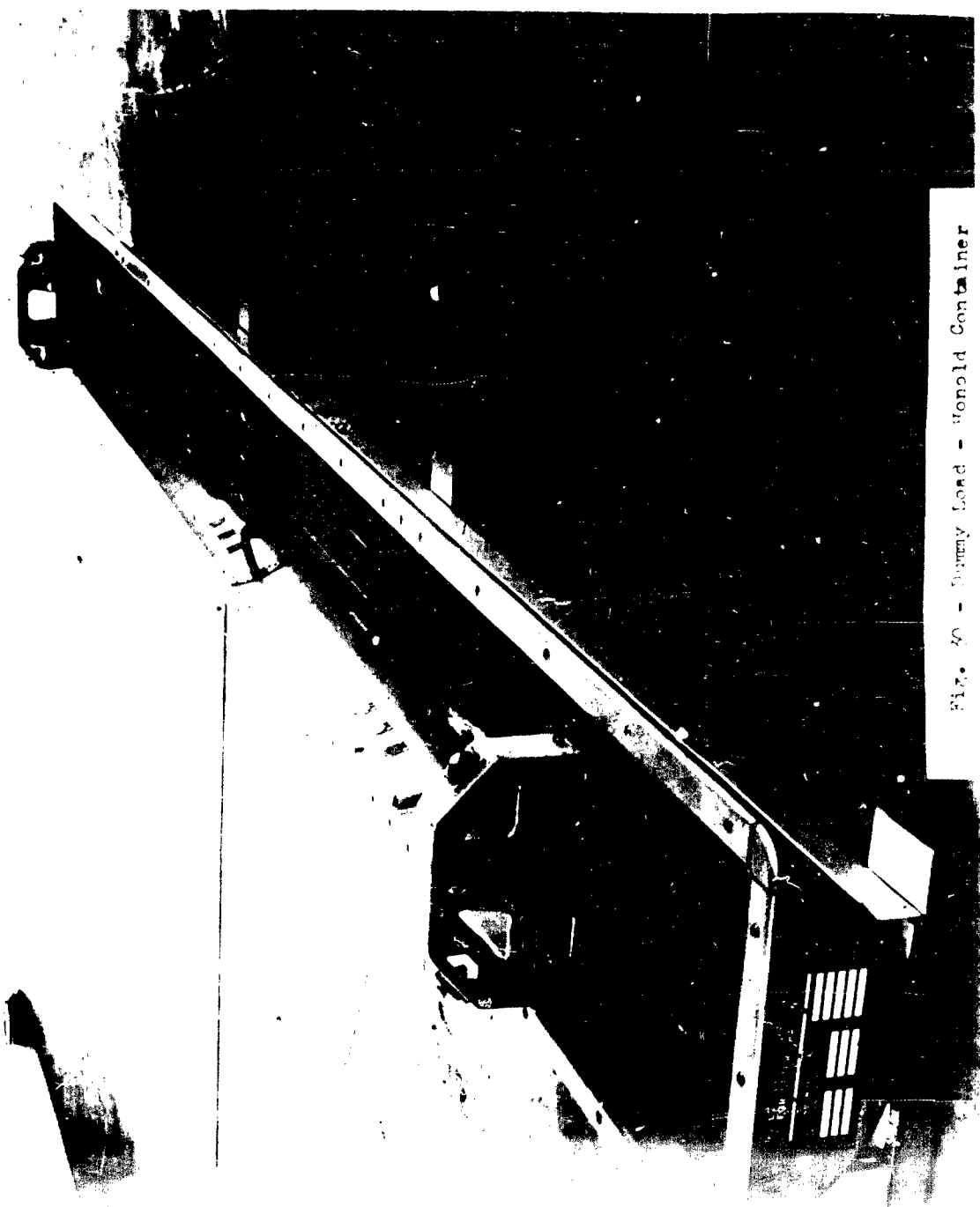


Fig. 40 - Dummy Load - Monold Container

the end of the 18 in. drop (see Figs. 31 and 32). It was also found that the "Camloc" fasteners used to fasten the two halves together were in general very difficult to lock and unlock and were torn loose from the mounting flange rather easily (Fig. 33). Materials Laboratory Technical Note No. WCRTC 52-13, dated 12 June 1952, (Ref. 6) concerning the Honold container tests recommended that a different skid design be utilized that would not be subject to bending and crushing and that a different type of fastener be utilized that would not be as easily susceptible to damage as the presently used "Camlocs."

With the above mentioned improvements incorporated in the Honold container, it is felt that it would prove to be an excellent container for the shipment of small sized rotor blades. It must be stated, however, that the Honold container does not meet the requirements set up, for it is not demountable and is not extensible and, as has been stated, failed to pass the drop-cornerwise tests.

CONCLUSIONS

The container developed by Kellett under Air Force Contract #F33(038)-12757 meets the requirements as originally set up in the subject contract. The container passed the third series of drop tests and incurred only minor damage. Although major damage was incurred by the exterior of the container during shipping tests, the interior and the blades remained unharmed. It appears that should such a container be put into production, it would be necessary to secure a more adequate bonding material to secure the skin to the frame and the honeycomb. It is concluded that for mass production purposes a single size or a standard length panel should be utilized instead of the two lengths utilized in the present container. The development of the Simmons "Dual-Lock" which occurred as a result of the subject container development is significant. As a quick connect and disconnect device it is very adequate. It appears that many applications of this positive locking device may be found in the packaging field.

It is felt that the Kellett container is overweight (875 pounds when loaded for shipment with R-6 blades, as compared with 420 pounds for the Honold container when loaded) and could be lightened without sacrificing strength.

The Honold container appears adequate for the job for which it was designed; i.e., for shipment of small radius rotor blades. The skids utilized on the Honold container are not adequate, but could easily be modified to withstand impact loading without crushing. It is felt that in view of the results of the shipping tests on the Kellett container, perhaps the gage of metal utilized in the construction of the Honold container is too thin and will be easily crushed if subjected to rough handling such as was experienced by the Honold container during the shipping tests.

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Fig. 31 - Failed Skid - Monold Container

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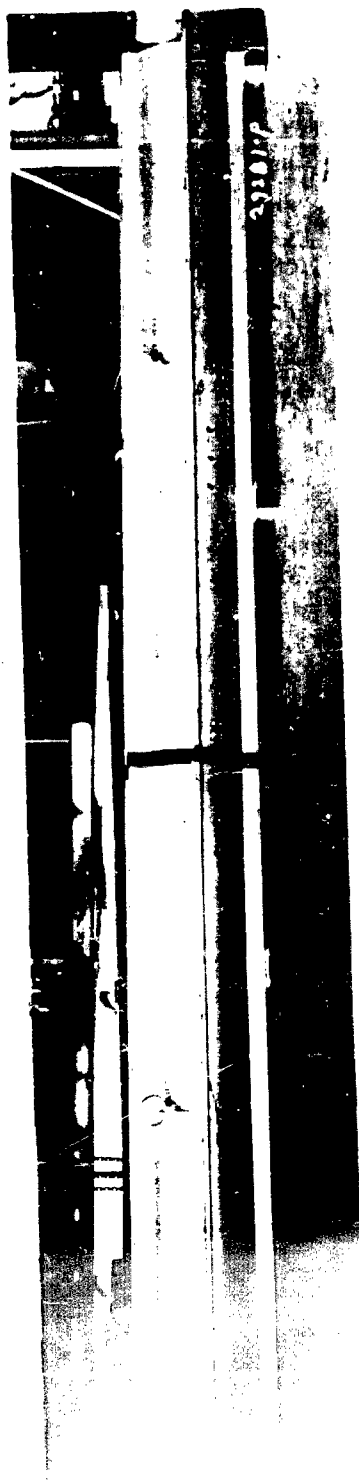
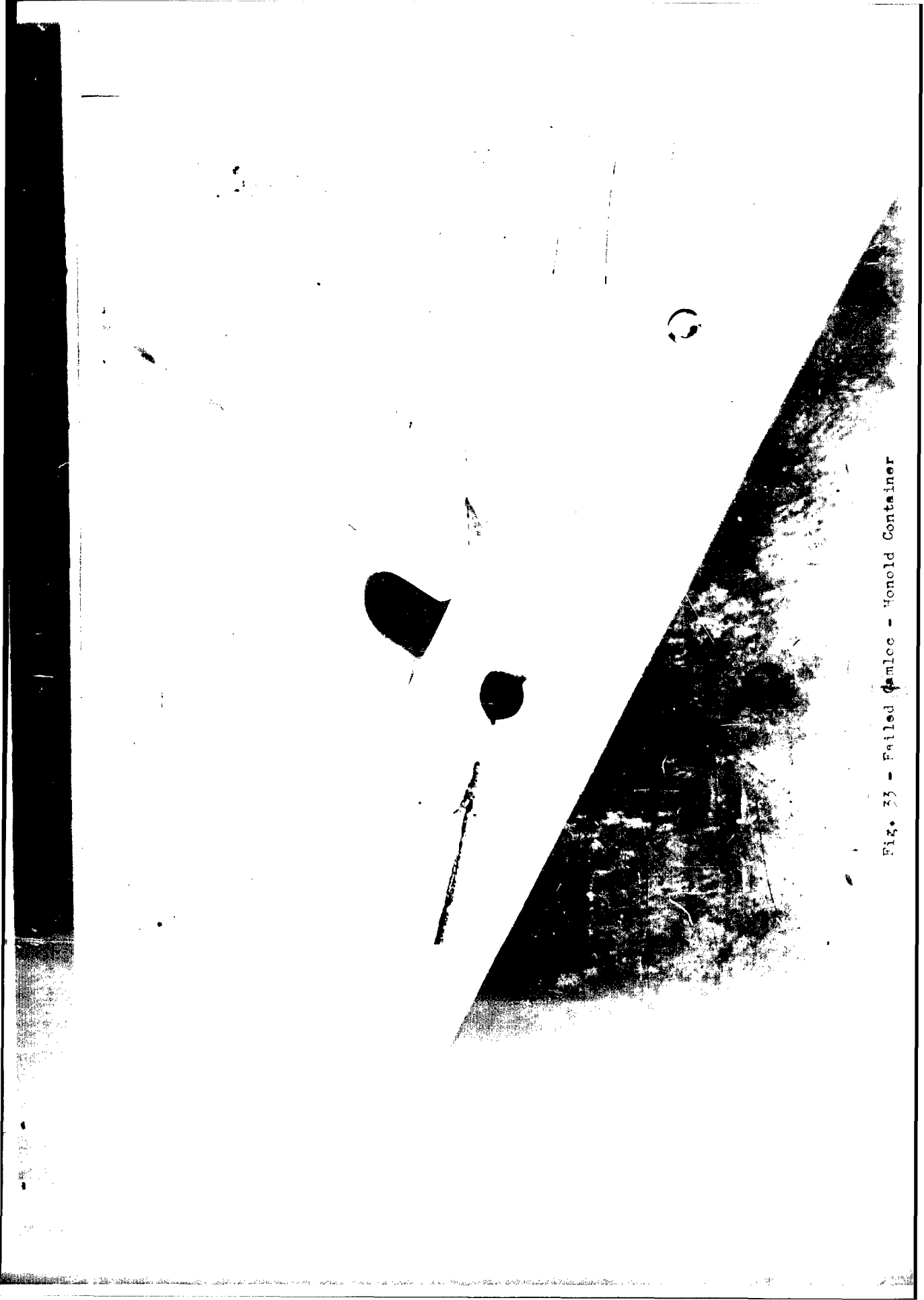


Fig. 33 - Failed Camlock - Monold Container



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