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The objective of the project was to establish the necessary production equipment requirements to set up a production facility to produce an expanded polyurethane pull-on type insulated boot and included the selection, evaluation, and design of equipment using standard process engineering practices and procedures. This report contains a boot manufacturing technique using liquid polyurethane injection molding equipment, a production process description with a flow chart and typical production layout; manning requirements; material and

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formula listings with purchasing, mixing, and storage requirements, physical properties requirements, acceptance standards with quality control procedures, equipment requirements with drawings where required, and other information that would be necessary to set up a manufacturing facility.

A

I. SUMMARY

The production methods contained in this report will provide a manufacturing line capable of producing 9 pair per hour minimum of completed lightweight insulated boots.

The method being proposed for automated production of lightweight insulated boots consists of premolding the boot outsole on an outsole injection molding machine, using a 12-station rotary unit with a two-stream injection unit. The molds will be heated and the injector will be equipped for heating/cooling of compounds. The outsoles will then be inspected and transported to the upper molding unit. The upper molding unit will be of the rotary type with electrically heated mold carriers, and will be equipped with a three-stream injector which is equipped to heat or cool the compounds. The outsole will be placed in the boot mold and the boot upper injection-molded to the outsole. The advantages of this method versus the use of one large machine capable of performing both functions are: manufacturing rate is increased; possibility of the high density outsole foam overlapping the upper foam is eliminated; allows for 100% weight/density inspection of the outsoles prior to molding the upper; buffing of the bottom edge of the outsole is eliminated; and mold costs may be reduced.

It has been determined that the Ransburg electrostatic coating method is the best method of coating the boots. The basic principle is to pump two components to a spinning disc, mixing the components just prior to depositing in a well located in the center of the disc. The disc can be programmed to raise and lower in order to deposit the coating where desired from top to bottom; i.e., about 35 mils just above the outsole to 10 mils at the top of the boots. The spinning disc "sprays" the coating toward the rotating boot and is electrostatically attracted to the boot.

Production methods and process descriptions were prepared and a boot fabrication technique developed. Manning requirements were determined, a list of materials was prepared, and chemical storage requirements determined. Boot acceptance standards, packaging methods, and warehousing requirements were proposed. User instruction tag, mold requirements, typical equipment layout, operations process chart, and last grading schedules were developed. Equipment requirements were tabulated.

II. PREFACE

The insulated boot, currently used by the Armed Services, is fabricated by techniques that are becoming obsolete in the footwear industry. The procedure involves many hand operations and in the case of the insulated boot, consists of the hand lay-up of 44 component pieces over a footwear last. The various parts are formed into an integral unit through the use of adhesives and the building tack inherent in the rubber compounds used. The resultant boot is functionally adequate but suffers from the drawback of excessive weight. The wool fleece now used in the standard insulated boots provides satisfactory insulation in undamaged boots; however, when the outer protective layer of the boots is punctured or torn, the wool fleece absorbs moisture, resulting in a rapid loss of insulating properties.

An expanded polyurethane pull-on type insulated boot consisting of five component parts has been developed. This new insulated boot weighs approximately 830 grams per boot in size 10R, as compared to approximately 1300 grams for the standard insulated boot. Experimental boots have been produced on manually operated pilot plant equipment.

There is no known industrial capability for mass production of the new insulated footwear in accordance with present design and physical property requirements. This report describes the work performed during the period 15 October 1975 to 1 June 1977 under continuation of a program previously initiated with Uniroyal Incorporated. Under the guidance of Project Officer Joseph E. Assaf, US Army Natick Research & Development Command, the establishment of production equipment requirements and the selection and evaluation of production equipment was performed by Uniroyal Incorporated, Naugatuck, Connecticut. The work was conducted under Project 7758035 Automated Production of Insulated Footwear under contract No. DAAG17-76-C-0016.

The Project Officer wishes to acknowledge the valued suggestions of Dr. Roy C. Laible, Chief of the Polymers & Organic Materials Branch of the Clothing, Equipment and Materials Engineering Laboratory and the guidance of Mr. Douglas S. Swain, Footwear Technologist at NARADCOM relative to design considerations.

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FIGURE 1: POLYURETHANE INSULATED BOOT

AUTOMATED PRODUCTION OF INSULATED FOOTWEAR

V. BOOT MANUFACTURING TECHNIQUE

The boot consists primarily of an outsole, upper, leg lining, outer coating and snow collar. In production the outsole is molded as a separate unit in a Desma 700 series or 1500 series, injection or pour machine by injecting or pouring the polyurethane compound into a mold which is maintained at a temperature of 190°F (88°C). The outsole is then cured for 15 minutes in the closed mold. The letters U.S., size and width are molded into the shank of the outsole. After the 15 minute cure time, the mold is opened and the outsole removed. The mold is brushed clean of any flash and prepared for the next molding. The outsole is trimmed, buffed, weighed and inspected. After inspection, approved outsoles are placed in an inventory bank to be used in subsequent processing.

The boot leglining and socklining are made of 1830/1 black, urethane coated nylon tricot weighing $4.8 ^{+0.5}_{-0.3}$ ounces per square yard ($162.8 ^{+17}_{-10.2}$ grams per square meter). These parts are clicker cut from roll stock using dies graded from the size 10R cutting pattern (Figure 12). The leg lining will be folded and the front seam edge closed, using a merrow style A-3-3 stitch, with a loose thread tension at eight stitches per inch (2.54 cm). The proper sized socklining is then stitched to the bottom of the leglining, using a merrow style A-3-3 stitch, with a loose thread tension at eight stitches per inch (2.54 cm). The coated side of the lining is to be placed to the inside on both parts. Number 69 black nylon thread is used in all stitching operations. The completed lining unit is then hooded over the last with the nylon side to the last. The polyurethane coated surface is wiped with vythene to remove any surface contamination, and the stitched seams are taped over with 3M scotch electric #29 tape 1/2" (1.27 cm) wide. A preheated outsole (170°F 76°C) is placed in the bottom of the mold cavity. The boot last with its lining assembly is lowered into the mold cavity and the mold is closed. The last is kept heated to 250°F (121°C), and the mold temperature is maintained at a temperature of 170°F (76°C). The polyurethane is then injected into the mold cavity defined by the bottom of the last and the top of the outsole. The sole plate (outsole portion of the mold) is raised, forcing the injected polyurethane into the space defined by the mold walls and the last sides. The foaming action of the polyurethane compound completes the mold fill. The molded boot is then cured for 17 minutes in the closed mold. At the completion of cure, the mold is opened, the last raised, and the boot removed from the last. The flash is then removed from the boot using a rubber roll buffer, inspected and repaired, if necessary. The repair procedure consists of routing out the bad areas, filling with repair compound and curing the repaired boot for ten minutes in a hot air oven at a temperature of 140°F (60°C). After curing, the repaired section is buffed into a smooth contour with the adjoining areas. Approved boots are then stored on boot trucks in an in-process bank prior to the electrostatic spray coating process.

In preparation for electrostatic spray coating, the boot is damp-wiped with methyl ethyl ketone over its entire outside surface, with the exception of the bottom of the outsole, to remove any surface contamination. A release agent (Stapler Wax) is applied to the vamp-throat area. The release agent is then allowed to dry at room temperature for 15 minutes. The boot is hooded over a metal support form (short last) and a vacuum-formed polyethylene spray mask is tacked over the bottom of the outsole of the boot, using two thumb tacks or two pieces of double-sided tape. The boot is then attached to the Ransburg electrostatic spray monorail. The boot is then passed through the electrostatic spray system where the boot is sprayed with a polyurethane coating compound for 12 minutes. During spraying the metal support form is grounded and the polyurethane spray is given an electrically positive charge to attract the spray coating to the surface of the boot.

The boot is then allowed to air-dry for 24 minutes at room temperature to allow the solvent to evaporate. The boot is then passed through a hot air cure oven for 24 minutes. The oven temperature is maintained at 250°F (121°C) for the duration of the cure. The boot is then allowed to air-cool at room temperature for 16 minutes. The metal support form and polyethylene spray mask are removed from the boot, and the boot is placed on a boot dryer truck (60-pair capacity). When the truck is full, it is placed in a final solvent evaporation oven for 12 hours. The final solvent evaporation oven is a hot air oven which is maintained at a temperature of 160°F (71.1°C) with a capacity of 180 pair of boots. After the boots are removed from the final solvent evaporation oven, they are allowed to cool at room temperature for one hour, and are trimmed to the proper height - 10 1/4" (26 cm) minimum. After trimming, the boot is moved to the finishing area where the collar is attached.

In the collar operation, the appropriate size collar is clicker cut from roll stock 1830/1 black, urethane coated nylon tricot weighing $4.8^{+0.5}_{-0.3}$ ounces per square yard ($162.8^{+17}_{-10.2}$ grams per square meter) using dies graded from the size 10R cutting pattern (Figure 13). After cutting the collar is eyeletted, centered to a die-cut location hole using a United Shoe Machinery Corp. Model B eyeletter with washer type eyelets. There are two eyelets and two washers per collar and the eyelet must be on the nylon tricot. With a one-half (side) part of the collar laid flat, nylon side up, and the eyelet to the left, and size notches to the bottom the contractual markings are stamped onto that part which is approximately 1" (2.54 cm) below the eyelet and centered within this area using white ink. With this side collar so stamped and placed, a mated side panel (not stamped) is placed over the first side, nylon-to-nylon. The curved side edges are then single-needle, lock-stitched together, using a Singer Model 168 post-seamer or similar machine. A stitching margin of 1/8" (0.32 cm) and a setting of eight stitches per inch (2.54 cm) are maintained. With the eyelets centered to the front position and the collar backseam centered at the rear of the boot top, the inside bottom edge of the collar is then attached to the inside of the top edge of the boot with the inside edge of the collar overlapping the inside top edge of the boot with a 1/4" (0.635-cm) margin, using an Ozan overedge sewing machine set at six stitches per inch (2.54 cm). A 36-inch (91.44-cm) black tubular cotton lace with black acetate tip is inserted through the eyelet, looping it around the collar. The top part of the collar is folded down overlapping the top outside edge of the boot by 3/4" (1.9 cm) and zig-zag stitched at six stitches per inch (2.54 cm) with a 1/8" (0.32-cm) minimum/1/2" (1.27 cm) maximum stitching overlap using a Singer Model 107W50 sewing machine. At the backseam of the collar, approximately 1" (2.54 cm) down from the folded top edge and lace, the collar is bar-tack stitched together, horizontally to the top edge for a distance of approximately 1" (2.54 cm), using a Singer Model 269 bar-tacker sewing machine. Each end of the lace is then double-loop tied to prevent it from pulling back through the eyelet.

Approved boots thus finished are final inspected, mated left foot to right foot of the same size and width, the nylon collar and lace turned down inside the boot, and transported to the packing area.

VI. PRODUCTION PROCESS DESCRIPTION

The proposed production process developed under this contract for automated production of lightweight insulated boots will require approximately 9500 square feet (882 square meters) of floor space and consists of:

1.	Major storage area	580 square feet (53.9 m^2)
2.	Shipping and receiving area	225 square feet (20.9 m^2)
3.	Compound mixing area	318 square feet (29.5 m^2)
4.	Laboratory and testing area	120 square feet (11.2 m^2)
5.	Rest Rooms and self-service cafeteria	242 square feet (22.5 m^2)
6.	Office area	144 square feet (13.4 m^2)
7.	Warehouse (400 cases - 2400 pair)	800 square feet (74.3 m^2)
8.	Boot production area	5943 square feet (552.1 m^2)
9.	Boot coating area	1128 square feet (104.8 m^2)

Depending upon where the line is located, some of the above required areas could be integrated with existing operations. (See attached layout Figure 7)

The following process outline and attached operations process chart Figure 6 covers the proposed processing sequence required to produce the lightweight insulated boots.

1. Material Storage:

   A. See chemical storage requirements Section XII for raw material storage and handling details.

   B. See in-process chemical storage requirements Section XIII for chemical storage and handling details.

2. Compound Preparation: 8-hr shift basis (See compound preparation Section XV for detailed analysis of compound formulations, mixing instructions, usage rates, and batch size determinations).

2. A. Upper Formulation:

a. **Propolymer** - upper component "A"

Place 5-gallon (18.9-liter) pail of 10% NCO PTMG prepolymer into 150°F (65.6°C) hot water bath. When the prepolymer is melted, empty the 5-gallon (18.9-liter) pail into the 5-gallon (18.9-liter) upper component "A" mixing tank and cap the tank with dry nitrogen. Set tank temperature control to 220°F (104.4°C) and turn on tank agitator. When the prepolymer reaches (104.4°C) 220°F continue to agitate for 15 minutes. The prepolymer is now ready for use.

b. **Hardener** - upper component "B"

Draw off the necessary amount of melted PTMG from drum in storage oven and place in upper component "B" mixing tank. Set "B" mixing tank temperature controller to 150°F (65.6°C). Melt preweighed amount of TMP in a container on 150°F (65.6°C) hot plate and pour into "B" component mixing tank. Weigh and add 1-4 BD, DC-193, T-12, and 901CO2 into "B" component mixing tank. Raise mixing tank temperature control to 220°F (104.4°C) and cap tank with dry nitrogen. When the material temperature reaches 220°F (104.4°C) continue to agitate for 45 minutes. The hardener is now ready for use.

c. **Blowing Agent** - upper component "C"

Set upper component "C" mixing tank temperature controller to 60°F (15.6°C). Weigh and add santicizer 140 into mixing tank. Remove Lacel-4 from freezer, weigh out required amount and add into mixing tank. Immediately return remainder of Lacel-4 to freezer. Turn on mixing tank agitator and cap tank with dry nitrogen. Agitate for 15 minutes at 60°F, (15.6°C), then reset tank temperature controller to 50°F (10°C) and continue to agitate. When blowing agent temperature reaches 50°F, (10°C), it is ready for use.

B. Outsole Formulation:

a. **Propolymer** - outsole component "A"

Remove 5-gallon (18.9-liter) pail of 15% NCO PTMG prepolymer from cold storage room and place into 150°F (65.6°C) hot water bath. When

2. B. Outsole Formulation: (continued)

a. Prepolymer (continued)

the prepolymer is melted, empty the 5-gallon (18.9-liter) pail into the 5-gallon (18.9-liter) outsole component "A" mixing tank and cap tank with dry nitrogen. Set tank temperature controller to 165°F (73.9°C), and turn on agitator. When the prepolymer reaches 165°F (73.9°C), continue to agitate for 15 minutes. The prepolymer is now ready for use.

b. Hardener - outsole component "B"

Draw off the necessary amount of melted PTMG from drum in storage oven and place in outsole "B" component mixing tank and tank temperature controller to 150°F (65.6°C). Turn on "B" mixing tank agitator. Weigh and add 1-4 BD, DC-193, DABCO WT, water, T-12 and 90PC02 to PTMG in mixing tank. Set mixing tank temperature controller to 165°F (73.9°C), and cap tank with dry nitrogen. When the material temperature reaches 165°F (73.9°C), continue to agitate for 45 minutes. The hardener is now ready for use.

C. Outer Coating

a. "A" Component

Weigh and add the required amounts of THF and Perchloroethylene to the "A" component coating mixing tank. Turn on the tank agitator. Draw off the necessary amount of melted B-602 from the drum in the storage oven and pour into mixing tank. Cap tank with dry nitrogen and mix for 30 minutes. The coating "A" component is now ready for use.

b. "B-1" Component

Weigh and add the required amounts of MDA, THF and CT-Black to the outer coating "B-1" component mixing tank. Turn on tank agitator and blanket tank with dry nitrogen. Mix for 15 minutes.

c. "B-2" Component

Weigh and add the required amounts of THF and DIBK to the outer coating "B-2" component mixing tank. Turn on tank agitator. Draw off the necessary amount of melted B-602 from the drum in the storage oven and pour into the mixing tank, cap tank with dry nitrogen and mix for 30 minutes.

2. C. Outer Coating (continued)

d. "B" Component

After the "B-1" and "B-2" components are mixed, connect the transfer hoses between the outlet of the "B-1" and "B-2" tanks and the inlets of the "B" tank. Open the vent valve on the "B" tank and check to see that the agitators are operating in all tanks. Pressurize the "B-1" and "B-2" tanks to 5 psi with dry nitrogen. Open the outlet valve from the"B-1" tank and the inlet valve to the "B" tank, allowing the material in the "B-1" tank to flow to the "B" tank. After the material transfer is complete, close the inlet valve to the "B" tank and the outlet valve of the "B-1" tank. Open the outlet valve from the "B-2" tank and the inlet valve to the "B" tank, allowing the contents of the "B-2" tank to slowly transfer to the "B" tank. After material transfer is complete, close the "B-2" tank outlet valve and the "B" tank inlet valve. Shut off the nitrogen pressure to tanks "B-1" and "B-2." Cap the "B" tank with dry nitrogen and agitate for 30 minutes. The outer coating compound "B" component is now ready for use.

3. Prepare Collar:

A. Cut collars - clicker machine

B. Stencil required information on collars

C. Eyelet collars

D. Seam collars

E. Deliver stitched collars to boot finishing area

4. Prepare Socklining:

A. Cut sockliner - clicker machine

B. Cut legliner

C. Close stitch legliner

D. Join sockliner

E. Deliver liner to upper molding area

5. Mold Outsole:

A. Clean mix head

5. **Mold Outsole:** (continued)

   B. Set ratio on LIM for 100 (A) component: 85.4 (B) component

   C. Check ratio in cup shot - adjust if required

   D. Check cup batch for mix, cream, rise and tack-free time. See Section XV Item 8-A for details

   E. Inject outsole mold

   F. Cure outsole 15 minutes at 190°F (84°C)

   G. Open mold - strip outsole

   H. Trim - buff - inspect outsole

   I. Weigh outsole

   J. Bank outsoles

   K. Deliver outsole to Desma boot molding preheater

6. **Mold Upper to Outsole:**

   A. Clean mix head

   B. Set ratio on upper LIM for (A) 100: (B) 52.4: (C) 12.5

   C. Check ratio in cup shot - adjust if required

   D. Check cup batch for cream, rise, and tack-free time. See Section XV Item 8-B for details

   E. Hood sockliner on last

   F. Wash socklining with Vythene (chlorinated solvent)

   G. Apply tape to socklining seams (3M #29)

   H. Position last in boot mold (set at 250°F, 121°C)

   I. Place heated (170°F, 76°C) outsole in boot mold cavity

   J. Close mold

   K. Inject foam

   L. Cure foam (17 minutes at 170°F (76°C) mold; 250°F (121°C) last)

   M. Open mold

   N. Strip boot

6. Mold Upper to Outsole: (continued)

    O. Buff flash

    P. Deliver to inspection station

7. Remove Flash, Inspect and Apply Outerskin

    A. Remove flash from boot outsole and upper

    B. Buff outsole side wall and mold joint lines

    C. Inspect

    D. Repair
    Rout out bad areas
    Fill with repair compound
    Cure (10 minutes - 140°F) (60°C)
    Buff to contour

    E. Bank boots

    F. Set up pumping unit on electrostatic spray unit

    G. Damp wipe boot with MEK

    H. Apply vamp patch - (dry 15 minutes RT)

    I. Slip boot over metal form

    J. Attach to overhead conveyor

    K. Spray boot (electrostatic spray) 12 minutes

    L. Dry - circulating air RT 10 minutes

    M. Cure - 250°F (121°C) oven 20 minutes

    N. Cool - circulating air RT 10 minutes

    O. Strip boot

    P. Deliver to trim and pack area

8. Trim, Final Inspect, Pack:

    A. Trim boot to proper height - 10½" (26.7 cm)

    B. Stitch collar to boot

    C. Pull out collar - insert lace

    D. Stitch collar to outside of boot

    E. Bar tack collar

8. <u>Trim, Final Inspect, Pack</u> (continued)

   F. Final inspect

   G. Pack

   H. Deliver to warehouse

VII. MANNING REQUIREMENTS

The following breakout is the thinking of the Uniroyal Industrial Engineering Department pertaining to the manning and operating of a facility for production of polyurethane lightweight insulated boots for the United States Army. It provides for the maximum production rate of 15 pair per hour under ideal conditions. No provisions are made for mold changes, unit setups, or mechanical or other downtime. It is based on comprehensive studies made of the actual stitching and molding methods used in the manufacturing of the boot, along with the application of standard industrial engineering practices and production experience.

The manning charts are for a facility other than a present contractor's plant. If this manufacturing line were located within a present contractor's facility, some of the required operations could be integrated with existing operations, thus eliminating the need for specific operators.

One Shift	Operators
Receiving-Shipping-Warehouse	1
Mix-Testing-Service	1
Utility Operators	1
Cut-Stencil-Eyelet-Stitch	2
Mold Outsoles	2
Mold Boots	2
Repair-Finish	1
Apply Boot Coating	1
Finish-Pack-Service	2
	13
Supervision	1
General Mechanical Coverage	1
Plant Protection	1
	3
One Shift Total....................	16

Three Shifts	Operators
Receiving-Service	1
Mix-Test-Cut-Stencil-Eyelet	4
Utility Operators	4
Mold Outsole-Service	6
Mold Boots-Service	6
Repair-Finish	6
Apply Boot Coating	3
Finish-Pack-Warehouse	4
	34

Three Shifts	Operators	(contd.)
Supervision	3	
General Mechanical Coverage	3	
Plant Protection	3	
	9	
Three Shift Total	43	

Supervision will consist of technically qualified personnel responsible for Management, Compounding and Testing. Mechanical coverage will be qualified electrical and hydraulic personnel. Plant Protection will also be responsible for Plant Cleaning and Maintenance.

VIII. LIST OF MATERIALS WITH PURCHASING SPECIFICATIONS

1.	LACE	Tubular Cotton, pressed flat Single end 64 Braiders per inch (25.2 braiders per cm) 22 Picks per inch (8.7 picks per cm) Size 20, 2-Ply Construction 18.75 Gross Yards per lb (37.5 m^2/kg) 112 lbs minimum tensile (50.9 kg) Tips - 0.010 ga. (0.254 mm) Clear Acetate 5/8" (1.59 cm) long
	SOURCE:	UNIROYAL, Inc., Naugatuck, CT
2.	EYELET	Type: Telescopic with Roll Setting Barrel Material: 0.011 ga. Aluminum (0.28 mm) Finish: Japaned Tumbled with Black Enamel Outside Diameter of Flange: 0.460" ± 0.006 (12 mm ± 0.15) Outside Diameter of Barrel: 0.228" ± 0.003 (5.8 mm ± 0.07) Overall Length: 0.195" ± 0.008 (4.9 mm ± 0.2)
	SOURCE:	Plymouth Div. Emhart Corp. New Bedford, MA
3.	WASHER	Type: Telescopic with Barrel Set and Scored Material: 0.009" Aluminum (0.23 mm) Outside Diameter of Flange: 0.445" ± 0.006 (11.3 mm ± 0.15) Outside Diameter of Barrel: 0.217" ± 0.004 (5.5 mm ± 0.1) Overall Length: 0.140" ± 0.008 (3.6 mm ± 0.2)
	SOURCE:	Plymouth Div. Emhart Corp., New Bedford, MA
4.	LASTING TAPE	Width: 1/2 inch (1.27 cm) Type: 3M Scotch Electric #29
	SOURCE:	Minnesota Mining & Manufacturing Co. St. Paul, MN
5.	THREAD	Nylon 69 Type II 3-ply Bonded Construction Size: E Final Twist: 5.0 twists per inch (2.54 cm) min. Length Per lb (0.46 kg): 5000 yd (4572 m) min. Breaking Strength: 8.5 lb (3.86 kg) min. Class I Elongation: 22% of maximum
	SOURCE:	Threads, Inc., Lawrence, MA

6. CHIPBOARD TUBE	0.040 ga. (1 mm) x 9" (23 cm) long x 6" (15.2 cm) diam.
SOURCE:	Stonington Paper Tube Co., Inc. East Hampton, MA
7. PRINTED INSTRUCTION TAG	6-1/2" (16.5 cm) x 5-1/2" (14 cm) folded to 3-1/4" (8.3 cm) x 5-1/2" (14 cm) 3/8" (0.95 cm) hole in upper left hand corner near fold, printed on four pages (see user instruction tag Section XX-10)
SOURCE:	Any local printing company
8. WHITE TISSUE PAPER	15" (38 cm) x 24" (61 cm)
SOURCE:	Walker-Goulard-Tellm Co., New York, N.Y.
9. CARTON	Plain Kraft, Printed Front Panel, Die-Cut, Self-locking CF, SW, B Flute, 200 lb Test (90 kilos) I.D. 18-1/4" L (46.5 cm) x 11" W (28 cm) x 5-13/16" D (14.8 cm) 1/pr
SOURCE:	Allied Container Corp., Newtown, CT
10. WATER SENSITIVE GLUED TAPE	3" Wide (7.6 cm), 60 lb, (27 kilograms), 3" pr
SOURCE:	Industrial Paper Co., Waterbury, CT
11. CASE	Plain Kraft, Printed Side Panel CF, RSC, SW, 275 lb Test (125 kilos) Stitched Joint, Tab-Out I.D. 37" L (94 cm) 19-5/8" W (50 cm) x 11-1/4" D (28.5 cm) O.D. 37-1/4" L (94.5 cm) x 19-7/8" W (51 cm) x 12-1/8" D (31 cm) 5.2 cu ft 0.15 cu meters
SOURCE:	Allied Container Corp., Newtown, CT

12. **SOCKLINER, LEGLINER AND COLLAR**

The following are specifications recommended for the sockliner and collar. This is based primarily on data submitted by both Gehring Textile for the fabric and Reeves Brothers for the coated fabric.

Physical Property	Test Method	Requirement
Reeves Style (coated) Construction		A05-010-000-540[1] Clear Polyether Polyurethane Coated Nylon Tricot
Weight (oz/sq yd)	FED-STD-191 (5041)	$4.8 {}^{+0.5}_{-0.3}$ (163 + 17 −10 gm/sq m)
Width (inches)	FED-STD-191 (5020)	52 (132 cm)
Gauge (inches)	FED-STD-191 (5030)	0.012 min. (0.3 mm)
Breaking Str. (lb) Warp X Fill	FED-STD-191 (5100)	70 x 70 min.(312N X 312N)
Elongation at 10 lb(%) Warp X Fill	FED-STD-191 (5100)	20 x 25 min.
Tear, Elmendorf, Grams	FED-STD-191 (5132)	1200 min.(11.8N)
Coating Adhesion, lb/inch Width	FED-STD- 601 (8211)	4.0 min. (7 N/cm)
Air Retention (Porosity)	Reeves ten inch (25.4 cm) diam. disc. with 1" (2.54 cm) inflation	No Leaks

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[1] Uncoated fabric is nylon tricot net (black) 2.4 oz/sq yd (81 g/sq m) 52" wide (132 cm) and count(Wales X Courses/inch) of 38 x 55 (min.) Gehring Textile Co. style 4112M.

SOURCE: Reeves Brothers, Inc., New York, NY

13. **OUTSOLE SPRAY MASK**

0.025 " (0.64 mm) polyethylene sheet - sheet size to suit the type of thermoformer used.

SOURCE: Cadillac Plastics Co., Detroit, MI

IX. MATERIAL LISTING - CHEMICALS

MATERIAL (TRADE NAME)	CHEMICAL NAME	SOURCE
Butanediol	1-4 Butanediol	GAF Corporation
Dabco WT	Tertiary Amine Catalyst	Air Products & Chemical, Inc.
DC-193	Silicone Surfactant	Dow Corning Co.
DIBK	Diisobutyl Ketone	Eastman Chemical Co.
Lucel-4	AZO Foaming Agent	Lucidol Chemicals
MDA	Methylene Dianaline	Dow Chemical Co.
MDI	Diphenylmethane - Diioscyanate	Mobay Chemical Co.
MEK	Methyl Ethyl Ketone	Celanese Chemical Co.
Methylene Chloride	Methylene Chloride	Dow Chemical Co.
Microlith Black CT	Black Pigment	Ciba Geigy
Nonstickenstoffe	Release Agent	Contour Chemical
90PC02 Black Pigment	Black Pigment Paste	Harwick Chemical Co.
Perchloroethylene	Tetrachloroethylene	Ashland Chemical
Polymeg 2000 (PTMG)	Poly Tetra Methylene Ether Glycol	Quaker Chemical Co.
Santicizer S-140	Cresyl Diphenyl Phosphate	Monsanto Chemical Co.
Stapler Wax	Mixture of Waxes	P.F. Staples & Co.
T-12	DiButyl Tin Dilaurate	M&T Chemical, Inc.
Toluene	Toluene	American Cyanamid

MATERIAL (contd.)

(TRADE NAME)	CHEMICAL NAME	SOURCE
THF	Tetrahydrofuran	DuPont, Inc.
TMP	Tri Methylol Propane	Celanese Chemical Co.
Vibrathane B-602	Polyether, Urethane Prepolymer	Uniroyal Chemical Division
Vythene	111 Trichloroethane	Dow Chemical

X. TYPICAL CHEMICAL PROPERTIES

The following is a listing of the typical properties of the chemical used in the manufacturing of the lightweight insulated boots as supplied by the manufacturers.

1. 1-4 BUTANEDIOL - ANHYDROUS GRADE AS MANUFACTURED BY G.A.F. CORPORATION

Specific Gravity	1.012 to 1.016
Equivalent Weight	45
Purity (minimum)	99.4%
Solidification Pt°C	19.3
Boiling Point	221 to 231°C
Viscosity @ 25°C	65 to 70 cps
Water Level	0.04%

2. DABCO WT AS MANUFACTURED BY AIR PRODUCTS AND CHEMICALS

Color	Amber
pH (2% aqueous solution)	4.5 ± 0.03
Water Level Maximum	3.7%
Viscosity @ 23°C	165 ± 15 cps
Flash Point	129°C
Pour Point	-37°C
Specific Gravity	1.167

3. DC-193 AS MANUFACTURED BY DOW CORNING

Viscosity @ 25°C	465 cps
Specific Gravity @ 25°C	1.07
Refractive Index @ 25°C	1.4515
Color - Gardner	2
Flash Point - Open Cup	204°C

4. DIISOBUTYL KETONE AS MANUFACTURED BY EASTMAN CHEMICAL COMPANY

Specific Gravity @ 20°C	0.807 to 0.814
Boiling Range (760mm):	Initial 163°C Dry Point 173°C

Flash Point:	TAG closed cup	49°C
	TAG open cup	55°C
Refractive Index		1.4230

5. LUCEL-4 AS MANUFACTURED BY LUCIDOL CHEMICALS (See Section XI)

Assay	90% min.
Form	Liquid
Color	Light Yellow
Freezing Point	<-78°C
Specific Gravity @ 20°C	0.86
Seta Flash Point (ASTM D-3243-73)	< 25°C

6. MEK AS MANUFACTURED BY CELANESE CHEMICAL COMPANY

Boiling Point	77°C to 82°C
Weight	6.95 lb/gallon (834 gm/liter
Molecular Weight	72.1
Specific Gravity	0.805
Flash Point - Closed cup	1.1°C

7. METHYLENE DIANILINE AS MANUFACTURED BY METHESON, COLEMAN, AND BELL

Formula Weight	198.2
Melting Point	90°C to 92°C

8. DIPHENYL METHANE DIISOCYANATE AS MANUFACTURED BY MOBAY CHEMICAL COMPANY

Isocyanate Equivalent	125.5
NCO Content by Weight	33.4%
Acidity, as HCL	0.003%
Viscosity @ 43°C	5 cps
Molecular Weight	250
Specific Gravity @ 43°C	1.225

9. 90PC02 BLACK PIGMENT AS MANUFACTURED BY HARWICK CHEMICAL COMPANY

Pigment	7.8%	
Dioctyl Phthalate	51.7%	
Paraplex G-50	40.5%	
Weight/Gallon	8.78 lb	(5.1 kg/liter)
Specific Gravity	1.05	

10. PERCHLOROETHYLENE AS MANUFACTURED BY ASHLAND CHEMICAL

Specific Gravity	1.627
Distillation Range (^{o}C)	2.0 max. including 121.0
Flash Point	None
Refractive Index @ 25^{o}C	1.503

11. POLYMEG 2000 (PTMG) AS MANUFACTURED BY QUAKER CHEMICAL COMPANY

Molecular WT	2000 ±100
OH Number	53-59
Acid Number	0.05 maximum
Moisture %	0.03 maximum
Volatiles %	0.10 maximum
APHA Color	90

12. PTMG UPPER PREPOLYMER AS MANUFACTURED BY UNIROYAL, INC.

Percent Free NCO	10.0 ±0.2
Amine Equivalent	412 to 428
Specific Gravity	1.09

13. PTMG OUTSOLE PREPOLYMER AS MANUFACTURED BY UNIROYAL, INC.

Percent Free NCO	15.0±0.2
Amine Equivalent	276 to 283
Specific Gravity	1.10

14. SANTICIZER S-140 AS MANUFACTURED BY MONSANTO CHEMICAL COMPANY

Specific Gravity	1.197 to 1.207
Acidity (meq/100 gm)	0.20 maximum

Molecular Weight	340
Moisture (KF in Methanol)	0.15% max.
Crystalizing Point	<-15°C
Viscosity @ 25°C	33.0 cps

15. T-12 AS MANUFACTURED BY M&T CHEMICAL COMPANY

Specific Gravity	1.05
Pour Point	>20°c
Acid Number	176
Tin Content	18.6%

16. THF AS MANUFACTURED BY DUPONT, INC.

Specific Gravity 20°C	0.886 to 0.889
Color-Not Darker than APHA	20
Water	0.03%
Peroxide by Weight (calculated as THF Hydroperoxide)	0.015%
Total Impurities by Weight	0.05%
Individual Impurities by Weight	0.02%
Stabilizer by Weight	0.025 to 0.04%

17. TMP AS MANUFACTURED BY CELANESE CORPORATION

Trimethylol Propane by Weight	98.0%
Hydroxyl Content by Weight	37.5% min.
Water Content by Weight	0.05%
Acidity as Formic Acid by Weight	0.002% max.
Phthalic Color - Gardner	1 max.

18. TOLUENE AS MANUFACTURED BY AMERICAN CYANAMID, INC.

Molecular Weight	92.13
Specific Gravity	0.866
Flash Point: Open Cup	7.2°C
Closed Cup	4.4°C

19. VIBRATHANE B-602 AS MANUFACTURED BY UNIROYAL, INC.

Percent Free NCO	2.95 to 3.15
AMINE Equivalent	1355 ± 65
Viscosity @ 70°C	20 Poise
Specific Gravity	1.04

Nonstickenstoffe release agent and Stapler Wax are commercial preparations with no typical chemical properties available. Methylene Chloride and Vythene are commercial cleaning solvents and thus no typical chemical properties are listed. No information on the Microlith Black CT pigment is available.

XI. LUCEL-4 SPECIAL HANDLING, STORAGE AND SAFETY REQUIREMENTS

1. SOLUBILITY

LUCEL-4 is very soluble in most organic solvents. It decomposes in acidic solvents.

2. HANDLING

LUCEL-4 is intended for industrial use only. It should be handled with care. All persons who handle LUCEL-4 should be thoroughly familiar with the following information.

3. FLAMMABILITY

LUCEL-4 is easily ignited and burns vigorously. It must be kept away from all sources of heat and ignition such as radiators, steam pipes, direct sunlight, open flames, and sparks. In the event of fire, wear self-contained breathing apparatus.

Suitable extinguishers for fighting a LUCEL-4 fire are dry chemical, foam, or carbon dioxide. If the fire is extensive, deluge with water and evacuate the area. If a fire occurs near LUCEL-4, wet the containers with water to prevent overheating.

4. STORAGE

LUCEL-4 should be stored by itself, away from other acidic or combustible materials. LUCEL-4 is extremely sensitive to mineral and organic acids. Acid contamination or exposure to temperatures above 115°F (46°C) causes vigorous decomposition with the release of nitrogen gas and flammable vapors which may self-ignite.

Although LUCEL-4 can be handled at room temperatures for short periods of time, it is recommended that it be stored below 0°F to obtain the best shelf life (prevent assay loss). It is stabilized with triethylamine. Solids may be present due to the stabilizer. Significant solids may indicate loss of stabilizer and possible low assay. Substantial loss of stabilizer can cause a more rapid rate of assay loss.

LUCEL-4 and all dilutions of LUCEL-4 should be stored with vented caps to prevent pressure buildup. Use only clean polyethylene containers for dilution and storage of dilutions and avoid all sources of contamination such as rust, dirt, and acidic materials.

Storage areas should be selected in accordance with local laws and regulations and subject to the approval of the insurance carrier.

5. SPILLAGE AND DISPOSAL

LUCEL-4 is volatile and in a confined or non-ventilated area a lethal concentration of vapor may result from a spill or leak, especially at room temperature.

In order to properly clean up spillage, a supply of inert, non-combustible absorbent should be kept on hand in the area where LUCEL-4 is handled. Only VERMICULITE and PERLITE have been found to be satisfactory.

Personnel dealing with the clean-up of spills should wear a gas mask (organic vapor canister) or use a self-contained breathing apparatus (SCBA) and protective equipment, including rubber gloves. Gas masks are generally suitable for use in ventilated areas but should never be used in confined areas. In confined areas where oxygen deficiency and high vapor concentration may occur, use a self-contained breathing apparatus.

If spillage occurs, immediately cover the spill with an excess of VERMICULITE or PERLITE only. Using breathing protection, sweep up the absorbed material and dispose of it at once. Depending upon local, state, or federal regulations the contaminated absorbed material can be disposed of by burning, burying, or hydrolysis with acid. Burning may be accomplished by placing in a shallow trench and igniting, from a safe distance, with a torch about 6 feet long.

If space is available the sweepings may be buried. The LUCEL-4 will gradually decompose.

The LUCEL-4 in the absorbent material may also be destroyed by hydrolysis with dilute mineral acid. The absorbed material should be wetted with water and then added slowly with stirring to an excess of a 5-10% aqueous sulfuric or hydrochloric acid solution. On decomposition, some of the products are flammable, so due precaution should be taken to provide proper ventilation and to prevent any sources of ignition.

If any problems arise contact the manufacturer for instructions.

6. TOXICITY

Acute inhalation toxicity studies in rats have shown the LD_{50} to be 4.4 mg/l (683 ppm v/v) for a 1-hour exposure.

The equilibrium vapor concentration of LUCEL-4 in a closed system at 25°C (77°F) was determined to be 20.4 mg/l (3151 ppm v/v). This means that in a closed area without ventilation, a lethal concentration of vapors could occur if a sufficient amount of LUCEL-4 has leaked or spilled, and sufficient time has elapsed. LUCEL-4 has an evaporation rate slightly lower than that of styrene monomer.

Acute oral toxicity studies in rats have shown the LD_{50} to be 228 mg/kg of body weight.

Acute dermal toxicity studies in albino rabbits have shown the LD_{50} to be 176.8 mg/kg of body weight for LUCEL-4.

Based upon the above data, LUCEL-4 should be considered highly toxic if absorbed through the skin and toxic if inhaled or swallowed. Personnel should avoid inhalation of LUCEL-4 vapors or vapors from any spillage. Care should be taken to avoid skin contact. Rubber gloves should be worn when handling LUCEL-4.

Do not take internally.

In case of contact immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. If soap is available use it also to wash skin. Get medical attention. Wash clothing before re-use. Discard contaminated shoes.

If inhaled remove to fresh air. If not breathing give artificial respiration. If breathing is difficult give oxygen.

If swallowed give large quantities of milk or water. Get immediate medical attention for lavage. Do not induce vomiting. Do not give an unconscious person anything by mouth.

I. CHEMICAL STORAGE REQUIREMENTS

CHEMICAL	STORAGE REQUIREMENTS	CONTAINER SIZE	COMMENTS
1. Butanediol	Store at room temp.	55-gal drum	Protect from exposure to moisture
2. Dabco WT	Store at room temp.	10-lb container	Protect from exposure to moisture
3. DC-193	Store at room temp.	5-gal pail	Protect from exposure to moisture
4. DIBK	Store at room temp.	55-gal drum	Protect from exposure to moisture
5. LUCEL-4	Store at 0°F (-18°C)	1-gal can	See Lucel special instructions Section XI
6. MDA	Store at room temp.	25-lb fiber container	Protect from exposure to moisture
7. MEK	Store at room temp.	55-gal drum	NFPA No. 30 flammable & combustible liquids code applies
8. Methylene Chloride	Store at room temp.	55-gal drum	Protect from exposure to moisture
9. Microlith Black Ct.	Store at room temp.	5-gal pail	—
10. Nonstickenstoffe	Store at room temp.	16-oz can	—
11. 90 PC02 Black Pigment	Store at room temp.	5-gal pail	—
12. Perchloroethylene	Store at room temp.	55-gal drum	Protect from exposure to moisture
13. Polymeg 2000 (PTMG)	Store below 100°F (38°C)	55-gal drum	Protect from exposure to moisture
14. Polymeg 2000 MDI Prepolymers	Store at 45 ± 5°F (6.7 ± 2.8°C)	5-gal pail	Protect from exposure to moisture
15. Santicizer S-140	Store at room temp.	55-gal drum	—

CHEMICAL	STORAGE REQUIREMENTS	CONTAINER SIZE	COMMENTS
16. Stapler Wax	Store at room temp.	1-lb can	—
17. T-12	Store at room temp.	1-gal pail	Protect from exposure to moisture
18. Toluene	Store at room temp.	55-gal drum	NFPA No. 30 flammable and combustible liquids code applies
19. THF	Store at room temp.	55-gal drum	NFPA No. 30 flammable and combustible liquids code applies
20. TMP	Store at room temperature	50-lb bag	Protect from exposure to moisture
21. Vibrathane B-602	Store at $75 \pm 5^{\circ}$F ($24 \pm 2.8^{\circ}$C)	55-gal drum	Protect from exposure to moisture
22. Vythene	Store at room temp.	55-gal drum	—

Note:

All materials must be protected against exposure to moisture. Containers being used must have drier tubes in vent hole and positive shutoff drain valves. If containers are opened and then closed after withdrawing material, the container must be blanketed with nitrogen.

Solvent storage must meet the recommendations of NFPA No. 30 "Flammable and Combustible Liquids Code".

When handling solvents, local or general,exhaust ventilation should be used to maintain solvent vapor concentrations below the explosive limit and the threshold limit values. Contact with skin and eyes should be avoided.

XIII. IN-PROCESS CHEMICAL STORAGE REQUIREMENTS

Chemical	In-Process Storage Requirements	Container Size	Amount Stored
1. Polymeg 2000 MDI Prepolymer-15% NCO	150°F (65.6°C) water bath	5-gal pail	One 5-gal pail
2. Polymeg 2000 MDI Prepolymer-10% NCO	150°F (65.6°C) water bath	5-gal pail	One 5-gal pail
3. Polymeg 2000	120°F (48.9°C) storage oven	55-gal drum	Two 55-gal drums
4. Vibrathane B-602	120°F (48.9°C) storage oven	55-gal drum	Two 55-gal drums

XIV. IN-PROCESS CHEMICAL TESTS: (POLYMEG 2000, PTMG UPPER PREPOLYMER, PTMG OUTSOLE PREPOLYMER)

1. Tests Performed

Test Property	Test Procedure
a. H_2O %	Photovolt Aquatester Procedure
b. NCO %	Chemical Procedure

2. Record Keeping Procedure

Log all data in a permanent bound ledger book—include material code, shift and date, test values and date test is run.

3. Test Equipment and Calibration Procedures

Equipment	Model	Supplier	Calibration
a. Aquatester II	702	Photovolt, Inc. New York City, N.Y.	1. Instrument is automatically standardized, but chemical check on accuracy can be made by checking standard supplied by Photovolt of 0.1% water in Methanol.
b. Sartorius Analytical Balance	2442	General Scientific	1. Place on pan a known weight which is equivalent to the optical scale range. Switch lowest weight decade to "1". Release balance. Adjust zero point.

3. Test Equipment and Calibration Procedures (contd.)

Equipment	Model	Supplier	Calibration
b. (contd.)			2. Turn weight application to "0". Scale swings through and must indicate exactly "100". If not, adjust sensitivity screw until it does.
c. Glass Ware 50 ml Burettes 250 ml Erlenmeyer Flasks 50 ml Pipettes 1000 ml Beaker 10 ml Graduate 500 ml Volumetric Flask	-	Fisher Scientific	None
d. Magnetic Stirrer	Thermix 118	Fisher Scientific	None
e. Miscellaneous Glass Syringe—1cc, 2cc, and 5cc Hypodermic Needle—4 1/2" - #12 Plastic Syringe—10cc with 6" plastic tube Plastic Funnel 3" diameter	-	Fisher Scientific	None

4. Test Procedures

A. Determination of Percent NCO:

APPARATUS

Analytical Balance
500-ml Volumetric Flask
10-ml Graduate

50-ml Automatic Burette
50-ml Automatic Pipette
3-200 ml Erlenmeyer Flask

REAGENTS

n-Dibutylamine

Tetrahydrofuran

0.5N Hydrochloric Acid

0.1% Bromo Phenol Blue Indicator

PROCEDURE

a. Prepare solution

   17.5 ml Dibutylamine

   Add THF to 500 ml volume

b. Swirl solution to mix well

c. Dry flasks; cap and condition at room temperature

d. Prepare Blank

   100 ml n-Dibutylamine/THF solution

e. Prepare Two Samples

   Weigh flasks and note initial weight
   Weigh sample directly into flask
   Use 1.0-gram sample for an NCO range of 8 to 10%
   Use 0.5-gram sample for an NCO range of 18 to 20%
   Add 100 ml of the n-Dibutylamine/THF solution to each sample flask

f. Place Teflon stirring bar in flask and place on magnetic stirrer

g. Start magnetic stirrer

h. Add 10 drops of Blue Bromophenol Indicator to flask

4. Test Procedures (contd.)

PROCEDURE (contd.)

i. Note initial reading of HCL in pipette

j. Titrate blank and sample to yellow color change with HCL

CALCULATION

$$\frac{(\text{Blank-Sample}) \text{ X } 0.5 \text{ X } 4.202}{\text{Weight of Sample}} = \% \text{ NCO}$$

B. Determination of Percent Water by the Photovolt Aquatest

APPARATUS

1cc - 2cc Hypodermic Syringe
#12 Hypodermic Needle - 4½ inches long

PROCEDURE

a. Prepare hypodermic needle and syringe

b. Fill syringe with material to be tested several times and discard

c. Fill syringe with 1 cc of material, free of any air bubbles

d. Set counter to zero

e. With machine in operating position and titrate switch in mid-position insert needle through rubber diaphragm and lower tip of needle below solution level.

f. Inject material into vessel

g. Immediately push down on titrate lever switch and release

Do not hold switch down

h. Titration will proceed until "OFF" light comes on

i. "END" light will come on after one minute and test is complete

j. Counter reads directly in micrograms of water

Test Procedures (contd.)

B. Determination of Percent Water by the Photovolt Aquatest (contd.)

PROCEDURE

k. Return titrate switch to standby position

CALCULATION

Volumetric - $\frac{\text{Counter Reading}}{\text{Specific Gravity}} \times 0.0001 = \%\ \text{Water}$

Weight - $\frac{\text{Counter Reading}}{\text{Sample Weight}} \times 0.0001 = \%\ \text{Water}$

ALTERNATE METHOD

APPARATUS

25 and 50-ml Volumetric Flasks
Rubber Septa
1 cc Hypodermic Syringe

REAGENTS

Tetrahydrofuran (THF)	Reagent Grade

PROCEDURE I (Samples with % H_2O in the 0.1 to 1.0% Range

a. Weigh 5.0 ± 0.1 gram sample into a dry 50-ml volumetric flask

b. Add 30 ml THF

c. Stopper flask and swirl to mix well

d. Dilute to volume with THF and mix well

e. Stopper flask with rubber septum

f. Prepare a blank in a dry 25-ml volumetric flask, using THF only

g. Stopper flask with rubber septum

B. Determination of Percent Water by the Photovolt Aquatest (contd.)

PROCEDURE I (contd.)

h. Accurately inject 1.0-ml samples of the blank into the titrating vessel, using a 1-cc syringe, until two readouts of micrograms water check within 10 units. Average readouts.

i. Flush the syringe with sample solution several times.

j. Accurately inject 1.0-ml of sample solution into titrating vessel, until two readouts agree to within 10 units of each other. Average readouts.

CALCULATION

% Water = (Microgram Sample - 0.9 (Micrograms Blank) x 0.001)

PROCEDURE II (Samples with % water in the 0.01 to 0.10% Range

a. Weigh 20 grams ± 0.1 grams sample into a dry 50-ml volumetric flask

b. Add 15-ml THF .

c. Stopper flask and swirl to mix well

d. Dilute to volume with THF and mix well

e. Stopper flask with rubber septum

f. Prepare a blank in a dry 25-ml volumetric flask, using THF only

g. Stopper flask with rubber septum

h. Accurately inject 1.0-ml samples of the blank into the titrating vessel, using a 1-cc syringe, until two readouts of micrograms water check within 10 units. Average readouts.

i. Accurately inject 1.0-ml of sample solution into titrating vessel until two readouts agree to within 10 units of each other. Average readouts.

CALCULATION

% Water = (Micrograms Sample - 0.6 (Micrograms Blank) x 0.00025)

XV. COMPOUND PREPARATION

I. UPPER AND OUTSOLE COMPOUND USAGE

(Based on 10R boot at maximum machine design production rate of 15 pair/hour)

Given: Outsole wt. - 320 grams
Upper wt. - 330 grams
Outsole ratio by parts - 70.485A : 81.4B
Upper ratio by parts - 95.10A : 49.96B : 16.80C

A. Outsole Compound Usage

a. Gross usage = 320 grams/boot x 2 boots/pair x 15 pair/hour x 24 hours/day x $\frac{1}{454 \text{ gm/lb}}$

= 508 lb/day (231 kg/day)

b. Component A usage = 508 lb/day x $\frac{70.485}{151.885}$ = 236 lb (107 kg/day)

c. Component B usage = 508 lb/day x $\frac{81.400}{151.885}$ = 272 lb (124 kg/day)

B. Upper Compound Usage

a. Gross usage = 330 gm/boot x 2 boots/pair x 15 pair/hr x 24 hr/day x $\frac{1}{454 \text{ gm/lb}}$

= 523 lb/day

b. Component A = 523 lb/day x $\frac{95.10}{161.86}$ = 307.3 lb/day (139.7 kg/day)

c. Component B = 523 lb/day x $\frac{49.96}{161.86}$ = 161.4 lb/day (73.4 kg/day)

d. Component C = 523 lb/day x $\frac{16.80}{161.86}$ = 54.3 lb/day (24.7 kg/day)

C. Using the approximations that the Prepolymers are 9.1 lb/gal, the Hardeners are 8.3 lb/gal and the Upper Blowing Agent is 9.3 lb/gal then the Usage Rates are:

a. Upper components

1. Component A (prepolymer) $= \frac{307.3 \text{ lb}}{9.1 \text{ lb/gal}} = 33.8$ gal/day (128 liters)

2. Component B (hardener) $= \frac{161.4 \text{ lb}}{8.3 \text{ lb/gal}} = 19.5$ gal/day (73.9 liters)

3. Component C (blowing agent) $= \frac{54.3 \text{ lb}}{9.3 \text{ lb/gal}} = 5.8$ gal/day (22 liters)

b. Outsole components

1. Component A (prepolymer) $= \frac{272 \text{ lb}}{9.1 \text{ lb/gal}} = 29.9$ gal/day (113.3 liters)

2. Component B (hardener) $= \frac{236 \text{ lb}}{8.3 \text{ lb/gal}} = 28.4$ gal/day (107.6 liters)

2. COMPOUND POT LIFE CRITERIA

Upper component A (prepolymer) 6 hr at 220°F (104°C)

Upper component B (hardener) 10 hr at 220°F (104°C)

Upper component C (blowing agent) 6 hr at 50°F (10°C)

Outsole component A (prepolymer) 6 hr at 165°F (73.9°C)

Outsole component B (hardener) 10 hr at 165°F (73.9°C)

3. COMPOUND TANK SIZING

Because the shortest pot life is 6 hours at operating temperatures, use 4 hours for compound tank refill time to allow for mixing at elevated temperatures, and still allow a safety margin. Therefore, each compound component tank should have a working capacity of 4 hours, Therefore, the compound mixing tanks should have the following working capacities.

Upper component A - 6 gallons (22.7 liters)
Upper component B - 4 gallons (15.2 liters)
Upper component C - 1 gallon (3.79 liters)
Outsole component A - 5 gallons (18.9 liters)
Outsole component B - 5 gallons (18.9 liters)

In actual use the tanks will be mounted on small flatbed push trucks. The upper A and B component tanks, and the outsole A and B component tanks, will be insulated and equipped with electric heaters for compound temperature control. The upper C component tank will be double-walled and equipped for circulating liquid cooling for temperature control. All tanks will have air operated agitators for compound mixing and provisions for nitrogen blanketing. The components will be formulated, mixed, and heated in these tanks in the humidity controlled mixing room. The tanks will be transported to the molding machines, their contents transferred to the respective molding machine compound tanks, cleaned and returned to the compound mixing room. The actual component transfer will be accomplished by connecting a hose between the component tank and the molding machine supply tank and pressurizing the component tank with nitrogen. Thus the differential pressure between the component tank and the supply tank will cause the component tank contents to flow to the molding machine supply tank.

4. COATING COMPOUND PREPARATION

Given: Ransburg spray efficiency = 90%
Coating formulation total solids = 45%
Dry weight of coating for size 10R boot = 109 grams
Maximum design coating speed = 30 boots/hour
Ratio of component A to B is 100 : 24.99 by weight
B component is a two-part mix with a ratio of 94 pts. B-1 to 100 pts. B-2 by weight

A. Gross compound usage

$$= 109 \text{ gm/boot} \times 30 \text{ boots/hr} \times \frac{100}{45} \times 24 \text{ hr/day} \times \frac{1}{454 \text{ gm/lb}} \times \frac{1}{0.9} = 426.8 \text{ lb/day } (194 \text{ kg/day})$$

B. A component usage

$$= \frac{100 \text{ gm}}{124.99 \text{ gm}} \times 426.8 \text{ lb/day}$$

$$= 341.5 \text{ lb/day } (155.2 \text{ kg/day})$$

C. Combined B component usage

$$= \frac{24.99 \text{ gm}}{124.99 \text{ gm}} \times 426.8 \text{ lb/day}$$

$$= 85.3 \text{ lb/day } (38.8 \text{ kg/day})$$

D. B-1 component usage

$$= \frac{94 \text{ gm}}{194 \text{ gm}} \times 85.3 \text{ lb/day}$$

$$= 41.3 \text{ lb/day } (18.8 \text{ kg/day})$$

E. "B-2"component usage $= \frac{100 \text{ gm}}{194 \text{ gm}} \times 85.3$ lb/day

$= 44.0$ lb (20 kg/day)

Using the approximation that components"A","B-1"and"B-2"weigh 8 lb/gal, then the component usage rates in gallons/24 hour day are as follows:

"A"component $= \frac{341.5 \text{ lb/day}}{8 \text{ lb/gal}} =$ 42.7 gal (161.7 liters/day)

Combined "B"component $= \frac{85.3 \text{ lb/day}}{8 \text{ lb/gal}} =$ 10.7 gal (40.5 liters/day)

"B-1"component $= \frac{41.3 \text{ lb/day}}{8} =$ 5.2 gal (19.7 liters/day)

"B-2"component $= \frac{44.0 \text{ lb/day}}{8 \text{ lb/gal}} =$ 5.5 gal (19.7 liters/day)

The coating formulation will be prepared once per day, therefore, the mixing tanks should be sized as follows:

"A"component tank - 50 gallons (189 liter) capacity

"B"component tank - 12 gallons (45.5 liter) capacity

"B-1"component tank - 7 gallons (26.5 liter) capacity

"B-2"component tank - 7 gallons (26.5 liter) capacity

The transfer of the"B-1"and"B-2"components to the"B"component tank and the transfer of the"A"and"B"components to the coating unit supply tank will follow the same procedure as the foam components previously described.

5. COMPOUND MIXING PROCEDURE

A. Upper Formulation:

a. Prepolymer

Place 5-gallon (18.9-liter) pail of 10% NCO PTMG prepolymer into 150°F (65.6°C) hot water bath. When the prepolymer is melted, empty the 5-gallon (18.9-liter) pail into the 5-gallon (18.9-liter) upper component A mixing tank and cap the tank with dry nitrogen. Set tank temperature control to 220°F (104°C) and turn on tank agitator. When the prepolymer reaches 220°F (104°C) continue to agitate for 15 minutes. The prepolymer is now ready for use.

b. Hardener

Draw off the necessary amount of melted PTMG from drum in storage oven and place in upper component"B"mixing tank. Set"B"mixing tank temperature controller to 150°F (65.6°C). Melt preweighed amount of TMP on 150°F (65.6°C) hot plate and pour into"B"component mixing tank. Weigh and add 1-4 BD, DC-193, T-12, and 90PC02 into"B"component mixing tank. Raise mixing tank temperature control to 220°F (104°C) and cap tank with dry nitrogen. When the material temperature reaches 220°F (104°C) continue to agitate for 45 minutes. The hardener is now ready for use.

c. Blowing Agent

Set upper component"C"mixing tank temperature controller to 60°F (15.6°C). Weigh and add santicizer 140 into mixing tank. Remove Lucel-4 from freezer, weigh out required amount and add into mixing tank. Immediately return remainder of Lucel-4 to freezer. Turn on mixing tank agitator and cap tank with dry nitrogen. Agitate for 15 minutes at 60°F (15.6°C), then reset tank temperature controller to 50°F (10°C) and continue to agitate. When blowing agent temperature reaches 50°F (10°C) it is ready for use.

B. OUTSOLE FORMULATION

a. Prepolymer

Remove 5-gallon (18.9-liter) pail of 15% NCO PTMG prepolymer from cold storage room and place into 150°F (65.6°C) hot water bath. When the prepolymer is melted, empty the 5-gallon (18.9-liter) pail into the 5-gallon (18.9-liter) outsole component"A"mixing tank and cap tank with dry nitrogen. Set tank temperature controller to 165°F (73.9°C) and turn on agitator. When the prepolymer reaches 165°F (73.9°C) continue to agitate for 15 minutes. The prepolymer is now ready for use.

b. Hardener

Draw off the necessary amount of melted PTMG from drum in storage oven and place in outsole"B"component mixing tank. Set temperature controller to 150°F (65.6°C). Turn on"B" mixing tank agitator. Weigh and add 1-4 BD, DC-193, Dabco WT, water, T-12 and 90PC02 to PTMG in mixing tank. Set mixing tank temperature controller to 165°F (73.9°C) and cap tank with dry nitrogen. When the material temperature reaches 165°F (73.9°C), continue to agitate for 45 minutes. The hardener is now ready for use.

C. Outer Coating

a. "A" Component

Weigh and add the required amounts of THF and Perchloroethylene to the "A" component coating mixing tank. Turn on the tank agitator. Draw off the necessary amount of melted B-602 from the drum in the storage oven and pour into mixing tank. Cap tank with dry nitrogen and mix for 30 minutes. The coating "A" component is now ready for use.

b. "B-1" Component

Weigh and add the required amounts of MDA, THF and CT-Black to the outer coating "B-1" component mixing tank. Turn on tank agitator and blanket tank with dry nitrogen. Mix for 15 minutes.

c. "B-2" Component

Weigh and add the required amounts of THF and DIBK to the outer coating "B-2" component mixing tank. Turn on tank agitator. Draw off the necessary amount of melted B-602 from the drum in the storage oven and pour into the mixing tank, cap tank with dry nitrogen and mix for 30 minutes.

d. "B" Component

After the "B-1" and "B-2" components are mixed connect the transfer hoses between the outlet of the "B-1" and"B-2" tanks and the inlets of the"B"tank. Open the vent valve on the "B" tank and check to see that the agitators are operating in all tanks. Pressurize the "B-1" and "B-2" tanks to 5 psi with dry nitrogen. Open the outlet valve from the "B-1" tank and the inlet valve to the B tank, allowing the material in the "B-1" tank to flow to the "B" tank. After the material transfer is complete, close the inlet valve to the "B" tank and the outlet valve of the B-1 tank. Open the outlet valve from the "B-2" tank and the inlet valve to the "B" tank, allowing the contents of the "B-2" tank to slowly transfer to the "B" tank. After material transfer is complete, close the "B-2" tank outlet valve and the "B" tank inlet valve. Shut off the nitrogen pressure to tanks "B-1" AND "B-2". Cap the "B" tank with dry nitrogen and agitate for 30 minutes. The outer coating compound B component is now ready for use.

6. COMPOUND FORMULATIONS

A. Upper Formula

a. Ingredients	Equivalents	Parts
PTMG (2,000 mol. wt.)	0.100	100.0
1-4 Butanediol	0.1511	6.8

A. Upper Formula (contd.)

a. Ingredients

Ingredients	Equivalents	Parts
TMP	0.0266	1.2
MDI	0.2824	35.3
DC-193		0.64
T-12		0.02
Lucel-4		5.5
Santicizer 140		11.3
90PC02 Black Pigments		1.1
		161.86

b. "A" Component (Prepolymer)

PTMG (10% NCO)	59.8
MDI	35.3
	95.1

c. "B" Component (Hardener)

PTMG	40.2
1-4 Butanediol	6.8
TMP	1.2
DC-193	0.64
T-12	0.02
90PC02	1.1
	49.96

d. "C" Component

Lucel-4	5.5
S-140	11.3
	16.8

This foam compound is run at a 1.02-isocyanate index based on the following equation:

$$\text{Isocyanate Index} = \frac{\text{No. of equivalents of MDI}}{\text{No. of equivalents of (PTMG, 1-4BD, TMP)}}$$

B. Outsole Formula

a. Ingredients

Ingredients	Equivalents	Parts
PTMG (2,000 mol. wt.)	0.0991	100.0
1-4 Butanediol	0.2000	9.0
Water	0.0333	0.3
MDI	0.3300	41.2
DC-193 (Silicone)		0.21
Dabco WT (Catalyst)		0.05
90PC02 (Pigment)		1.12
T-12 (Catalyst)		0.005
		151.885

b. **"A" Component** (Prepolymer)

	Parts
PTMG (15% NCO)	40.2
MDI	41.2
	81.4

c. **"B" Component** (Hardener)

PTMG	59.800
1-4 Butanediol	9.000
Water	0.300
DC-193	0.210
Dabco WT	0.050
90PC02	1.120
T-12	0.005
	70.485

This foam compound is run at 0.99 isocyanate index based on the following equation:

$$\text{Isocyanate Index} = \frac{\text{No. of Equivalents of MDI}}{\text{No. of Equivalents of (PTMG, 1-4 BD, Water)}}$$

C. **Outer Coating Formula**

a. **"A" Component**

	Parts
B-602	1700
Perchloroethylene	1300
THF	466.6

b. **"B" Component**

1. (B-1)

MDA	400
THF	1000
CT-BLACK	20

2. (B-2)

B-602	400
DIBK	300
THF	500

Weighing and mixing of "A" and "B" components must be done with properly grounded, explosion proof equipment where dictated by safe handling procedures for flammable solvents. Adequate ventilation must also be provided.

7. **COMPOUND RATIOS**

A. **Upper Compound**

A: B: C	95 : 49.6 : 16.8

B. **Outsole Compound**

A: B	81.4 : 70.485

C. Outer Coating Compound

B-1 : B2	94 : 100
A : B	100 : 24.99

8. COMPOUND CHARACTERISTICS - FREE RISE CUP SAMPLE

A. Upper Foam

a. Index 102

b. Cream Time 3 to 4 seconds

c. Rise Time 22 to 24 seconds

d. Tack Free Time 3 minutes

B. Outsole Foam

a. Index 99

b. Cream Time 3 to 4 seconds

c. Rise Time 32 to 40 seconds

d. Tack-Free Time 34 to 36 seconds

C. Definitions

a. Cream Time: time from discharge from mixer to initiation of blowing

b. Rise Time: time from cream time to full expansion

c. Tack Free Time: time from full expansion to until foam surface is not tacky to light touch.

XVI. ACCEPTANCE STANDARDS -- VISUAL EXAMINATION

1. First Inspection -- 100%	Major	Minor
A. Socklining		
a. Die cut parts not of proper dimensions	X	
b. Die cut parts not correctly stitched		
1. Over 10 stitches per inch (3.94 stitches per centimeter)	X	
2. Less than 6 stitches per inch (2.36 stitches per centimeter)	X	
3. Sharp or rough stitch seam		X
c. Missing, loose or torn	X	
d. Wrinkled or creased		
1. Small (less than 3/4 inch (1.9 cm) long by 1/8" (0.32 cm) wide		X
2. Large (greater than 3/4 inch (1.9 cm) long by 1/8" (0.32 cm) wide	X	
e. Depressions or ridges on insole	X	
f. Seams not sealed	X	
B. Outsole		
a. Cleats not formed, incomplete or blisters, poor blow	X	
b. Untrimmed, unbuffed sole edge, buffing dust	X	
c. Excessive buff, cuts, unrepairable damage	X	

XVI. ACCEPTANCE STANDARDS -- VISUAL EXAMINATION (contd.)

B.	Outsole (contd.)	Major	Minor
d.	Small voids 1/8" (0.32 cm), dirty soles		X
e.	Overlap of outsole by upper		X
f.	Dirty soles (not washed)		X
g.	Outsole weight 315 grams max., size 10R	X	
C.	Molded Upper		
a.	Socklining missing, loose or torn	X	
b.	Socklining slightly wrinkled or creased		X
c.	Depressions or ridges on insole	X	
d.	Foam strike through		X
e.	Poor blow of upper foam (irregular or none)	X	
f.	Poor adhesion upper to outsole	X	
g.	Surface blisters to 1/2" (1.27 cm) diam., surface blemishes		X
h.	Flashline groove (void) unbuffed flashline	X	
i.	Not clean (solvent washed)		X
j.	Incomplete repairs, damaged boot, cuts	X	
D.	Release Coating Application to Foam at Vamp		
a.	Application in wrong location	X	
b.	Insufficient coating	X	

2. Final Inspection -- 100%	Major	Minor
A. Outerskin Coating		
a. Uncoated or missed area	X	
b. Damage or broken skin	X	
c. Pinholes or flecks (not thru skin)		X
d. Discernible mold lines		X
e. Blisters, bubbles or depressions within 3" (7.6 cm) from top		X
f. Contamination		X
g. Blushing and/or discoloration of skin		X
h. Slight ridges, sags or drips on outsole (unbuffed)		X
B. Closure		
a. Torn or cut	X	
b. Missing laces or non-functional	X	
c. Height less than 3" (7.62 cm)		X
d. Folds in collar material under stitching		X
e. Irregular stitching, loose, broken stitches	X	
f. Stitching not within specification	X	
g. Overlap to top edge of boot greater than 3/4 inch (1.9 cm)		X
C. Marking		
a. Size missing	X	
b. Cuff stencilling including size not legible		X
D. Complete Boot		
a. Creased or wrinkled	X	
b. Misshaped (damaged or compressed foam)	X	

2. Final Inspection -- 100% (contd.)	Major	Minor
D. Complete Boot (contd.)		
c. Poor alignment upper and outsole	X	
d. Outside back height less than 10¼ inches (26 centimeters)	X	
e. Weight (size 10R) more than 800 grams	X	
E. Packing and Shipping		
a. Incorrect packing	X	
b. Mixed sizes in box	X	
c. Tissue and cardboard insert missing		X
d. Box label not legible		X
e. Incorrect count in box	X	
f. Incorrect address on shipping box	X	
g. Shipping container marking not legible		X

XVII. PHYSICAL PROPERTIES REQUIREMENTS: OUTSOLE, UPPER, COATING, SOCKLINING AND SNOW COLLAR

TABLE 1

1. Physical Property Requirements - Outsole - Upper - Coating

Physical Property[1]	Test Method	Outsole Requirement	Upper Requirement	Outer Skin Requirement
a. Color	-	Black	-	Black
b. Density lb/ft	ASTM D-2406-65 Par 62-67	25 ± 3	14 ± 3	-
c. Tensile Strength (psi)	ASTM D-412-66	Min. 600	-	Min. 2700
d. 100% Modulus (psi)	-	-	-	Max. 700
e. Ultimate Elongation (%)	ASTM D-412-66	Min. 250	-	Min. 450
f. Compression Deflection @ 25%	ASTM D-1056-67T Par 17-20			
At room temperature (psi)		Max. 55	Max. 15	
At -20°F (psi)[2]		Increase not more than 60% from orig.	Increase not more than 50% from orig.	
g. Compression set at 50% deflection (24 hr recovery) at room temperature at 158°F	ASTM D-1056-67T Par 21-23	Max. 15 Max. 70	Max. 15 Max. 85	-
h. Polyair Flex (no hammer)	-	Min. 15000 cycle	-	-
i. Gehman Stiffness Test T-10°F	ASTM 1053-65 except par 8&9	-65°F	-65°F	-65°F
j. Water Absorption % 6 inch head - 48 hr[3]	Fed. Std. 601 method 1241	Max. 8	Max. 50	-
k. Tear (PPI)	ASTM 624-54 Die C for upper & outsole Die B for outer-skin	Min. 125	Min. 25	Min. 160

XVII. PHYSICAL PROPERTIES REQUIREMENTS: OUTSOLE, UPPER, COATING, SOCKLINING AND SNOW COLLAR (contd.)

TABLE 1

1. Physical Property Requirements - Outsole - Upper - Coating (cont'd)

Physical Property	Test Method	Outsole Requirement	Upper Requirement	Outer Skin Requirement
l. Hardness Shore A	ASTM D-2240-64T			
Original		Min. 45	-	-
After 70 hrs @ 212^{o}F	ASTM D-573-67T	Not more than 15 point change from original	-	-
At - 20^{o}F (after 2 hrs)[4]		Not more than 15 point change from original	-	-
m. NBS Abrasive Index	ASTM D-1630-61			
Original		Min. 10	-	-
After 70 hrs @ 212^{o}F	ASTM D-573-67T	Min. 10	-	-

[1] All foam physical properties run on molded slabs.

[2] The test specimen and test apparatus shall be conditioned at -20^{o}F ± 2^{o}F for two hours prior to initiating test.

[3] The complete skin and sockl ining shall be removed prior to testing.

[4] A specimen at least 0.250 inches thick and at least one inch wide by two inches long shall be tested for hardness as specified in ASTM D2240-64T. The same specimen shall then be conditioned for two hours at -20^{o}F (+3.6^{o}C) and the hardness then determined at that temperature. The difference between the two determinations shall be recorded as the hardness change.

XVII. PHYSICAL PROPERTIES REQUIREMENTS (contd.)

TABLE 2

2. Physical Property Requirements - Socklining and Snow Collar

The following are specifications recommended for the Sockliner and Collar. This is based primarily on data submitted by both Gehring Textile for the fabric and Reeves Brothers for the coated fabric.

Physical Property	Test Method	Requirement
Reeves Style (Coated)		A05-010-000-540*
Construction		Clear Polyether Polyurethane Coated Nylon Tricot
Weight (oz/sq yd)	CC-T-191 (5041)	4.8 + 0.5 -0.3
Width (inches)	-	52
Gauge (inches)	CC-T-191b (5030)	0.012 min.
Tensile (Grab.) (lb)		
Warp X Fill	CC-T-191b (5100)	70 x 70 min.
Elongation at 10 lb (%)		
Warp X Fill	CC-T-191b (5100)	20 x 25 min.
Tear, Elmendorf, Grams	CC-T-191b (5132)	1200 min.
Coating Adhesion, lb/inches	Fed. Std. 601 (8211)	4.0 min.
Air Retention (Porosity)	Reeves ten inch diameter disc with one inch inflation	No leaks

*Uncoated fabric is nylon tricot net (black) 2.4 oz sq yd (min.) 52" wide (min.) and count (Wales X Courses) of 38 x 55 (min.) (Gehring style 4112 M).

XVIII. PHYSICAL PROPERTY TESTS

1. Test Procedures

Test Property	Test Procedure
A. Density lb/ft^3	ASTM D-2406-65T Pars 62-67 or Sartorius Procedure
B. Tensile PSI	ASTM D-412-66
C. 100% Modulus PSI	ASTM D-412-66
D. Ultimate Elongation %	ASTM D-412-66
E. Compression Deflection PSI	ASTM D-1056-67T Pars 17-20
F. Compression Set %	ASTM D-1056-67T Pars 21-23
G. Gehman Stiffness Test - T10	ASTM D-1053-65 Except Pars 8 9
H. Water Absorption %	Federal Standard 601 - Method 1241
I. Tear Strength PPI	ASTM 624-54 (Die C)
J. Hardness-Shore A - Orig.	ASTM D-2240-64T
after 70 hr @ 212°F	ASTM D-573-67T
K. NBS Abrasive Index - Orig.	ASTM D-1630-61
after 70 hr @ 212°F	ASTM D-573-67T

2. Record Keeping: Procedure

A. File data sheets returned from Physical Testing for individual tests run.

B. Log all data in a permanent bound ledger book--include material code, test values and date run.

XVIII. PHYSICAL PROPERTY TESTS (contd.)

3. Test Equipment and Calibration Procedures

	Equipment	Model	Supplier	Calibration
A.	NBS Abrader	-	H.W. Wallace Co. Croydon Surrey, England	Calibrate against known standard specified by ASTM (Cured rubber pieces)
B.	Gehman Stiffness Tester	-	B.K. Elliott Cleveland, OH	Calibrate against known standard
C.	Shore A Hardness Tester	-	Shore Instrument Co., Jamacia, NY	Test standard metal piece supplied with instrument and adjust to proper value
D.	Polyair Flexer	-	Polyair, Inc. Kittsee, Austria	No calibration method available
E.	Electric Oven (RT 400°F)	-	Precision Scientific Chicago, IL	Check control instrument against thermometer
F.	Scott Ball Burst Tester	-	Scott Testers Providence, RI	Check against known standard supplied by ASTM
G.	Snap Gauge (0.001" divisions to 1")	5822	Ames Company Waltham, MA	Gauge shim of known thickness. Zero pointer
H.	Torbal Balance	PL-12	Torsion Balance Co. Clifton, NJ	Place on pan a known weight and adjust zero point

3. Test Equipment and Calibration Procedures (contd.)

Equipment	Model	Supplier	Calibration
I. Instron Tester with Environmental (Chamber)	TM	Instron Company Camden, MA	1. Zero pen to chart (bypass load cell) 2. With load cell in line compensate for clamping mechanism weight by taring to zero on chart 3. Hang known weight in jaw for full-scale load and calibrate by setting pen to full-scale chart line. (Tensile & Elongation) 4. For compression deflection step 3 would be to place a known weight on load cell pan equivalent to the scale load and calibrate by setting pen to full-scale chart line
J. Steel Sample Cutting Dies: 1/8" x 1-1/4" 2" x 2", 1" x 1", 1.28" diameter, 1" x 8", Die C Tear, 1/2" Tensile Dumbell, 2" x 6"	-	Brockton Cutting Die & Manufacturing Co. Avon, MA 02322	None
K. Molds for producing slabs 5" x 12" x 1/4", 5" x 12" x 3/4"	-	Compo Industries Waltham, MA	None

XIX. BOOT PACKAGING AND WAREHOUSING

The following packaging method has been developed based on the size 10R boot and may require some modification to accommodate the larger XW sizes.

1. Packaging Method

One chipboard tube shall be placed inside each boot. Each boot is then compressed so that the tube becomes oval.

A printed instruction tag, having a hole in its folded upper left hand corner, shall be inserted with the lace of the left boot only. The two ends of the lace shall be loop-tied. The mated right foot boot lace ends shall also be loop-tied. The flat die-cut carton (Figure 2) is then assembled. One sheet of tissue paper is placed on the bottom with its edge parallel to the right panel and extending approximately 5" (12.7 cm) beyond. One boot is then placed on this tissue. This boot shall have its outsole parallel to the carton's rear panel and its back parallel to the right panel. The remaining portion of the tissue then covers this boot. A second sheet of tissue is placed with its end parallel to the carton's left side panel, extending approximately 5 inches (12.7 cm) beyond. The other mated boot, of the same size and width is placed on this tissue with its back parallel to the carton's left side panel (Figure 3), and the outsole parallel to the front panel. The remaining portion of the tissue is then placed over this boot. The top flap is then closed inside the front panel, and secured at the edge with a 3"-(76-cm) wide tape, extending approximately 1" (2.54 cm) down the front, printed panel. Six pair of one size only,* packaged, shall be placed within the case (Figure 4). Bottom flaps of the case are closed by metal staples, two on each flap widthwise, plus two lengthwise. Top flaps shall be secured by a solid coating of glue Silicate covering the entire contact area. In addition, one strip of 3" wide water sensitive tape shall be placed over the top joining, and extending 2" down each end panel.

*NOTE: Towards the end of the contract, when it becomes necessary to place two or more sizes within the same case, it is permissible to mix sizes, provided such case contains the proper size detail, plus a white printed label reading "MIXED SIZES". This label is placed alongside the other required case printing.

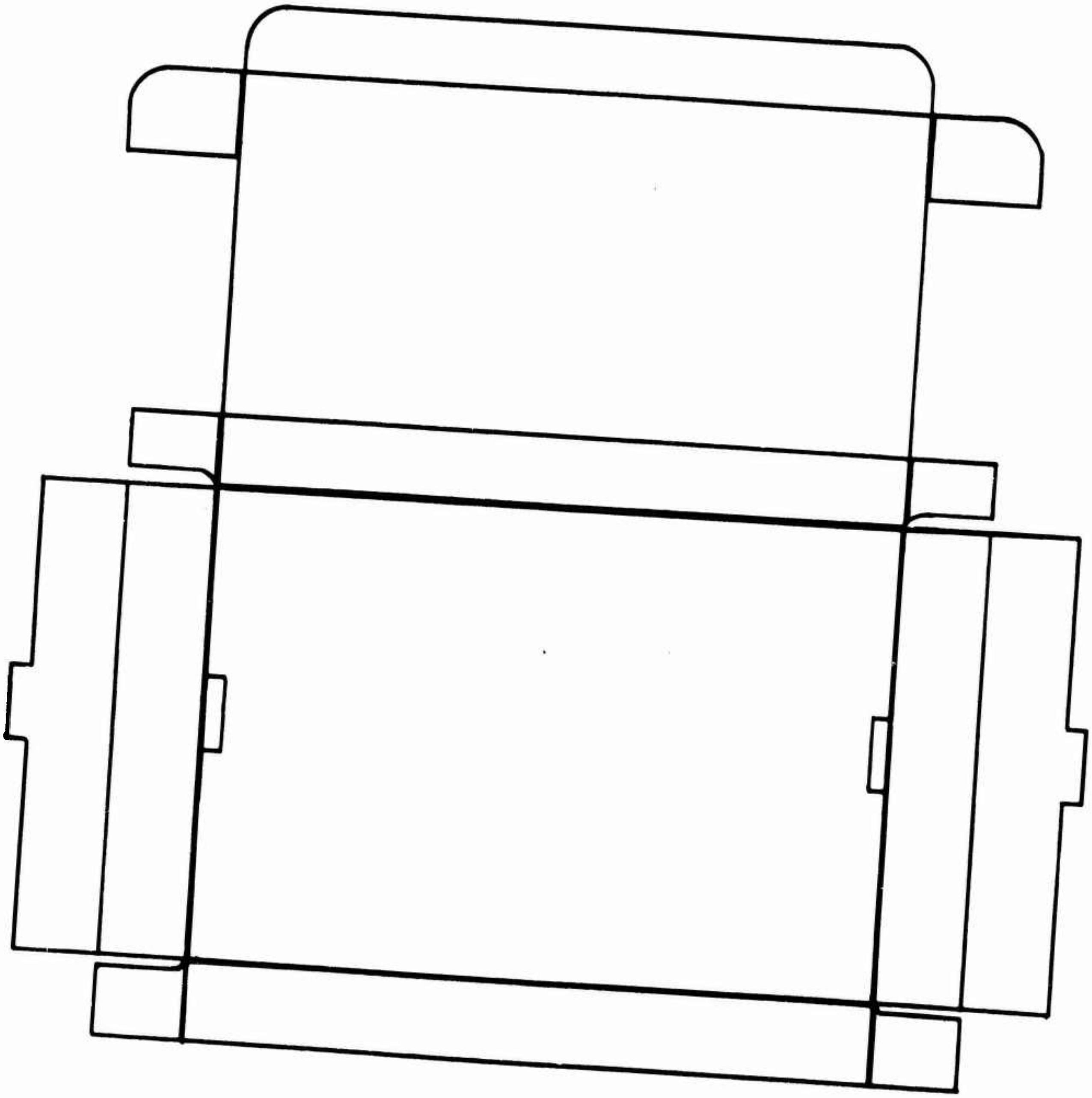


FIGURE 2 DIE-CUT CARTON

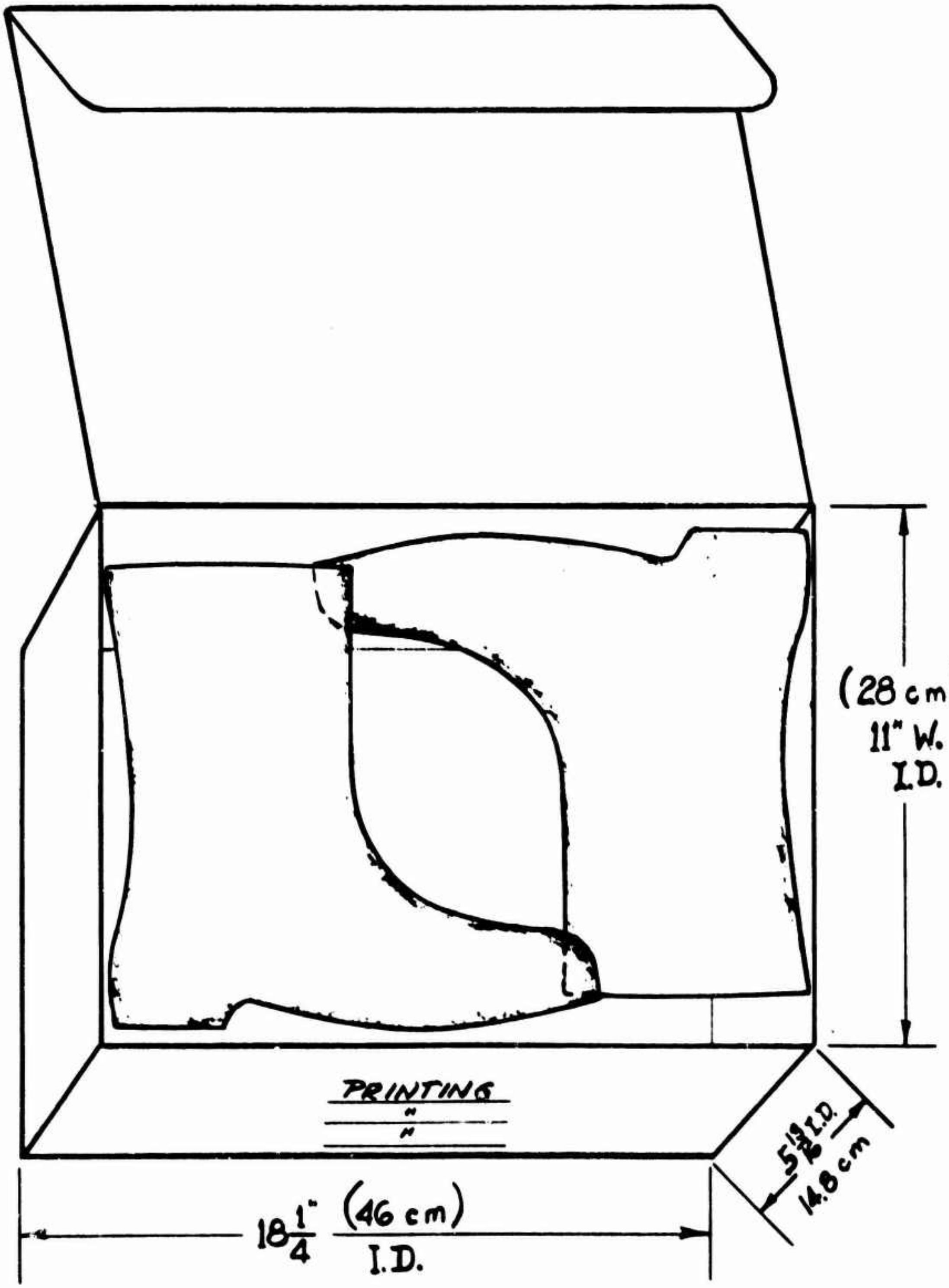


FIGURE 3 CARTON ASSEMBLY

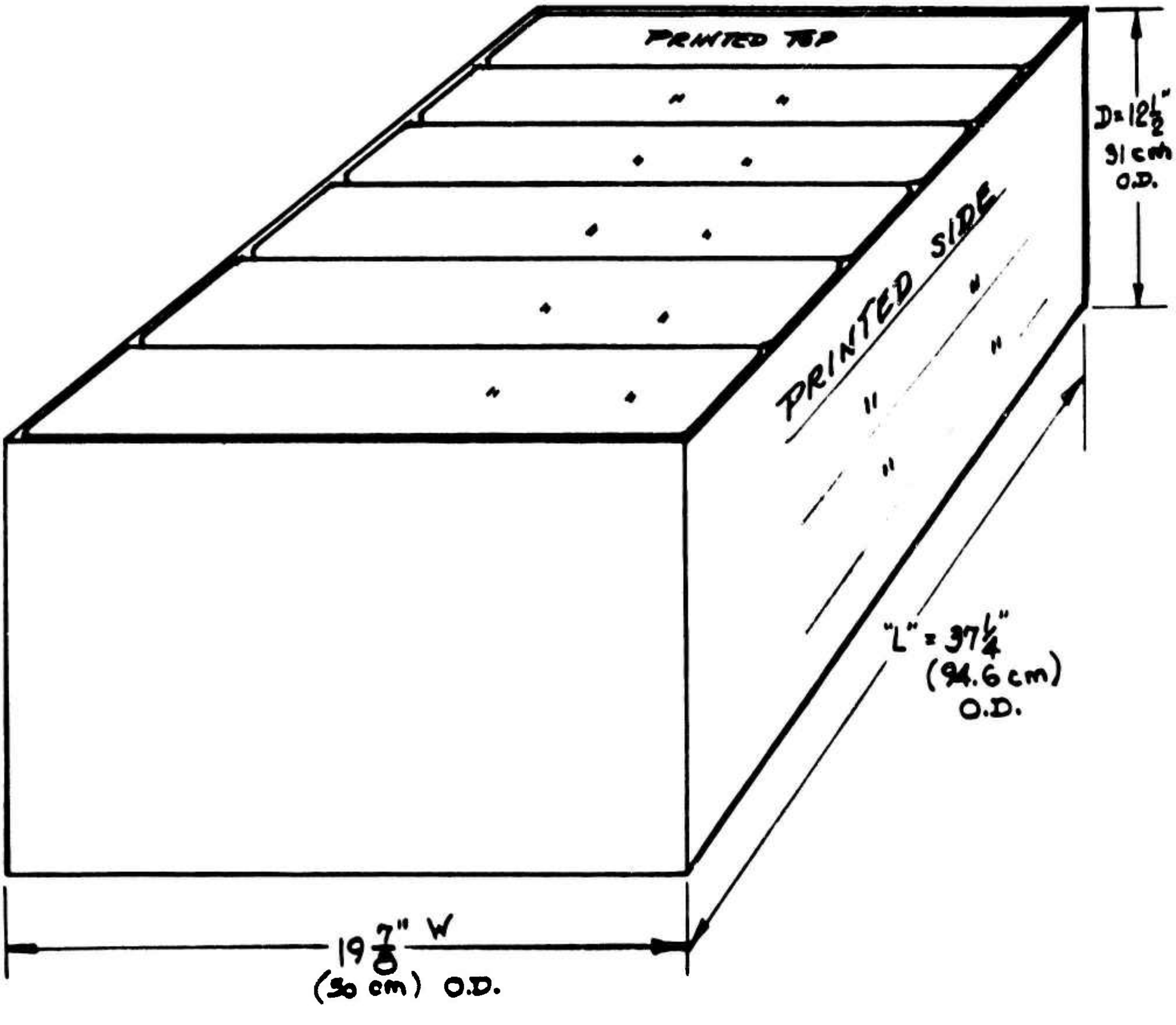


FIGURE 4 CASE LAYOUT

2. Packing Materials - Boot/Carton

A. 0.040 Ga. Chipboard tube 9" (23 cm) x 6" (15.2 cm) Dia. Slit-Length 2/Pr.

B. Printed instruction tag 6½" (16.5 cm) x 5½" (14 cm) folded to 3¼" (8.3 cm) x 5½" (14 cm) with 3/8" (0.95 cm) hole in upper left hand corner near fold, printed on 4 pages. 1/pr.

C. 15" (38 cm) x 24" (61 cm) white tissue paper 2/pr.

D. Carton - Plain Kraft, Printed Front Panel,
Die-Cut, Self-Locking
CF, SW, B Flute, 200 lb test (90 kilos)
I.D. 18¼" L (46.5 cm) x 11" W (28 cm) x 5-13/16" D (14.8 cm) 1/pr.

E. 3" Wide (7.6 cm), 60 lb, (27 kilograms), Water Sensitive Glue Tape 3"/pr.

3. Packaging Materials - Case

A. Case - Plain Kraft, Printed Side Panel
CF, RSC, SW, 275 lb test (125 kilos)
Stitched Joint, Tab-Out 1/6 pr.
I.D. 37" L (94 cm) x 19-5/8" W (50 cm) x 11¼" D (28.5-cm)
O.D. 37¼" L (94.5 cm) x 19-7/8" W (51 cm) x 12-1/8" D (31 cm) 5.2 cu ft
(0.15 cu meters)

B. Staples on bottom flaps

C. Glue brushed on top flaps contact surface

4. Carton Printing

To be printed by the case manufacturer, in the center of the front end panel using 5/16" (0.79 cm) black capital letters and numerals as follows:

(First 9 digits of the National Stock Number)
BOOT, BLACK, COLD WEATHER, INSULATED
1 PAIR SIZE
DAAG-17-76-C-0016
A - MO/YR

The following is to be added at packing, using 5/16" (0.79 cm) black capital numerals.

1st line - (The last four digits of the National Stock Number)
3rd line - (The actual size)
5th line - (The actual month and year packed)

5. Printing - Exterior Case

To be printed by the case manufacturer on one side panel, beginning in the upper 1/3rd portion, directly to the left, using 1/2" (1.27 cm) Black Capital letters and numerals as follows:

(First 9 digits of the National Stock No.)
BOOT, BLACK
COLD WEATHER, INSULATED
6 PAIR SIZE
WT. LB (KILOGRAMS) 5.2 cu ft
UNIROYAL, INC. 0.15 cu meters
Naugatuck, CT 06770
SHIPMENT NO. CO.

From:
UNIROYAL, INC.
NAUGATUCK, CT

TO:

The following is to be added at Packing, using 1/2" (1.27 cm) Black Stencilling:

<u>1st LINE</u> - The last four digits of the National Stock No.

<u>4th LINE</u> - The actual size

The following is to be added at Warehouse shipping, using 1/2" (1.27 cm) Stencilling:

<u>5th LINE</u> - The actual weight

<u>8th LINE</u> - The shipment number and company number

To the right:- in the line with "TO":
- The consignee address

6. Warehouse Space

To warehouse 2,400 pair of boots (400 cases) 800 square feet (53.9 square meters) of floor space will be required. The warehouse will consist of five double rows of ten cases across by four cases high separated aisle ways. This layout may be subject to change, depending upon line location and local fire codes.

10. User Instruction Tag

The following user instruction tag was developed for the lightweight insulated boot and would be a purchased item.

INSTRUCTION TAG

BOOTS, COLD WEATHER, INSULATED, (BLACK) FOR WET-COLD USE

FACTS ABOUT THE INSULATED LIGHTWEIGHT BOOT

These boots have been designed to protect your feet from cold injury and frostbite in areas where moisture and cold are critical factors, and where the mean monthly temperature ranges between 14°F (-10°C) and 68°F (20°C). The boot should not be worn where temperatures fall below -20°F (-28.5°C).

The foot is kept warm through the use of microcellular polyurethane both in the upper section of the boot and the outsole.

Marching, running, or heavy work for long periods of time will cause the feet to sweat. However, this moisture cannot damage the insulation because of the waterproof lining inside the boot. The feet, even if damp, will stay warm. After a few days, your feet become used to this feeling. If these boots are worn continuously, the skin appears wrinkled and white as if it had been soaked in water. Drying the feet and putting on dry clean socks will eliminate this condition. If ice water spills into the boot, it warms to body temperature rapidly.

FOLLOW THESE INSTRUCTIONS:

Wear with one pair of socks, wool, cushion sole. Tie the lace of the snow collar snugly to hold the sock in place and to prevent slipping and wrinkling. Field trousers are to be worn outside the boots.

SIZES: Boots are supplied in whole sizes. Widths are EXTRA NARROW, NARROW, REGULAR, WIDE, EXTRA WIDE. Try on the same size insulated boots as your leather boot. If you wear a half size in leather boots, try on the next larger or smaller size for proper fit. MAKE SURE THE INSULATED BOOTS FIT PROPERLY. They have a "soft" fit. Be sure yours are large enough. Fit snug, but not tight.

Change socks at least once daily.

If your feet begin to get cold, button up all your garments and exercise the entire body by swinging the arms, stamping the feet, and rapid movement of the toes.

10. User Instruction Tag (contd.)

Wash the inside of the boot with soapy water once a month.

TRENCH FOOT AND FROSTBITE are serious cold injuries which can cause painful and permanent disability. These injuries can be prevented by proper care of your feet. No boot will keep your feet from freezing if in sub-zero weather you remain motionless for several hours. Wear the insulated boot properly and DO NOT BECOME A COLD WEATHER CASUALTY!

(The above shall be printed on 6½" (16.5 cm) x 5½" (14 cm) tag stock, so that when it is folded to 3¼" (8.3 cm) x 5½" (14 cm) the wording shall be on the front and back of each of two pages).

NOTE: A 3/8" (0.95 cm) hole shall be punched in the upper left hand corner of the fold.

XX. MOLD REQUIREMENTS

The last dimensions with standard proportionate grade as shown on Table 3 and Table 4, the government owned #54 master last, last drawing #D-021576 Figure 8, the dimensionalized boot drawing #D-3222-1A, Figure 9, and the outsole mold drawings #D-3222-6, Figure 10, and #D-3222-7 Figure 11 , provide the necessary mold requirements to enable fabrication of molds for sizes 8R, 9R, 10R, 11R and 12R, as well as sizes 10XW, 11XW, 12XW, 13XW and 14XW. Detail mold prints are not furnished for the upper mold as this will vary according to the machine eventually selected and these dimensions are furnished by the injection molding machine manufacturer to fit his machine. A general print of the outsole mold and the outsole cavity part of the upper mold based on a Desma outsole unit and Desma 1547 boot molding machine are presented for clarification purposes only. The actual dimensions of these molds will vary according to the injection molding machine selected.

TABLE 3

LAST DIMENSIONS WITH STANDARD PROPORTIONATE GRADE

(REGULAR WIDTH)

54R EX 2496	GRADE	8R	9R	10R	11R	12R	
Waist	1/4"	9-11/16"	9-15/16"	10-3/16"	10-7/16"	10-11/16"	
Ball	1/4"	9-3/4"	10"	10-1/4"	10-1/2"	10-3/4"	
Long Heel	3/8"	14-13/16"	15-3/16"	15-9/16"	15-15/16"	16-5/16"	
Ankle, 5½ Up	1/4"	12"	12-1/4"	12-1/2"	12-3/4"	13"	Grade measurement taken 1/8" grade up & down per size
Calf, 9-5/8" Up	1/4"	13-27/32"	13-31/32"	14-7/32"	14-15/32"	14-23/32"	Grade measurement taken at 1/8" grade up & down per size
Rubber Stick							Stick graduation 1/3" per size
Bunch to Toe		8-1/8	9-1/8	10-1/8	11-1/8	12-1/8	
Toe Thickness 1" back from front edge of toe		1-22/48"	1-23/48"	1-24/48"	1-24/48"	1-25/48"	Grade toe templates 1/48" in thickness per size. Templates required
Bottom Profile	Bottom profile coordinated so as to have same heel height all sizes. Templates required						
Back Profile	Grade 1/32" in height to each full size. Template required						
Last Bottom Paper Length		10-47/48"	11- 15/48"	11-31/48"	11-47/48"	12-15/48"	Grade 1/3" in length
Last Bottom-Width		3-33/48"	3-37/48"	3-41/48"	3-45/48"	4-1/48"	Grade 1/12" in width

TABLE 4

LAST DIMENSIONS WITH STANDARD PROPORTIONATE GRADE

(EXTRA WIDE WIDTHS)

54 XW	GRADE	10 XW	11 XW	12 XW	13 XW	14 XW
Waist	1/4"	10-11/16"	10-15/16"	11-3/16"	11-7/16"	11-11/16"
Ball	1/4"	10-3/4"	11"	11-1/4"	11-1/2"	11-3/4"
Long Heel	3/8"	16"	16-3/8"	16-3/4"	17-1/8"	17-1/2"
Ankle, 5½ Up	1/4"	13"	13-1/4"	13-1/2"	13-3/4	14
Calf, 9-5/8" Up	1/4"	14-23/32"	14-31/32"	15-7/32"	15-15/32"	15-23/32"
Bunch to Toe		10-1/8"	11-1/8"	12-1/8"	13-1/8"	14-1/8"
Toe Thickness	1/48"	1-25/48"	1-26/48"	1-27/48"	1-28/48"	1-29/48"
Bottom Profile		10R	11R	12R	13R	14R
Back Profile	1/32"	10R+1/16"				
Last Bottom Length	1/3"	11-31/48"	11-47/48"	12-15/48"	12-31/48"	12-47/48"
Last Bottom Width	1/12"	4-1/48"	4-5/48"	4-9/48"	4-13/48"	4-17/48"
Stick Measurement		± 1/32"				
All Girth Measurements		± 1/16"				
Last Against Bottom Paper		± 1/32" Length				
		± 1/48" Width				

XXI. STITCHING REQUIREMENTS

1. Socklining/Leglining Stitching Procedure

The boot leglining and socklining are made of 1830/1 black, urethane coated nylon tricot weighing $4.8^{+0.5}_{-0.3}$ ounces per square yard ($162.8^{+17}_{-10.2}$ grams per square meter). These parts are clicker cut from roll stock using dies graded from the size 10R cutting pattern. The leg lining will be folded and the front seam edge closed, using a merrow style A-3-3 stitch, using a loose thread tension at eight stitches per inch (2.54 cm). The proper sized sockling is then stitched to the bottom of the leg lining, using a merrow style A-3-3 stitch, using a loose thread tension at eight stitches per inch (2.54 cm). The coated side of the lining is to be placed to the inside on both parts. Number 69 black nylon thread is used in all sockliner/legliner stitching operations.

2. Collar Stitching Procedure

In the collar operation, the appropriate size collar is clicker cut from roll stock 1830/1 black, urethane coated nylon tricot weighing $4.8^{+0.5}_{-0.3}$ ounces per square yard ($162.8^{+17}_{-10.2}$ grams per square meter) using dies graded from the size 10R cutting pattern. After cutting the collar is eyeletted, centered to a die-cut location hole using a United Shoe Machine Model B eyeletter with washer type eyelets. There are two eyelets and two washers per collar and the eyelet must be on the nylon tricot. With a one-half (side) part of the collar laid flat, nylon side up, and the eyelet to the left, and size notches to the bottom the contractual markings are to be stamped onto that part which is approximately 1" (2.54 cm) below the eyelet and centered within this area. White ink shall be used. With this side collar so stamped and placed, a mated side panel (not stamped) is placed over the first side, nylon-to-nylon. The curved side edges are then single needle, lock-stitched together, using a Singer Model 168 post-seamer or similar machine. A stitching margin of 1/8" (0.32 cm) and a setting of eight stitches per inch (2.54 cm) are to be maintained. With the eyelets centered to the front position and the collar backseam centered to the rear of the boot top, the inside bottom edge of the collar is then attached to the inside of the top edge of the boot with the inside edge of the collar overlapping the inside top edge of the boot with a 1/4" (0.635 cm) margin, using

2. Collar Stitching Procedure (contd.)

an Ozan overedge sewing machine set at six stitches per inch (2.54 cm). A 36-inch (91.44-cm) black tubular cotton lace with black acetate tip is inserted through the eyelet, looping it around the collar. The top part of the collar is folded down overlapping the top outside edge of the boot by 3/4" (1.9 cm) and zig-zag stitched at six stitches per inch (2.54 cm) with a 1/8" (0.32-cm) minimum/1/2" (1.27-cm) maximum stitching overlap using a Singer Model 107W50 sewing machine. At the back seam of the collar, approximately 1" (2.54 cm) down from the folded top edge and lace, the collar is bar-tack stitched together, horizontally to the top edge for a distance of approximately 1" (2.54 cm), using a Singer Model 269 bar tacker sewing machine. Number 69 black nylon thread is used in all collar stitching operations.

3. Stitching Standards

A. Leglining

Close stitch leglining - front - merrow stitch style A-3-3 - loose tension - eight stitches per inch (2.54 cm) standard - ten stitches per inch (2.54 cm) maximum - six stitches per inch (2.54 cm) minimum.

B. Socklining

Close stitch leglining/socklining - merrow stitch style A-3-3 - loose tension - eight stitches per inch (2.54 cm) standard - ten stitches per inch (2.54 cm) maximum - six stitches per inch (2.54 cm) minimum.

C. Collar

a. Eyelet

Number 606 telescopic black enamelled aluminum eyelet - two per collar required.

b. Collar Seaming

Seam collar ends 1/8" (0.32 cm) - single needle lockstitch seam - eight stitches per inch (2.54 cm) standard - ten stitches per inch (2.54 cm) maximum - six stitches per inch (2.54 cm) minimum.

c. Collar Attaching - Inside

Join collar inside bottom to boot inside top edge overlapping boot with 1/4" (0.635 cm) margin Ozan overedge type stitch - six stitches per inch (2.54 cm) standard - eight stitches per inch (2.54 cm)

c. Collar Attaching - Inside (contd.)

maximum - five stitches per inch (2.54 cm) minimum - over lap 1/8" (0.32 cm) minimum, 1/2" (1.27 cm) maximum.

d. Collar Attaching - Outside

Join collar outside bottom to boot outside top edge overlapping boot with 1/2" (0.635 cm) margin - zig-zag lockstitch - six stitches per inch (2.54 cm) standard - five stitches per inch (2.54 cm) minimum - eight stitches per inch (2.54 cm) maximum - 1/8" (0.32 cm) minimum stitching overlap - 1/2" (1.27 cm) maximum stitching overlap.

e. Bar Tack Collar

Horizontal bar tack collar one inch (2.54 cm) below folded top edge of collar - single needle lockstitch seam or bar tack seam one inch (2.54 cm) long.

f. Thread

Number 69 black nylon thread to be used in all stitching operations.

4. Stitching Equipment

A. Collars

a. Seam Collars - Singer 138 WSV7 Post Seamer or Singer 168 WSV7 Post Seamer

b. Eyelet Collars - U.S.M. Model "B" Eyelet Machine with telescopic hopper

c. Stitch Collar to Boot (Inside) - Ozan Overedge Stitching Machine

d. Stitch Collar to Outside of Boot - Singer 107 W50 Zig-Zag Sewing Machine

e. Bar Tack Collar to Boot - Singer 269 Bar Tacker

B. Leglining

a. Close Stitch Leglining - Front of Leg - Merrow Stitcher Style A-3-3

b. Close Stitch Leglining - Bottom of Leg - Merrow Stitcher Style A-3-3

XXII. OUTSOLE SPRAY MASK

1. Equipment and Materials Required

Item	Description	Source
A. Vacuum Former	Starlett Model S-2424-A	Comet Industries 2500 York Road Elk Grove Village, Illinois 60007
B. Mask Material	0.025 Gauge Polyethylene Sheet	Cadillac Plastics Co. Detroit, Michigan
C. Master Form	Drawing D-3291 Sheet No. 1	Fabricate From Boot Outsoles

2. Fabrication Procedure

Cut polyethylene sheets to size as specified by Vacuum Former manufacturer. Place vacuum box and master form on vacuum former per manufacturer's instructions. Place cut polyethylene sheet in clamping frame. Heat for 60 seconds with top and bottom heaters at 55% setting - stock temperature 195-200°F (90.6-93.3°C). Vacuum form sheet over master form. Cool formed spray mask for 40 seconds. Release vacuum and remove spray mask from unit. Trim spray mask as shown on drawing D-3291 sheet No. 1 (Figure 16). Trials conducted have shown the above equipment and forming method can be expected to yield 30 spray masks per hour of operation.

XXIII. OUTERSKIN COATING

1. Outerskin Coating Process Description

It has been determined that the Ransburg electrostatic coating method is the best method of coating the boots. The basic principle is to pump two components to a spinning disc, mixing the components just prior to depositing in a well located in the center of the disc. The disc can be programmed to raise and lower in order to deposit the coating where desired from top to bottom. The spinning disc "sprays" the coating toward the rotating boot and is electrostatically attracted to the boot.

In preparation for electrostatic spray coating, the boot is damp wiped with methyl ethyl ketone over its entire outside surface - with the exception of the bottom of the outsole - to remove any surface contamination. A release agent (stapler wax) is applied to the vamp-throat area. The release agent is then allowed to dry at room temperature for 15 minutes. The boot is hooded over a metal support form (short last) and a vacuum-formed polyethylene spray mask is tacked over the bottom of the outsole of the boot, using two thumb tacks or two pieces of double-sided tape. The boot is then attached to the Ransberg electrostatic spray monorail. The boot is then passed through the electrostatic spray system where the boot is sprayed with a polyurethane coating compound for 12 minutes. During spraying the metal support form is grounded and the polyurethane spray is given an electrically positive charge to attract the spray coating to the surface of the boot.

The boot is then allowed to air-dry for 24 minutes at room temperature to allow the solvent to evaporate. The boot is then passed through a hot air cure oven for 24 minutes. The oven temperature is maintained at 250°F (121°C) for the duration of the cure. The boot is then allowed to air cool at room temperature for 16 minutes. The metal support form and polyethylene spray mask are removed from the boot, and the boot is placed on a boot dryer truck (60-pair capacity). When the truck is full, it is placed in a final solvent evaporation oven for 12 hours. The final solvent evaporation oven is a hot air oven which is maintained at a temperature of 160°F (71.1°C) with a capacity of 180 pair of boots. After the boots are removed from the final solvent evaporation oven, they are allowed to cool at room temperature for one hour. See sketch No. 052477 "General Layout for Electrostatic Boot Coating" Figure 5, for process configuration.

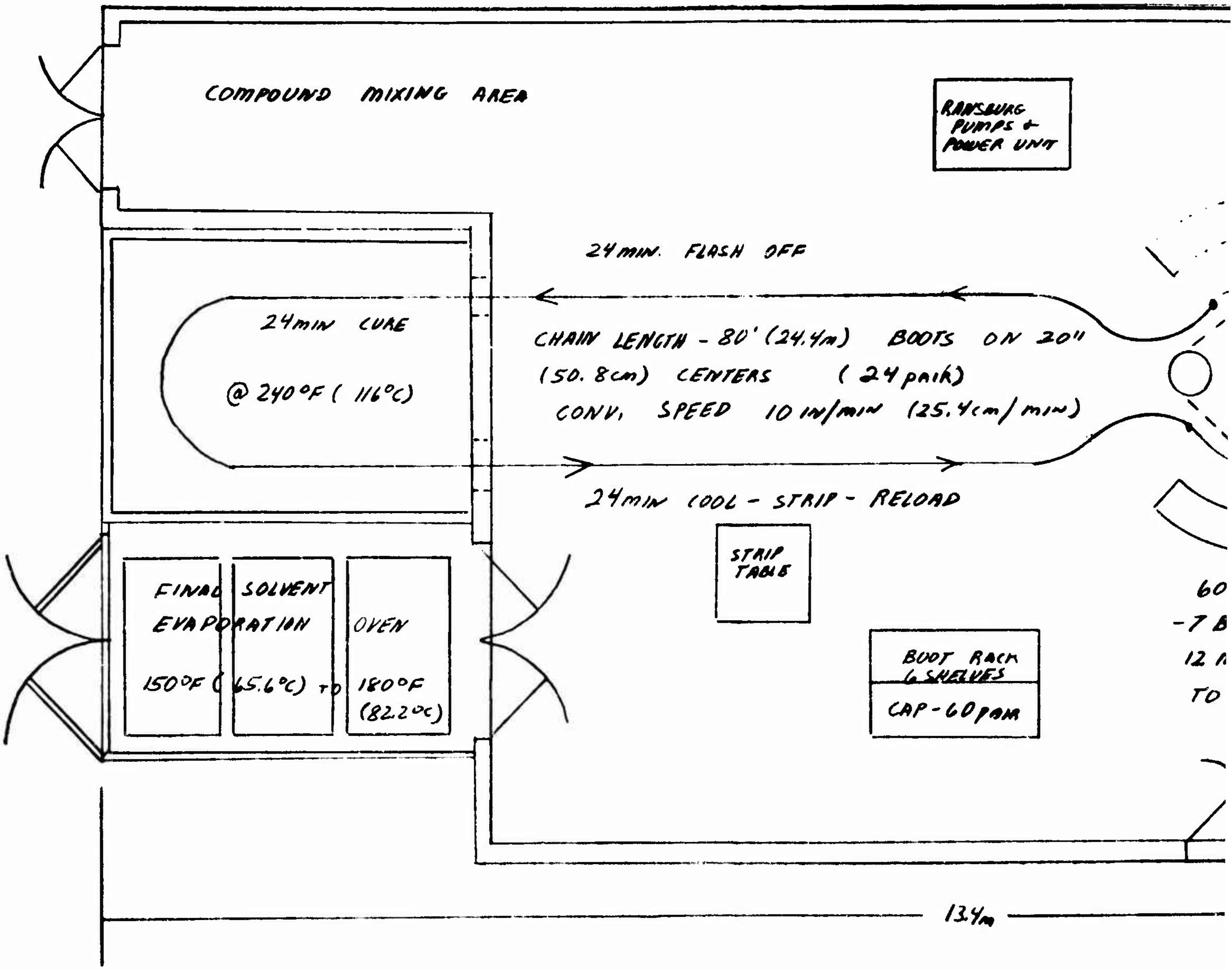
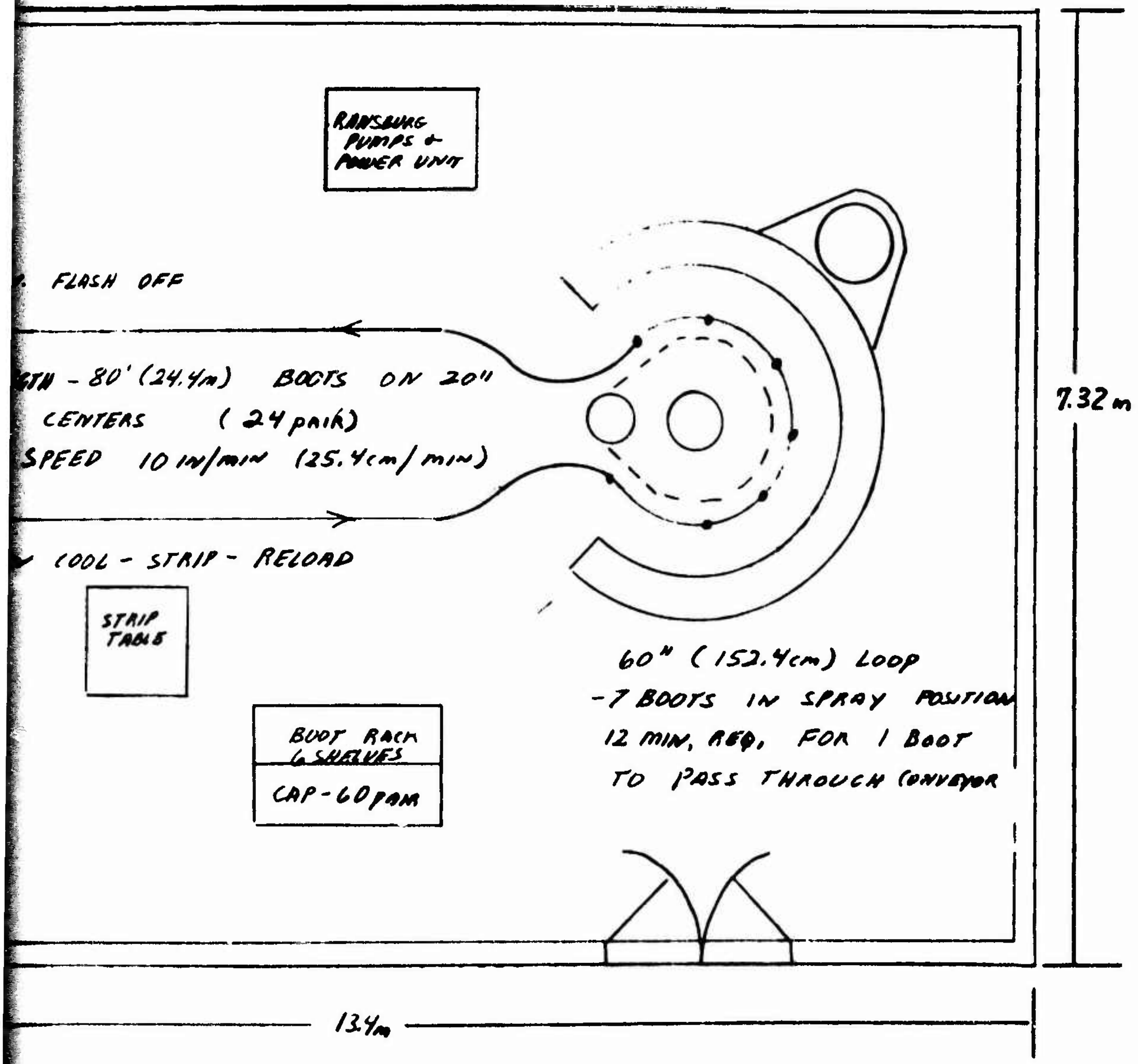


FIGURE 5. GENERAL LAYOUT FOR ELECTROSTATIC BOOT

1



LAYOUT FOR ELECTROSTATIC BOOT COATING

D-052477

2. Coating Cycle Times

Operation	Temperature	Time
A. Spraying	Room Temperature	12 minutes
B. Solvent Flash Off	Room Temperature	24 minutes
C. Cure	250°F (121°C)	24 minutes
D. Cool	Room Temperature	16 minutes
E. Heat Soak	160°F (71.1°C)	12 hours
F. Cool	Room Temperature	1 hour

3. Ventilation Requirements

See "Moeller Engineering Electrostatic Coating System" Appendix G, "Environmental Considerations Ruling on Compliance with State Regulations" Appendix D, and Figure D-1 Appendix D.

4. Environmental Criteria

See "Ruling on Compliance with State Regulations" in Appendix D.

5. Equipment Design Criteria

Based on successful trials made and the data collected, the following are the specifications used to design the complete electrostatic spray system. (See "Ransburg Trip Report" by R. J. VanTwisk in Appendix A.)

A. The layout, Figure 5, details the room size, conveyor length and speed, cure oven, evaporation oven, etc.

    a. Area of room, including ovens 44 ft (13.4 m) x 24 ft (7.32 m) = 1056 sq ft (98.1 sq m)

    b. Total length of conveyor 80 ft (24.4 m) - 48 boots (24 pair) to fill on 20 inch (50.8 cm) centers. Conveyor speed 10 inches/minute (25.4 cm/minute) (adjustable from 8 inches (20.32 cm) to 14 inches (35.56 cm)/minute). Diameter of loop in booth - 60 inches (152.4 centimeters).

B. The solvent evaporation rates in the various areas are as follows:

Area	Calculated Grams Per Hour	Design Grams Per Hour (Approx. 50% Safety Factor
Spray Booth	2400	3600
Flash-off Area	210	300
Cure Oven	690	900
Cool Down	270	350
Final Evaporation Oven	510	700
	4080 grams/h	5850 grams/h
	or 9.1 lb/h	or 12.9 lb/h

C. Cure oven explosion-proof electric heat source and controls to provide temperature from 180°F (82.2°C) to 260°F (126.7°C) ± 10°F (5.55°C).

D. Final evaporation oven to provide temperature from 150°F (65.6°C) to 180°F (82.2°C) ± 10°F (± 5.55°C).

E. Sufficient exhaust (CFM) to be provided to completely exhaust all solvent fumes. Heating of makeup air (BTU's required) to be provided for 0°F (-17.8°C) outside air.

F. Final exhausted fumes to meet EPA and State of Connecticut regulations for the solvent system as used.

G. The basic standard Ransburg equipment to be used with the following modifications.

   a. Barmag gear pumps to be 0.5 cc/revolution, and 1 cc/revolution.

   b. Polyethylene hoses from feed tank to suction side of pumps, and from discharge side of pumps to static mixer to be 1/4" (0.635 cm) I.D.

   c. The static mixer used should be sized to properly mix a flow rate of 180 grams to 250 grams per minute.

   d. The vertical reciprocating action of the disc need be only 20 inches (50.8 cm) maximum, with adjustable settings, to achieve a minimum of 10 inches (25.4 cm). In addition, two additional micro switches on the reciprocating control that can be adjusted to any point between the top and bottom stroke controls will be required. While the cam will pass over and mechanically activate the "middle" micro switches, it will only stop the stroke at this point when these switches are electrically activated. They are to be electrically activated by means of a percentage timer. This will permit directing the spray toward a certain section of the boot (as example, the vamp area) for a time percentage of 0% to 100% of the 12 minutes the boots are sprayed. The reciprocating speed should be adjustable from 10 ft (3.048 m) to 20 ft (6.096 m) per minute.

e. The disc should be of the type where the material enters the well through the bottom. Diameter 15" (38.1 cm) RPM variable from 600 to 1200 revolutions per minute.

f. The boot rotation speed to be variable from 3 RPM to 9 RPM.

g. The compounds to be fed to the pumps from a 5-gallon (18.9-liter) and 20-gallon (75.6-liter) pressure tank. The air source to pressurize the tanks must be dry air provided by a commercial air dryer.

H. The room must be humidity controlled to 50% humidity, + 10% - 20%. The incoming makeup air temperature can be figured at 90°F (32.2°C) maximum. No cooling of air is required.

6. General Planned Operating Parameters

A. Last sizes can be two sizes smaller than the boot being sprayed. This will facilitate mounting and removing from the last. A removable toe will be required.

The lasts will be of a thinner wall thickness to reduce weight - as thin as possible in relation to suitable strength. (See drawing No. D-3154 sheet 8 Figure 15)

The conveyor will require 24 pair of lasts to fill. It is possible to run three sizes at one time at a given material through-put setting. Therefore, 8 pair of lasts for each whole size will be required (widths will not affect requirements). If ten whole sizes are to be run, storage area and racks for 80 pair of lasts will be needed.

B. The total through-put of the material in grams per minute is calculated by multiplying the desired dry weight per boot by 222% (to account for 45% total solids); multiplying by seven (7 boots in booth); and dividing by 12 minutes (spray time). This result multiplied by 112% to account for 90% spray efficiency equals the total through-put. Example: 100 grams dry weight desired.

x 222% = 222 grams
x 7 = 1554 grams
÷ 12 minutes = 130 grams/minute
x 112% = 156 grams/minute total through-put

The total through-put is the material delivered by both pumps, and must also be in the proper ratio dictated by the formulation. To obtain the same gauge of coating on a size 5 boot (run with size 4 and size 6) as on a size 13 boot (run with size 12 and size 14) it will be necessary to calculate the surface area of the upper and adjust the through-put accordingly. On a percentage comparison basis the through-put of each pump can be controlled by the RPM speed by means of a dial setting. The actual grams per minute is checked through a petcock at the delivery end of the hose by running for 1 minute into a paper cup and weighing. Additional adjustment to pump speed can then be made to provide the exact delivery rate required.

C. With a production rate of 30 boots per hour, one operator is all that is required to remove last, relast another boot, wipe boot with solvent and place mask. However, for safety reasons, (one operator should not work alone in a closed room) two should be figured in the manning table. The second operator can mix compounds, fill supply tanks as needed, service racks in-and-out of final evaporation oven, and remove masks before boots enter oven if necessary (required work time 2 minutes each, 24 minute cycle).

D. The equipment, materials,and manufacturing methods for the spray masks are covered in a separate section of this report. The masks were removed before cure in the trials. However, since the masks fit the design area perfectly, it may be possible to leave them on during cure. They will soften, but the close fit should keep them to the proper shape. After 16 minutes cool-down, they should be sufficiently stiff to remove and reuse. Very little spray is deposited on the bottom of the masks. They can be used continuously for at least one day. Any coating then can readily be peeled off after an 8-hour air cure.

E. An air-operated vice, mounted on a table to clamp the hanger strip on the top of the last, will facilitate removal of last from boot. After 16 minutes cool-down, the boot is about 100°F (37.8°C) and can be handled without gloves. However, the last is about 170°F, (76.7°C) due to the insulating qualities of the boot. The last should be water quenched before it is recycled.

F. A rack to hold the boots is shown on the layout. The rack dimension is 5 ft (1.52 m) long x 3 ft (0.91 m) wide x 84 inches (213 cm) high. There are 6 shelves in the rack, each shelf holding 10 pair. These racks will pass through the final evaporation oven allowing 12 hours to drive off any remaining solvent. Boots will then be ready for final operations.

G. Coating Thickness Specifications

a. All areas other than vamp 0.035" ± 0.005 (0.889 mm ± 0.127)

b. Vamp area 0.030" ± 0.010(0.762 mm ± 0.254)

7. Coating Gauge Test Method

To test the coating gauge a boot is to be coated with a release agent (Staplers Wax) and electrostatically sprayed with coating. After curing, the boot is to be cut up the back and the coating removed from the boot in one piece. This coating is to be checked for gauge, tensile, elongation, and other testing as specified.

8. Coating Equipment

See "Moeller Engineering Electrostatic Coating System" for equipment required, Appendix G.

XXIV. MOLDING MACHINE THROUGHPUT CALCULATIONS

1. Outsole Molding Unit (Based on Desma Equipment)

704-12 with Desma conversion package

15-minute cure @ 190°F (84°C)

Assume 1 station lost for sole removal
1 station lost for injection

Cure must be accomplished in 10 stations

$\frac{\text{15 minutes}}{\text{10 stations}}$ - 1.5 minutes/station

Cycle Time = 1.5 minutes x 12 stations = 18 minutes

Unit Capacity = 1 pair of outsoles ever 3 minutes
= 20 pair of outsoles/hr assuming no production or mechanical losses

CYCLE:

Station 1:	Strip outsole and buff flash	1.5 minutes
Station 2:	Inject outsole) Cure outsole)	1.5 minutes
Station 3-	Cure outsole	15 minutes

Mold opens between Station 12 & 1

Mold closes between Station 1 & 2

2. Upper Molding Unit (Based on Desma Equipment)

Note: 12 station Desma 1546 Unit
17 minutes cure time

Assume: 1 station lost for lasting and stripping
1 station lost for injection
Cure must be accomplished in 10 stations

$\frac{\text{17 minutes}}{\text{10 stations}}$ = 1.7 minutes/station

Cycle time = 1.7 minutes x 12 stations = 20.4 minutes

2. Upper Molding Unit (contd.)

Unit Capacity = 1 pair of boots every 3.4 minutes
= 17.6 pair/hour

For one operator 2 minutes work time is required - use 2 min./station

Unit Capacity = 1 pair of boots every 4 minutes
= 15 pair/hour

CYCLE:

Station 1:	Strip boot and set on conveyor Sock line last Tape sockliner seam Vythene wash sock Place outsole in cavity	2.0 minutes
Station 2:	Inject Cure upper	2.0 minutes
Station 3:	Cure upper	2.0 minutes
Station 4:	Cure upper	2.0 minutes
Station 5:	Cure upper	2.0 minutes
Station 6:	Cure upper	2.0 minutes
Station 7:	Cure upper	2.0 minutes
Station 8:	Cure upper	2.0 minutes
Station 9:	Cure upper	2.0 minutes
Station 10:	Cure upper	2.0 minutes
Station 11:	Cure upper	2.0 minutes
Station 12:	Cure upper	2.0 minutes

Mold opens between Station 12 & 1

Mold closes between Station 1 & 2

XXV. MOLDING UNIT OPERATING REQUIREMENTS

Based on trials utilizing a polyair SA-1 polyurethane mixer, a Desma PSA-71 polyurethane mixer, a Desma 1547 boot station, a size 10R boot mold and a polyair unit station, the following molding unit operating requirements were established for the outsole and upper molding units.

1. Outsole Molding Unit

A. General Requirements

Twelve-station unit with mold size capability of up to size 14XW. Individual stations to be equipped for mold heating with feedback type temperature controls capable of maintaining molds at 190°F ± 2.8°). Polyurethane mixing unit to be equipped for two-component metering and mixing with the through-put variable from 40 to 80 grams per second. Mixer to be equipped with two 20-cc pumps driven by quick change ratio gears by a single electric motor. "A" and "B" component valves to be operated by a common actuator with provisions for individual valve lead/lag adjustment. Shot volume to be controlled by means of impulse counters. One impulse counter required for every two stations. Unit to be supplied with two compound tanks and necessary compound hoses. Compound tanks, compound hoses, pump blocks, and mixing head to be equipped for heating/cooling as required to maintain proper material temperatures. All necessary temperature control systems to be supplied with unit.

B. Detail Requirements

a. Material Tanks

Two material tanks of 5-gallons (18.9-liter) working capacity, with steel double walls and necessary fittings for recirculating heating/cooling media, variable speed agitators, top fill ports, bottom drain cocks, and stainless steel material filters. Tanks to be equipped for nitrogen pre-pressure up to 5 atmospheres with the necessary safety valves, regulators, and line valves. Direct reading thermometers and thermocouples for material temperature control to be installed in tanks. All tank seals to be of Viton or Teflon.

b. Recirculating Temperature Control System to Provide the Following Temperature Ranges:

Head		70 to 200°F	(21.1°C to 93.3°C)
Pumps	A.	70 to 200°F	(21.1°C to 93.3°C)
	B.	70 to 200°F	(21.1°C to 93.3°C)
Compound Lines	A.	70 to 200°F	(21.1°C to 93.3°C)
	B.	70 to 200°F	(21.1°C to 93.3°C)
Tanks	A.	70 to 200°F	(21.1°C to 93.3°C)
	B.	70 to 200°F	(21.1°C to 93.3°C)

With Actual Operating Temperatures to be:

Mixing Head		125°F	(51.7°C)
Pumps:	A.	165°F	(73.9°C)
	B.	165°F	(73.9°C)
Compound Lines	A.	165°F	(73.9°C)
	B.	165°F	(73.9°C)
Material Tanks	A.	165°F	(73.9°C)
	B.	165°F	(73.9°C)

c. Unit to be capable of handling and mixing materials with viscosity ranges from 100 to 1500 cps.

d. Unit to be capable of operating at a ratio of 70.485 to 81.4 of "A" to "B" component.

2. Upper Molding Unit

A. General Requirements

Twelve-station unit with mold size capability of up to size 14XW. Individual stations to be equipped for mold heating with feedback type temperature controls capable of maintaining the molds at the temperatures listed. Polyurethane mixing unit to be equipped for three-component metering and mixing with the through-put variable from 40 to 80 grams per second. Mixer to be equipped with two 20-cc and one 6-cc pump driven by quick change ratio gears by a single electric motor, or by a single electric motor for the "A" and "B" components, with a second drive for the "C" component with the necessary electronics for synchronization of the two motors.

2. Upper Molding Unit (contd.)

A. General Requirements (contd.)

"A", "B", and "C" component valves to be controlled by a single actuator or alternately "A" and "B" component actuated by a single actuator with the "C" component actuated by a separate actuator with the necessary electronic controls for valve synchronization and lead/lag adjustment. Shot volume to be controlled by means of impulse counters. One impulse counter required for every two stations. Unit to be supplied with three compound tanks and necessary compound hoses. Compound tanks, compound hoses, pump blocks, and mixing head to be equipped for heating/cooling as required to maintain proper material temperatures. All necessary temperature control systems to be supplied with unit.

B. Detail Requirements

a. Material Tanks

Three material tanks with steel double walls and necessary fittings for recirculating heating/cooling media, variable speed agitators, top fill ports, bottom drain cocks, and stainless steel material filters. Tanks to be equipped for nitrogen prepressure up to 5 atmospheres with the necessary safety valves, regulators, and line valves. Direct reading thermometers and thermocouples for material temperature control to be installed in tanks. All tank seals to be of Viton or Teflon. Tanks to have the following working capacities:

Upper component A	- 6-gallons	(22.7 liters)
Upper component B	- 4-gallons	(15.2 liters)
Upper component C	- 1-gallon	(3.79 liters)

b. Recirculating temperature control system to provide the following temperature ranges:

<u>Head</u>		70 to 250°F	(21.1 to 121°C)
<u>Pumps</u>	A.	70 to 250°F	(21.1 to 121°C)
	B.	70 to 250°F	(21.1 to 121°C)
	C.	32 to 60°F	(0 to 15.6°C)
<u>Compound Lines</u>	A.	70 to 250°F	(21.1 to 121°C)
	B.	70 to 250°F	(21.1 to 121°C)
	C.	32 to 60°F	(0 to 15.6°C)

b. Recirculating temperature control system to provide the following temperature ranges: (contd.)

<u>Tanks</u>	A.	70 to 250°F (21.1 to 121°C)
	B.	70 to 250°F (21.1 to 121°C)
	C.	32 to 60°F (0 to 15.6°C)

With actual operating temperatures to be:

(1) <u>Tanks</u>		
a) Prepolymer	220°F	(104°C)
b) Hardener	220°F	(104°C)
c) Blowing Agent	50°F	(10°C)
(2) <u>Hoses</u>		
a) Prepolymer	220°F	(104°C)
b) Hardener	220°F	(104°C)
c) Blowing Agent	50°F	(10°C)
(3) <u>Pumps</u>		
a) Prepolymer	220°F	(104°C)
b) Hardener	220°F	(104°C)
c) Blowing Agent	50°F	(10°C)
(4) <u>Head</u>	110°F	(43.3°C)

c. Mold Temperatures

Last heated to:	250°F	(121°C)
Right ring heated to:	170°F	(76°C)
Left ring heated to:	170°F	(76°C)
Sole plate heated to:	170°F	(76°C)

d. Unit to be capable of handling and mixing materials with viscosity ranges from 100 to 1500 cps.

e. Unit to be capable of operating at a ratio of 95.10A to 49.96B to 16.80C.

XXVI. LINE TEST PROCEDURE

1. Equipment

A. Operate line equipment demonstrating all preparatory, making, and finishing operations can operate at the required level to produce 9 pair of finished boots per hour.

B. Mold boots in each size mold, purchased as part of the contract to demonstrate the making machine capability to accommodate the required mold sizes. Perform all finishing operations on the molded foam boots to demonstrate complete boots can be made in all required sizes. It is recommended that one pair of size 14XW molds be purchased to test the ability of the line equipment to handle the largest size required.

C. Two boots made in the same mold under identical process conditions will be sectioned in half at the mold center line and gauged at various points. The gauges of the two boots at corresponding points will be compared to show the reproducibility of thickness demonstrating the positive last location in the mold cavity. In addition, the gauges obtained will be compared with the insulation thickness range as shown in Attachment 2 Item 1 (d) of solicitation No. DAAK 60-77-R-0020, Appendix II, to verify that the correct insulation thickness is incorporated into the mold.

D. Successful molding of the boots will verify the following:

a. The ability of the injectors to handle Quasi Prepolymer PTMG compounds.

b. The two and three stream capability of the injectors.

c. The ability to independently heat or cool the individual components.

d. The ability to change shot size for various boot sizes.

e. The ability to change component ratios for different compounds.

E. Three boots made in the same mold under identical process conditions will be weighed and compared to demonstrate the preciseness of the shot size setting.

F. The mixing head will be heated and cooled to verify the capability of running hot or cold.

G. The compound nitrogen capping system will be demonstrated.

H. The use of the temperature controls on the unit stations will be demonstrated.

I. The compound tanks will be heated and cooled to demonstrate the ability to change compound temperature.

J. No compound metering capability will be incorporated into the unit stations. All compound metering will be controlled from the molding unit control panels.

K. Run injectors with varying gear combinations. Use same length of time per trial shot and catch output in a container. Weigh the containers to demonstrate the change in weight delivered. Run multiple shots at any one setting to demonstrate reproducibility of shot weight.

L. Randomly select boot components at various stages of completion and demonstrate specifications are being met as required.

M. With supply pumps in ratio raise and lower mixing head through-put and take multiple cup samples at a minimum of 3 settings. Check total output at the various settings and check cups taken at same settings and compare weight delivered.

N. Catch the output of each pump individually and catch a minimum of 3 cups to demonstrate the time versus output is reproducible at a given pump setting.

O. With the supply pumps in ratio catch the output at various stations which because of varying mold size require different shot sizes. Catch a minimum of 3 cups at the selected stations and weigh to demonstrate reproducibility.

P. The remaining boots will be electrostatically spray-coated to demonstrate the capabilities of the coating system. In addition, one boot will be coated with a release agent prior to spraying so that the coating may be removed from the boot after curing and checked for gauge uniformity. All areas other than vamp 0.030" minimum, 0.040" maximum; vamp area 0.020" minimum, 0.040" maximum.

2. Boots

A. Test boot sections, or slab shot at same time as boots were made, against Table 1. Take a randomly selected yard of sockclining-snow collar coated fabric and test against Table 2.

B. Take completed boot selected randomly and test against acceptance standards Section XVI.

C. Take randomly selected boots and test for water pickup and measurement requirements as per Appendix H.

XXVII. QUALITY CONTROL PROCEDURE

1. Startup Procedure (Check the following at startup)

A. Supply Containers

a. Level of compound
b. Agitator running - where required
c. Temperature
d. Pressure level

B. Ratio Checks

a. Check flow of each component on each foam machine (LIM) to determine if ratios are correct

C. Mixer Housing and Screw

a. Cleanliness
b. Pressure to shutoff valves
c. Leaks - supply lines - valves
d. Screw running free
e. Temperature of mix head

D. Foam-Cup Check

a. Catch mixed compound from LIM in cup and let blow. Check cream, rise and tack free time. Check free blow density.

E. Molds

a. Temperature

F. Electrostatic Spray

a. Check flow rates of each component through mixer
b. Check total through-put through mixer
c. Spray boot previously coated with release agent
d. Strip coating and check gauge

2. Running Procedure

A. Repeat ratio check at approximately shift midpoint (4 hours). If experiencing problems in foam quality, run as required to pin-point problem.

B. Change mixing screw every 2-4 hours as material buildup dictates.

C. Make foam slab after machine has equalized - approximately 1/2 hour after startup and then once per day.

D. Check foam slab for density, appearance and fold corner on itself to determine the degree of cure.

E. Weigh complete boot.

F. Gauge boot at points.

   a. 3½" down on front and rear mold parting line.
   b. Midway between front and rear mold parting line and 3½" down from top edge.

G. Inspect boots per Section XVI "Acceptance Standard - Visual Examination".

H. Test foam slabs twice per week against Table 1.

I. Select two pair of complete boots weekly and test against Table 1 and for water pickup.

XXVIII. EQUIPMENT REQUIREMENTS:

The listed equipment model numbers and sources are for reference purposes only and are not to be considered the only sources available. In most cases generic equivalent are available.

1. Laboratory and Testing Equipment

ITEM	QUANTITY	MODEL	SUPPLIER
A. Aquatester II	1	702	Photovolt, Inc. New York City, NY
B. Sartorius Analytical Balance	1	2442	General Scientific
C. Glass Ware	-	-	Fisher Scientific
50 ml Burettes 250 ml Erlenmeyer Flasks 50 ml Pipettes 1000 ml Beaker 10 ml Graduate 500 ml Volumetric Flask			
D. Magnetic Stirrer	1	Thermix 118	Fisher Scientific
E. Miscellaneous	-	-	Fisher Scientific
Glass Syringe - 1 cc, 2 cc, and 5 cc Hypodermic Needle - 1½" - #12 Plastic Syringe - 10 cc with 6" plastic tube Plastic Funnel 3" diameter			
F. Stop Watch	1	-	-

1. Laboratory and Testing Equipment (contd.

ITEM	QUANTITY	MODEL	SUPPLIER
G. Instron Tester with Environmental (Chamber)	1	TM	Instron Company Camden, MA
H. Steel Sample Cutting Dies: 1/8" x 1¼", 2" x 2", 1" x 1", 1.28" diam., 1" x 8", Die C Tear, 1/2" Tensile Dumbell, 2"x6"	1 ea	-	Brockton Cutting Die & Manufacturing Co. Avon, MA 02322
I. Molds for producing slabs 5" x 12" x 1/4", 5" x 12" x 3/4"	1 ea	-	Compo Industries Waltham, MA
J. NBS Abrader	1	-	H. W. Wallace Co. Croydon Surrey, England
K. Gehman Tester	1	-	B. K. Elliott Cleveland, OH
L. Shore A Hardness Tester	1	-	Shore Instrument Co., Jamacia, NY
M. Polyair Flexer	1	-	Polyair, Inc. Kittsee, Austria
N. Electric Oven (RT 400°F)	1	-	Precision Scientific Chicago, IL
O. Scott Ball Burst Tester	1	-	Scott Testers Providence, RI
P. Snap Gauge (0.001")	1	5822	Ames Company Waltham, MA

1. Laboratory and Testing Equipment (contd.)

ITEM	QUANTITY	MODEL	SUPPLIER
Q. Torbal Balance	1	PL-12	Torsion Balance Co., Clifton, NJ

2. Preparatory Requirements

	REQUIRED QUANTITY	DESCRIPTION	SOURCE
A. Fabric Cutting:			
a. Cutting press	1	Atom Model G-999	Hudson Shoe Machinery Co.
b. Cutting dies	6 sets	-	Brockton Cutting Die Co.
c. Cut parts-trucks	4	Drawing No. D-3290 Figure 14	-
d. Die rack	1	SR-712	Cutters Exchange Co.
e. Lay up table	1	Cut line cutting table	Cutters ExchangeCo.
f. Roll let off rack	1	No. 11620-UW	Cutters Exchange Co.
g. Cut parts-baskets	20	No. 31618	Cutters Exchange Co.
B. Stitching:			
a. Post seamer	2	Model 138 WSVZ	Singer Corp.
b. Eyelet Machine	1	Model "B" with telescopic hopper	United States Shoe Mach. Corp.
c. Ozan overedge machine	2	-	Ozan Corp.
d. Zig-zag machine	2	Model 107W50	Singer Corp.
e. Bar tacker	2	Model 269	Singer Corp.
f. Merrow stitch	2	Style A-3-3	Merrow Sewing Machine Corp.
g. Stitched parts-trucks	4	Drawing No. D-3290 Figure 14	-
h. Stitched parts-baskets	20	No. 31618	Cutters Exchange Co.
i. Thread racks	1	XR-712	Cutters Exchange Co.

2. Preparatory Requirements (contd)	REQUIRED QUANTITY	DESCRIPTION	SOURCE
C. Spray Mask Forming:			
a. Vacuum former	1	Starlett Model S-2424-A	Comet Industries 2500 York Road Elk Grove Village, Illinois 60007
b. Master form	1 pr/mold size	Drawing D-3291 Sheet No. 1 Figure 16	Fabricate From Boot Outsoles
c. Mask storage racks	2	XR712	Cutters Exchange Co.
d. Last storage racks	4	XR812	Cutters Exchange Co.
D. Compound Preparation & Mixing:	QUANTITY	MODEL/DESCRIPTION	SOURCE
a. Eight drum PTMG/B602 storage oven with exhaust system 8'x12'x7'	1	PS-3-655	Dispatch Oven Co.
b. 55-gallon drum rollator	4	190328	Global Equipment Co.
c. MDI prepolymer melting bath	1	Drawing No.D-3287 Sheets 1,2,3 Figures 19-20-21	-
d. 14-cu ft freezer -explosion-proof	1	- 14 cu ft explosion-proof	-
e. 10 x 14 ft compound mixing - B602 storage room	1	Separate room within building with temperature and humidity control system (75°F ± 5°F - 24 ± 2.8°C) 50% relative humidity ± 5%) heating, lighting, ventilation and sprinkler system	

D. Compound Preparation (contd.) & Mixing

	QUANTITY	MODEL/DESCRIPTION	SOURCE
f. General exhaust and air conditioning system for compound mixing room	1 lot	Fabricate to suit area	-
g. 3' x 8' compound mixing bench with exhaust hood		Fabricate or purchase to suit area	-
h. Gram scale 0 to 1 kilogram	1	-	Fisher Scientific
i. 6'x6'x6' walk-in MDI prepolymer cooler	1	6'x6'x6' walk-in cooler	-
j. 55-gallon drum truck	2	#149332	Global Equip. Co.
k. Flammable liquid storage cabinet	2	#183170	Global Equip. Co.
l. Solvent (dispensing plunger cans)	5	4301T1	McMaster Carr Supply Co.
m. Safety cans 1-gallon capacity	5	3994Y14	McMaster Carr Supply Co.
n. Outsole component mixing tanks "A" and "B"	4	5-gallon working capacity MDI prepolymer mixing/holding tanks-electrically heated with turbine type agitators Teflon coated, 15PSI pressure rated with safety valve and bottom outlet. Tanks to be equipped with Nitrogen Blanketing Controls	STA-Warm Co.

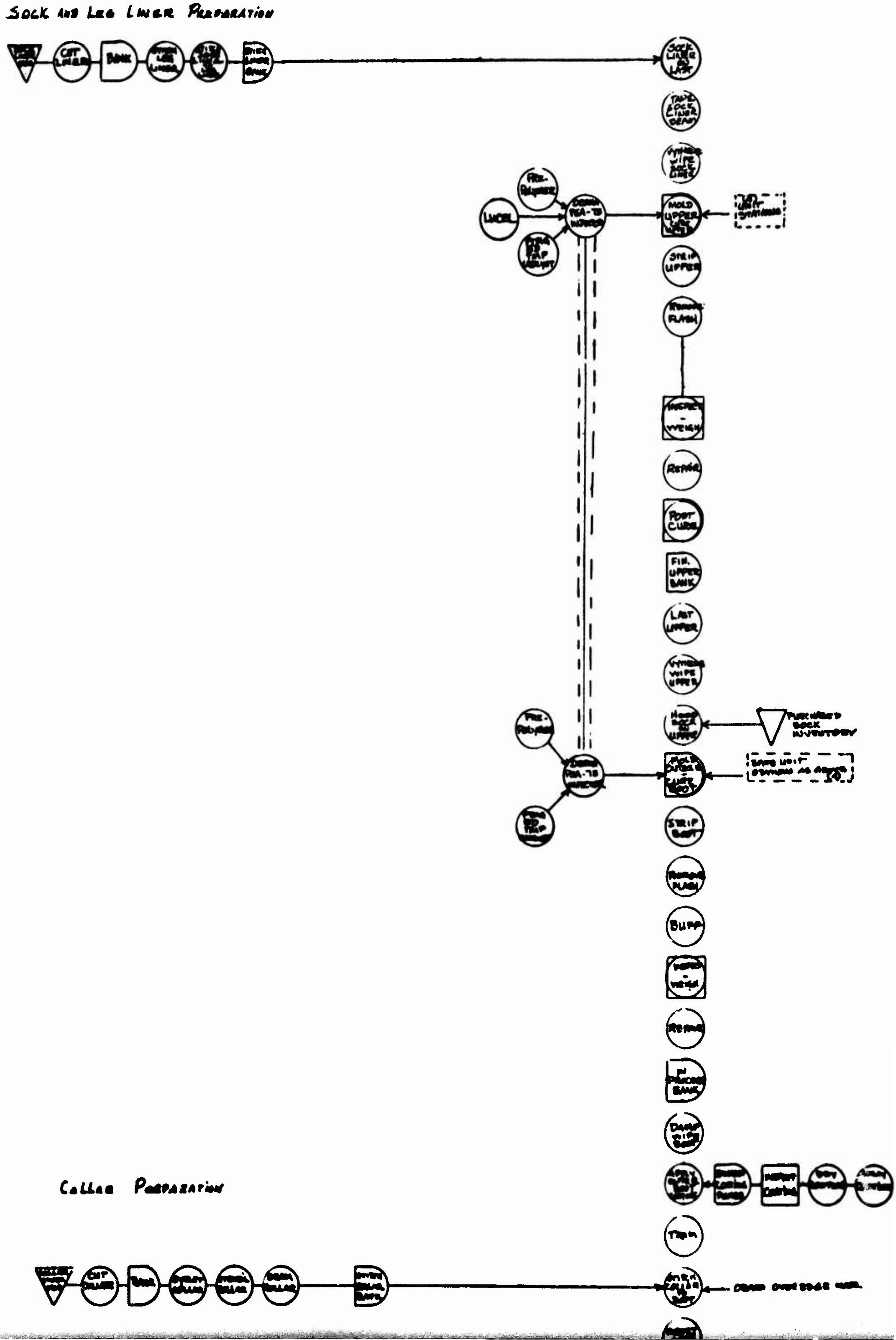
D. Compound Preparation & Mixing (contd.)	QUANTITY	MODEL/DESCRIPTION	SOURCE
o. Upper component mixing tanks			STA-Warm Co.
"A" component	2	Same as above but with 6-gallon working capacity	
"B" component	2	Same as above but with 4-gallon working capacity	
"C" component	2	1-gallon jacketed blowing agent mixing tank with turbine type agitator and atmospheric vent	STA-Warm Co.
p. Temperature Control system for "C" component tank	2	Chilled water/heating system	Thermalator Corp.
q. Coating mixing tanks			
"A" component	1	50-gallon working capacity - same as n. but without heating system	STA-Warm Co.
		12-gallon working capacity - same as above	"
"B-1" component	1	7-gallon working capacity - same as above	"
"B-2" component	1	7-gallon working capacity - same as above	"

D. Compound Preparation & Mixing (contd.)	QUANTITY	MODEL/DESCRIPTION	SOURCE
r. 2'x4' flat bed trucks	3	#108324	Global Equip. Co.
s. Nitrogen capping system	1 set	Nitrogen tank with regulator	Lease from any welding supply firm
t. Barrel cradles	2	#149547	Global Equip. Co.
u. Misc.			
1. Drier tubes	4	-	-
2. Gate valves	4	-	-
3. Drip pans	2	-	-
4. Grounding cables	As required	-	-
5. Floor scale		0-500 lb	-
6. Bench scale		0-50 lb	-
3. Molding Area			
A. Outsole molding machine	1	See Section XXV	Desma GMBH West Germany
B. Upper molding machine	1	"	"
C. Outsole molds	6 pair	-	"
D. Upper molds	6 pair	-	"
E. Teflon Coat Molds	-		Precision Coating Co. Dedham, MA
F. General exhaust system in molding areas with local exhaust system over polyurethane mixing head	1	To suit building area & equipment locations	-

3. Molding Area (contd.	QUANTITY	MODEL/DESCRIPTION	SOURCE
G. 60 pair capacity boot transport and drying trucks	8	Drawing No. D-3290 Sh.2 Figure 22	-
H. Outsole transport/storage trucks	4	Drawing No. D-3290 Sheet 1 Figure 14	
I. Flash buffer with dust collector	1	Baldor Grinder #3288 with stand & dust collector	Baldor Electric Co. St. Louis, MO
J. Outsole scale	1	0-1 kilogram	-
K. Boot scale	1	0-5 kilogram	-
L. Outsole preheat oven- 240 pair capacity	1	RS-3	Dispatch Oven Co.
M. Repair oven - 10 pair capacity	1	V-35	Dispatch Oven Co.
N. Post cure oven 50 pair capacity	1	SC-350	Grieve Corp. Round Lake, IL
O. Outsole mold storage rack	1	SP-112	Global Equip. Co.
P. Upper mold storage rack	2	Steel framed wood shelving 9623Y 1b	McMaster Carr Supply Co.
Q. 30" x 72" boot inspect and repair table	1	D-8064 wood top work bench	Fidelity Products Minneapolis, MN
R. Hand router	1	Dremmel Tool Set	Local Mill Supply House

4. Spray Coating Area	QUANTITY	MODEL/DESCRIPTION	SOURCE
A. Ransburg electrostatic coating unit complete with boot carriers, exhaust system, and tanks	1 system	See Moeller Engineering "Electrostatic Coating System" in Appendix G	-
B. Electrostatic spray coating lasts	8 pair per mold size	Drawing No. 3154 Sheet 8 Figure 15	Wellman Corp. Medford, MA
C. 72" x 36" work table	-	D-8036 steel top work bench	Fidelity Products
D. Drier trucks	-	See Item 3-G	-
5. Finishing Area			
A. Snow cuff marking machine	1	Model 1050	Markem Machine Co.
B. Stamping dies for cuff marking machine	As required	See packing writeup for description	Markem Machine Co.
C. Boot height gauge	1	Vernier height gauge Model 2195 8712	Rutland Tool & Supply Co.
D. Boot trimmer	1	Colli G.P. - 1	Four Points Ind. New Hyde Park, NY
E. Misc. Tables	As required	To suit installation	-
6. Packing Area			
A. Warehouse trucks	2	#108314	Global Equip. Co.
B. Tape dispenser	1	Tape shooter Jr.	Counterboy, Inc.

5. Packing Area (contd.)	QUANTITY	MODEL/DESCRIPTION	SOURCE
C. Case Stapler	-	Carton Bottom Stitcher #1954 YZ	McMaster Carr Supply Co.
D. 48" x 72" Caseout Table	1	To suit installation	Fabricate
E. Walking Pallet Truck	1	204321	Global Equip. Co.
F. Misc.		See packing writeup for details	-
a. Carton Stamps	-		-
b. Case Stamps	-		-
c. Case Stencils	-		-
d. Case Gluing Supplies	-		-


Sock and Leg Liner Preparation
Cut Liner
Bank
Stitch Liner Bank
Sock Liner on Last
Tape Sock Liner Seam
Wipe Sock Liner
Pre-Polymer
Lucel
Desma PEA-75 Injector
Mold Upper
Strip Upper
Remove Flash
Inspect - Weigh
Repair
Post Cure
Fin. Upper Bank
Last Upper
Wipe Upper
Purchased Sock Inventory
Pre-Polymer
Desma PEA-75 Injector
Same unit station as above
Strip Boot
Remove Flash
Buff
Inspect - Weigh
Repair
In Process Bank
Damp Wipe Boot
Trim
Collar Preparation
Cut Collar
Bank

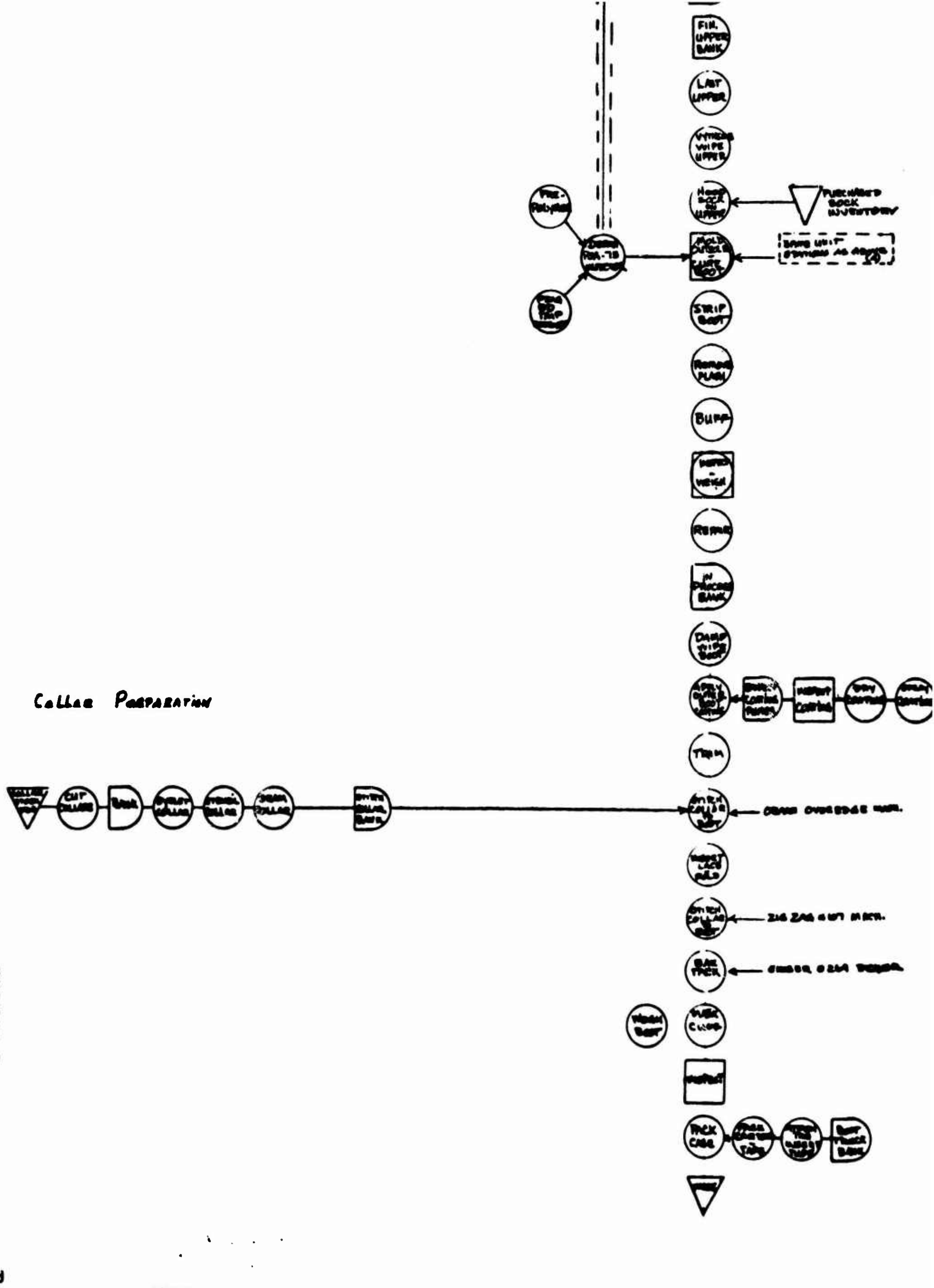


FIGURE 6

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D-11667

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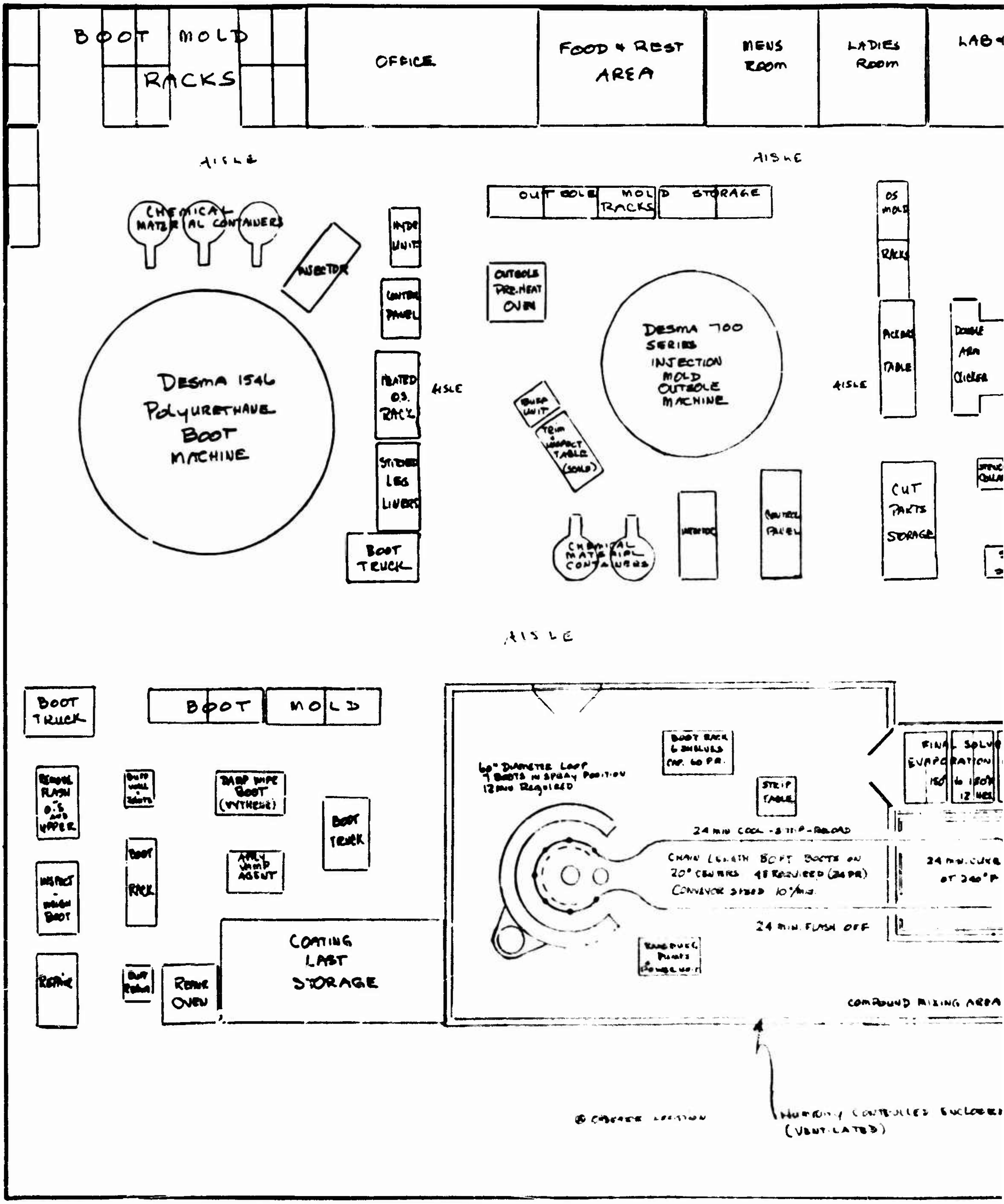
D

2


BOOT MOLD RACKS
OFFICE
FOOD & REST AREA
MENS ROOM
LADIES ROOM
LAB
AISLE
AISLE
OUT SOLE MOLD RACKS STORAGE
OS MOLD RACKS
CHEMICAL MATERIAL CONTAINERS
INJECTOR
INJECT UNIT
CONTROL PANEL
OUTSOLE PRE-HEAT OVEN
DESMA 1546 POLYURETHANE BOOT MACHINE
HEATED O.S. RACK
AISLE
DESMA 700 SERIES INJECTION MOLD OUTSOLE MACHINE
ACCESS TABLE
DOUBLE ARM CLICKER
AISLE
BUFF UNIT
TRIM & INSPECT TABLE (SCALE)
STITCHED LEG LINERS
BOOT TRUCK
CHEMICAL MATERIAL CONTAINERS
INJECTOR
CONTROL PANEL
CUT PARTS STORAGE
AISLE
BOOT TRUCK
BOOT MOLD
REMOVE FLASH O.S. AND UPPER
BUFF WELL & SKIRTS
DAMP WIPE BOOT (XYTHENE)
BOOT TRUCK
BOOT RACK
APPLY VAMP AGENT
INSPECT - WEIGH BOOT
REPAIR
BUFF REPAIR
REPAIR OVEN
COATING LAST STORAGE
60" DIAMETER LOOP
7 BOOTS IN SPRAY POSITION
12 MIN REQUIRED
BOOT RACK 6 SHELVES CAP. 60 PR.
STRIP TABLE
24 MIN COOL - STRIP - RELOAD
CHAIN LENGTH 80 FT BOOTS ON 20" CENTERS 48 REQUIRED (24 PR)
CONVEYOR SPEED 10'/MIN.
24 MIN. FLASH OFF
RANSBURG PUMPS POWER UNIT
FINAL SOLVENT EVAPORATION 150 to 180°F 12 MIN
24 MIN. CURE AT 240°F
COMPOUND MIXING AREA
OPERATOR LOCATION
HUMIDITY CONTROLLED ENCLOSURE (VENTILATED)

1

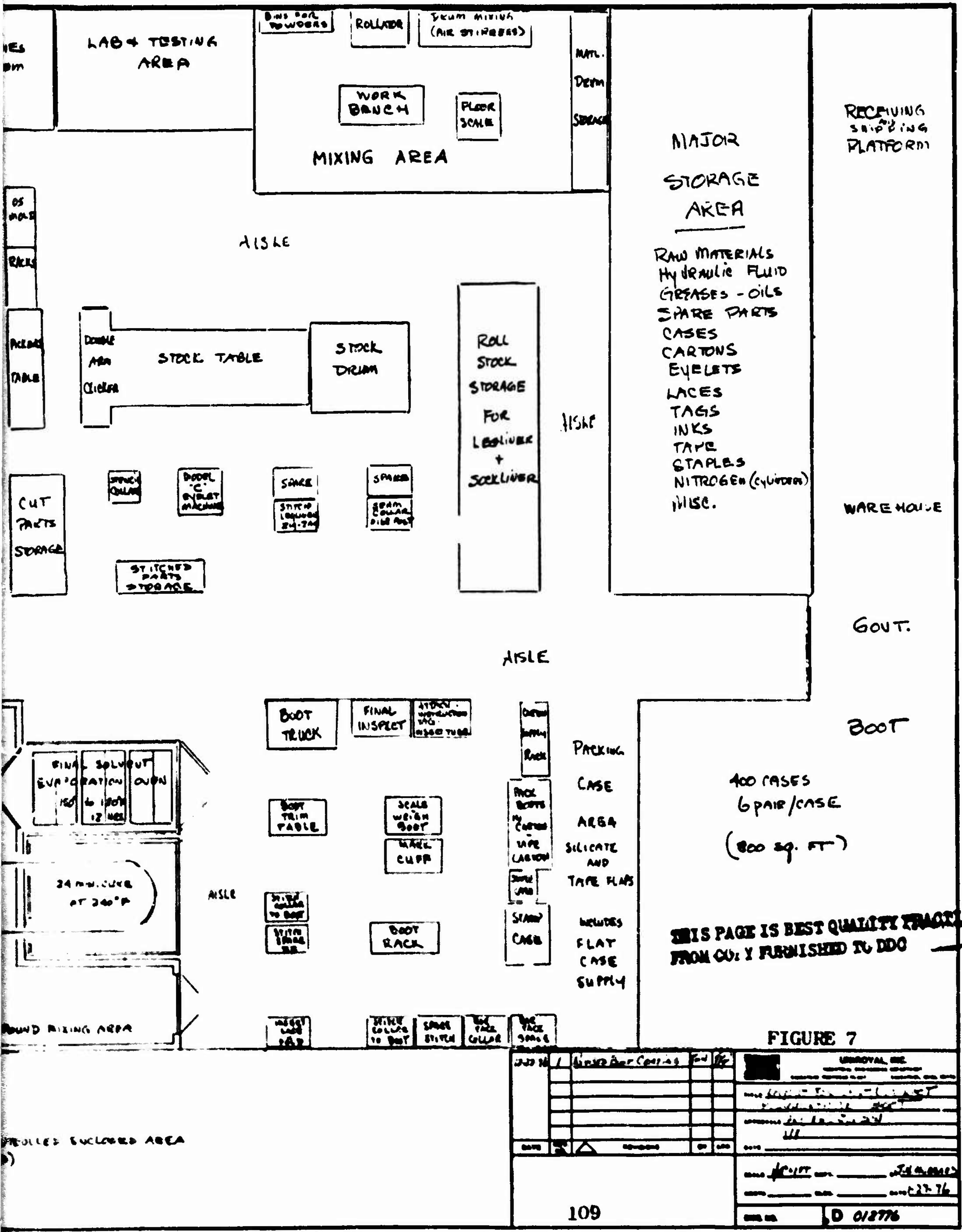
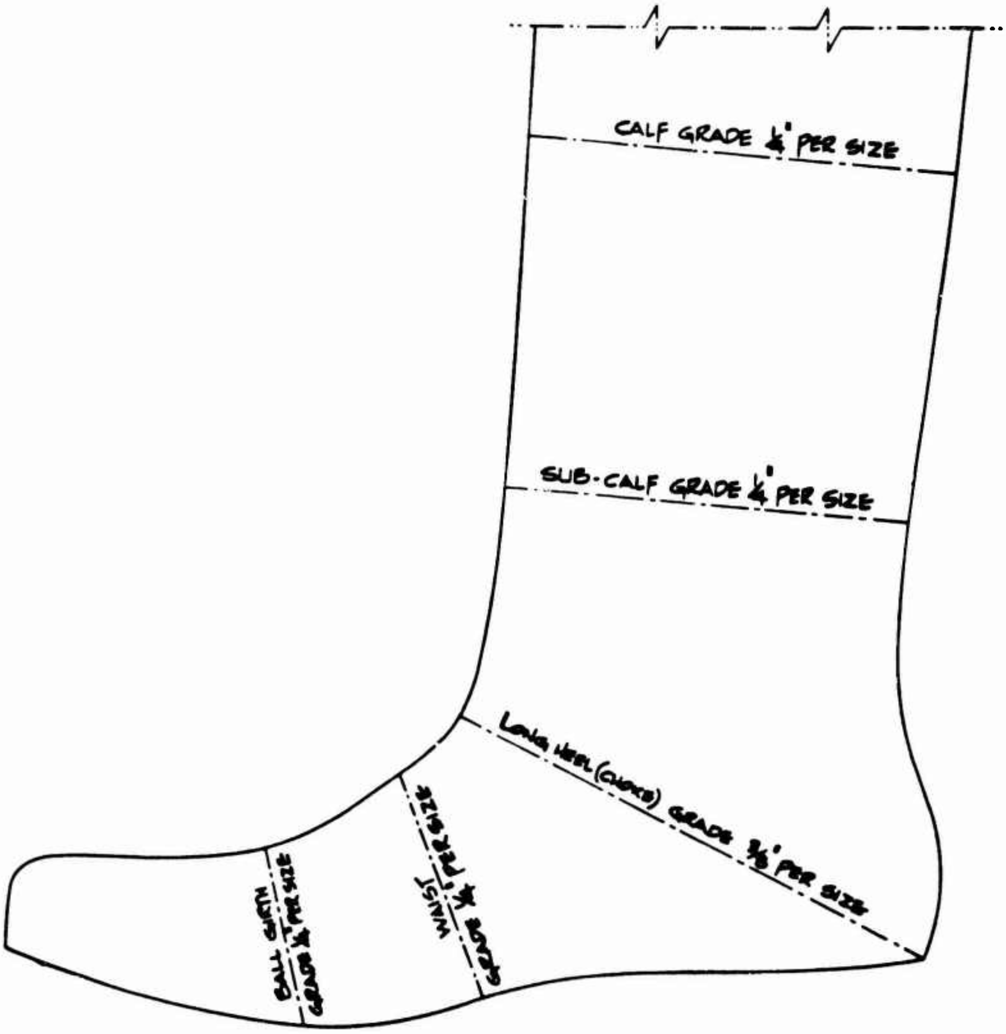
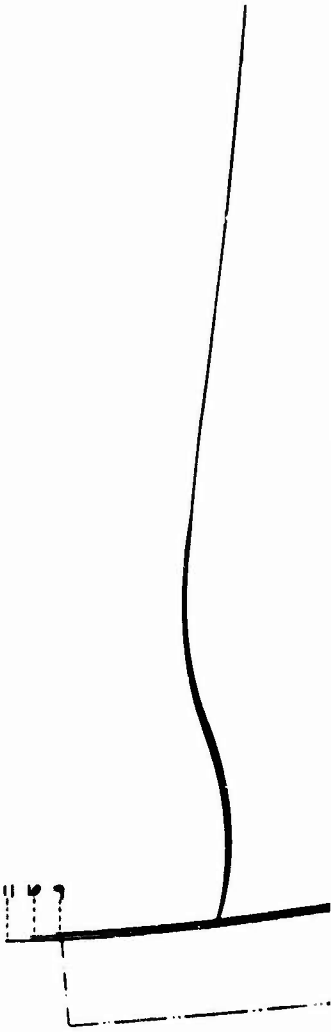

LAB & TESTING AREA
BINS FOR POWDERS
ROLLATOR
DRUM MIXING (AIR STIRRERS)
WORK BENCH
FLOOR SCALE
MIXING AREA
MATL. DRUM STORAGE
MAJOR STORAGE AREA
RAW MATERIALS
Hydraulic FLUID
GREASES - OILS
SPARE PARTS
CASES
CARTONS
EYELETS
LACES
TAGS
INKS
TAPE
STAPLES
NITROGEN (cylinders)
MISC.
RECEIVING SHIPPING PLATFORM
WAREHOUSE
GOVT.
BOOT
400 CASES
6 pair/CASE
(800 sq. FT)
AISLE
RACKS
PACKING TABLE
DOUBLE ARM CLICKER
STOCK TABLE
STOCK DRUM
ROLL STOCK STORAGE FOR LEGLINER + SOCKLINER
AISLE
CUT PARTS STORAGE
STRETCH COLLAR
MODEL "C" EYELET MACHINE
SPARE
STITCH LEGLINER
SPARE
SEAM COLLAR
STITCHED PARTS STORAGE
AISLE
BOOT TRUCK
FINAL INSPECT
ATTACH INSTRUCTION TAG INSERT TUBE
CARTON SUPPLY RACK
PACK BOOTS IN CARTON
TAPE CARTON
STAPLE CASE
STAMP CASE
PACKING CASE AREA
SILICATE AND TAPE FLAPS
INCLUDES FLAT CASE SUPPLY
FINAL SOLVENT EVAPORATION OVEN
150 to 180°F
12 HRS
BOOT TRIM TABLE
SCALE WEIGH BOOT
MARK CUFF
24 MIN. CURE AT 240°F
AISLE
STITCH COLLAR TO BOOT
STITCH SPARE
BOOT RACK
COMPOUND MIXING AREA
INSERT LACE PAD
STITCH COLLAR TO BOOT
SPARE STITCH
TAPE COLLAR
TAPE SPACE
CONTROLLED ENCLOSED AREA
UNIROYAL, INC.
D 012776

FIGURE 7

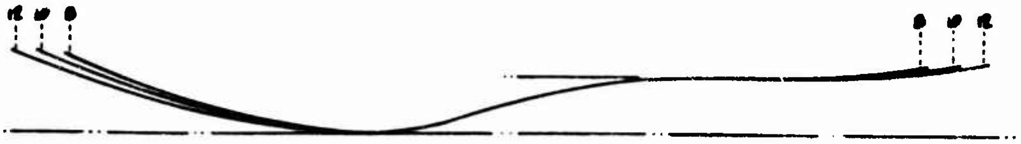
2



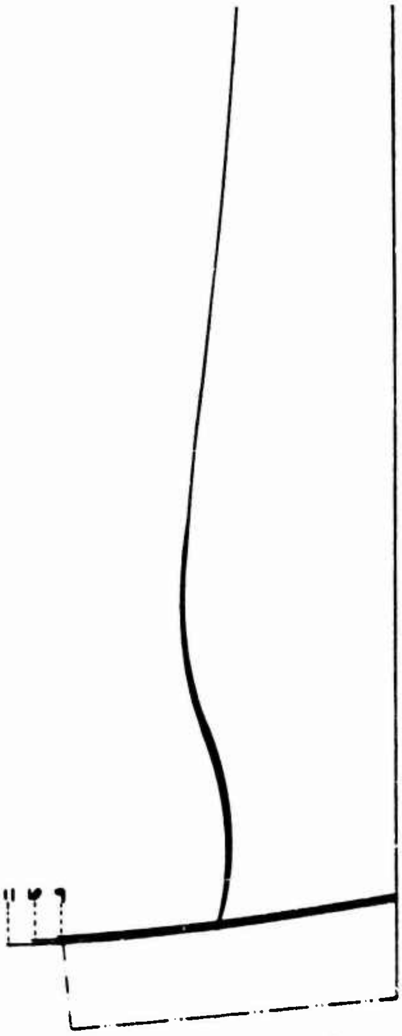
POINTS OF MEASUREMENT



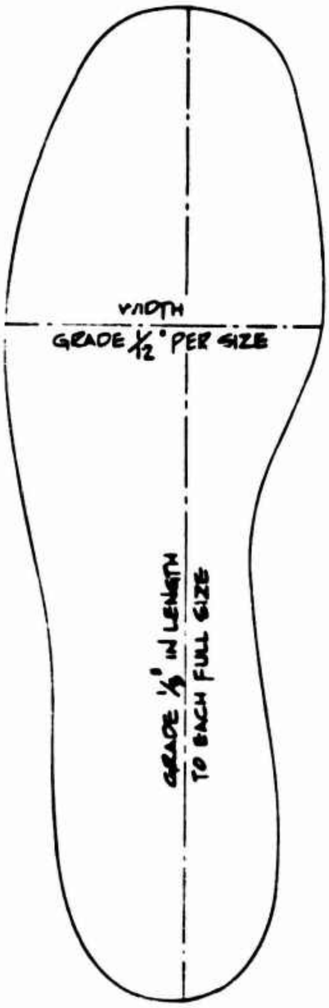
BACK PROFILE & GRADE



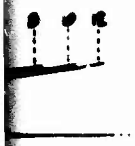
COORDINATED BOTTOM PROFILE



BACK PROFILE & GRADE 1/32" TO EACH SIZE



PAPER LAST BOTTOM & GRADE



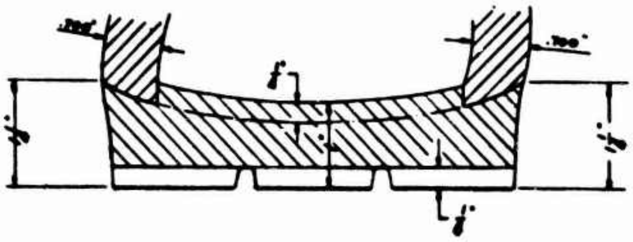
TOE TEMPLATE & GRADE

FIGURE 8

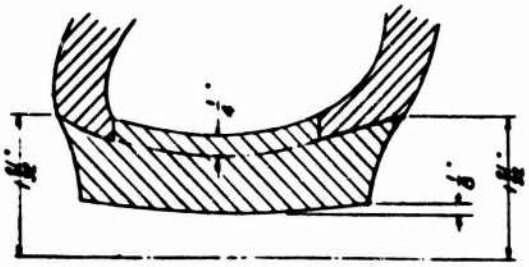
UNIROYAL, Inc.

DWG NO D-[illegible]

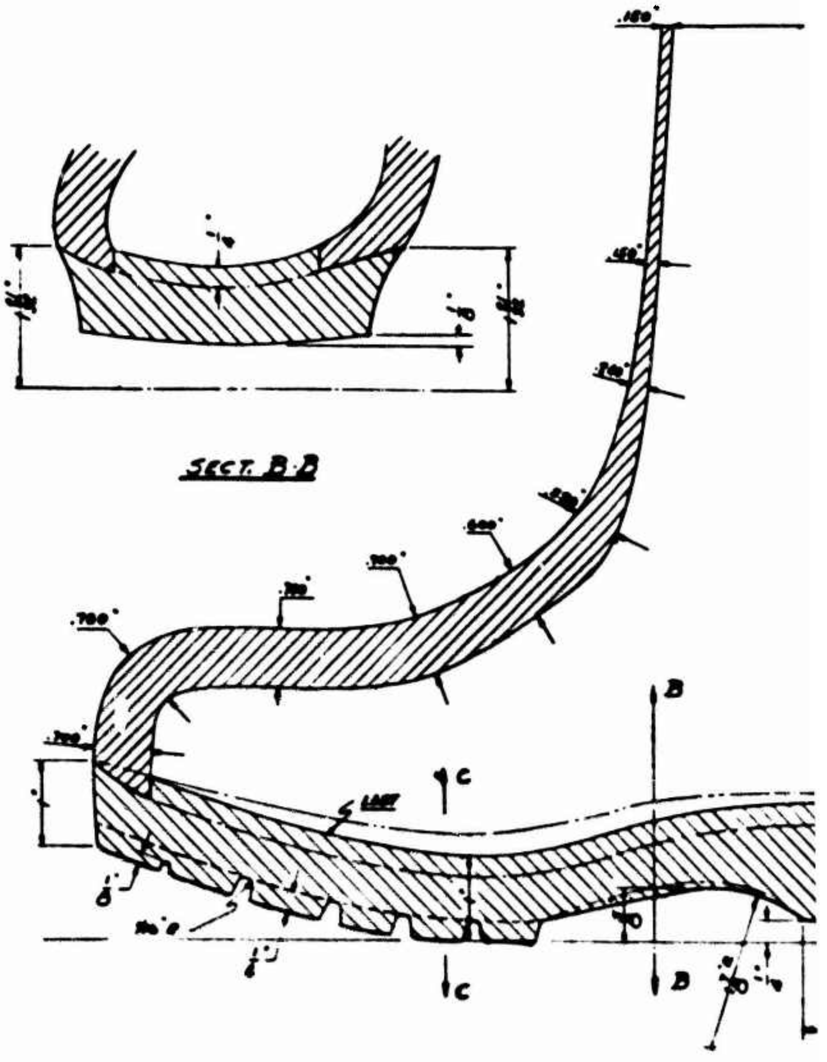
2

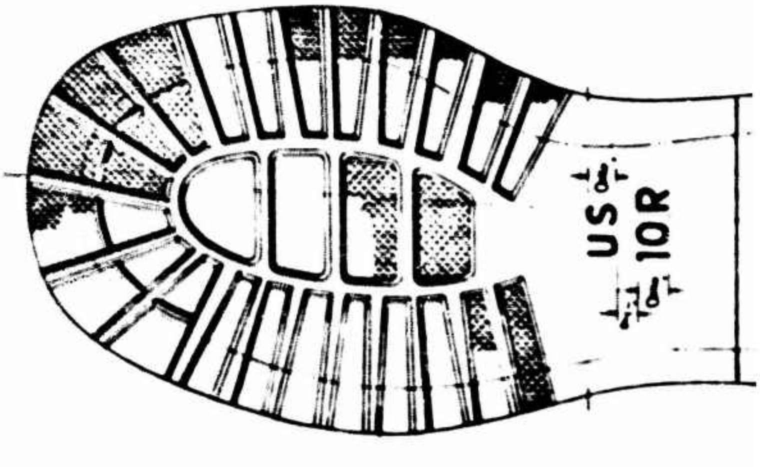


SECT. C-C



SECT. B-B





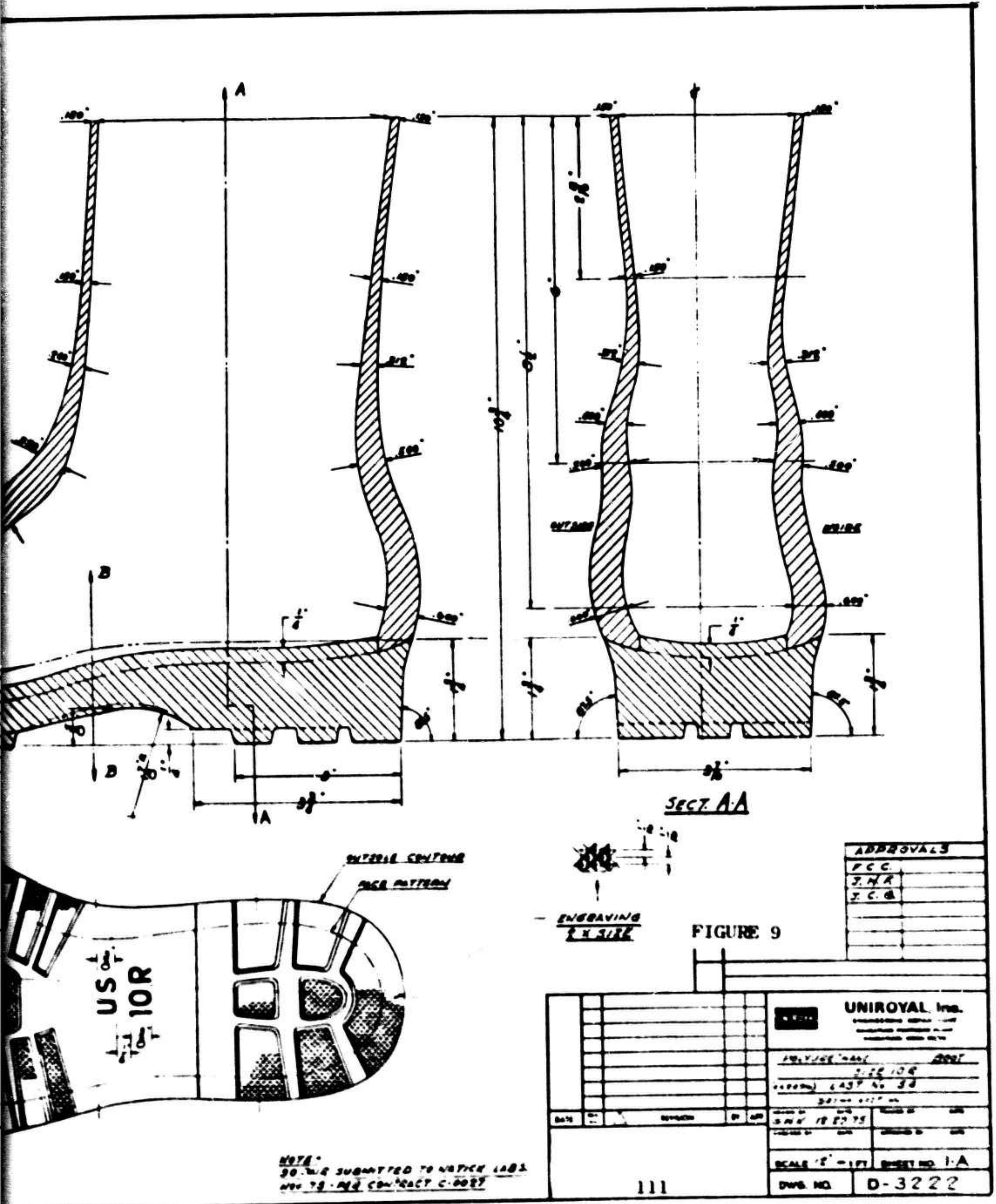
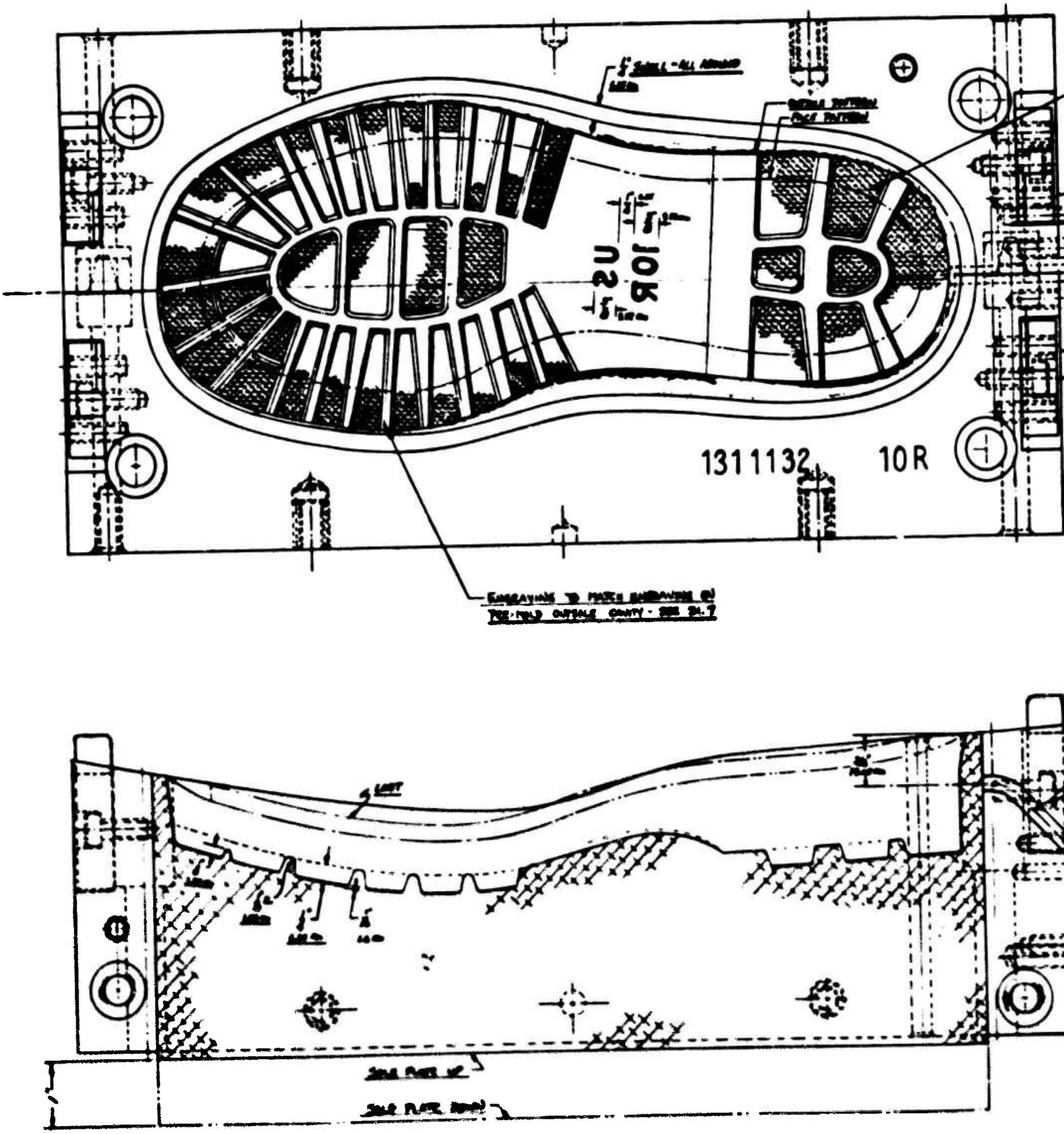

A
B
.100
.200
.212
.400
.500
.600
.900
OUTSIDE
INSIDE
SECT. A-A
OUTSOLE CONTOUR
FACE PATTERN
ENGRAVING
2 X SIZE
US
10R
APPROVALS
F.C.C.
J.H.R.
J.C.B.
UNIROYAL, Inc.
POLYURETHANE BOOT
SIZE 10R
CUSTOM LAST No. 38
S.W.K. 12.27.75
SCALE
SHEET NO. 1-A
DWG. NO.
D-3222
NOTE:
30 PAIR SUBMITTED TO NATICK LABS
NOV 75 - PER CONTRACT C-0027

FIGURE 9

2



ENGRAVING TO MATCH ENGRAVING ON
PRE-MOLD OUTSOLE CAVITY - SEE 31.7

SECTION AT SPLIT LINE

DESMA RINGS & SOLE PLATE - FOR
PRE-MOLDED OUTSOLE DESMA 1517

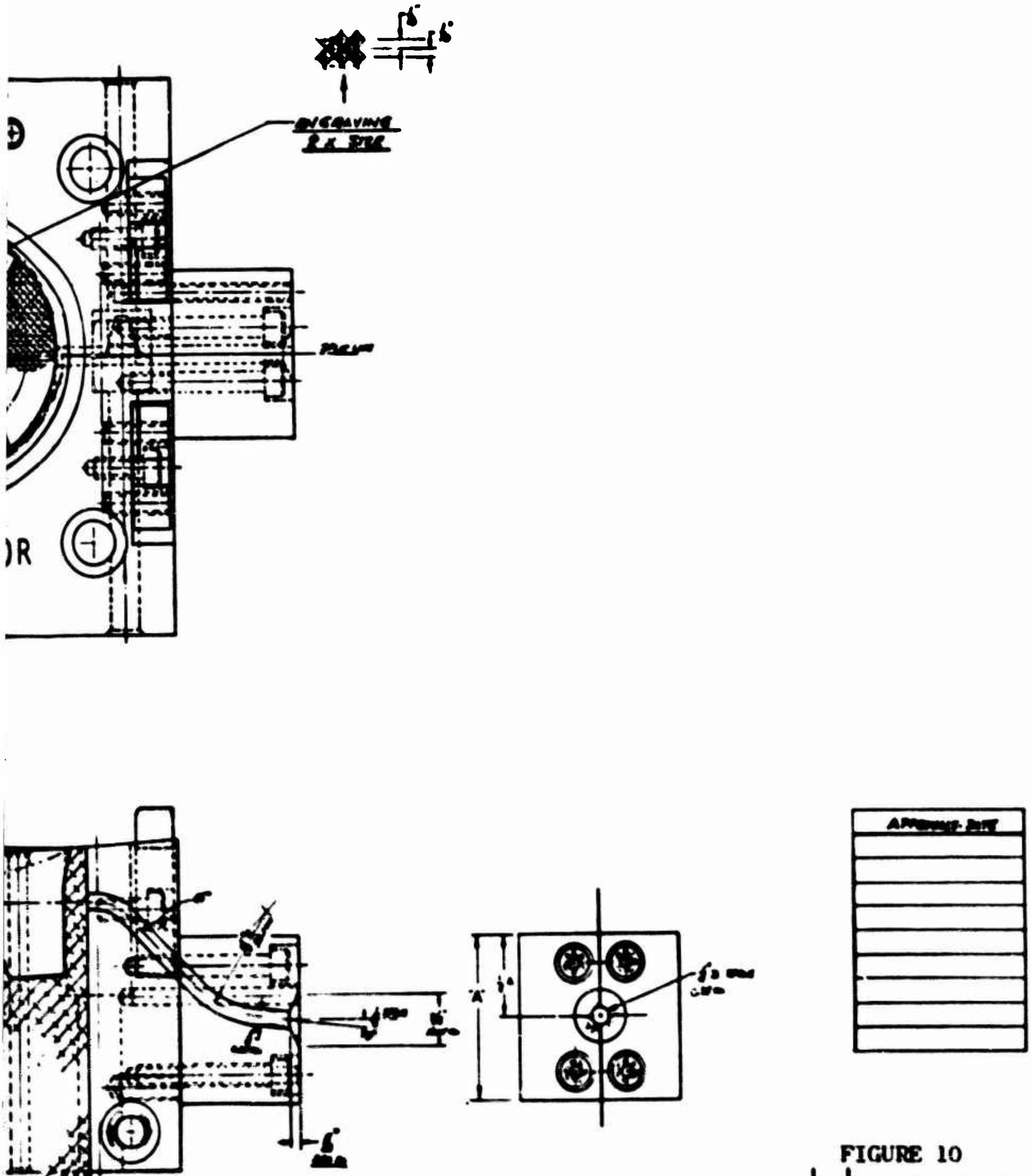


FIGURE 10

NOTES:

[illegible]

[illegible]

UNIROYAL, Inc.

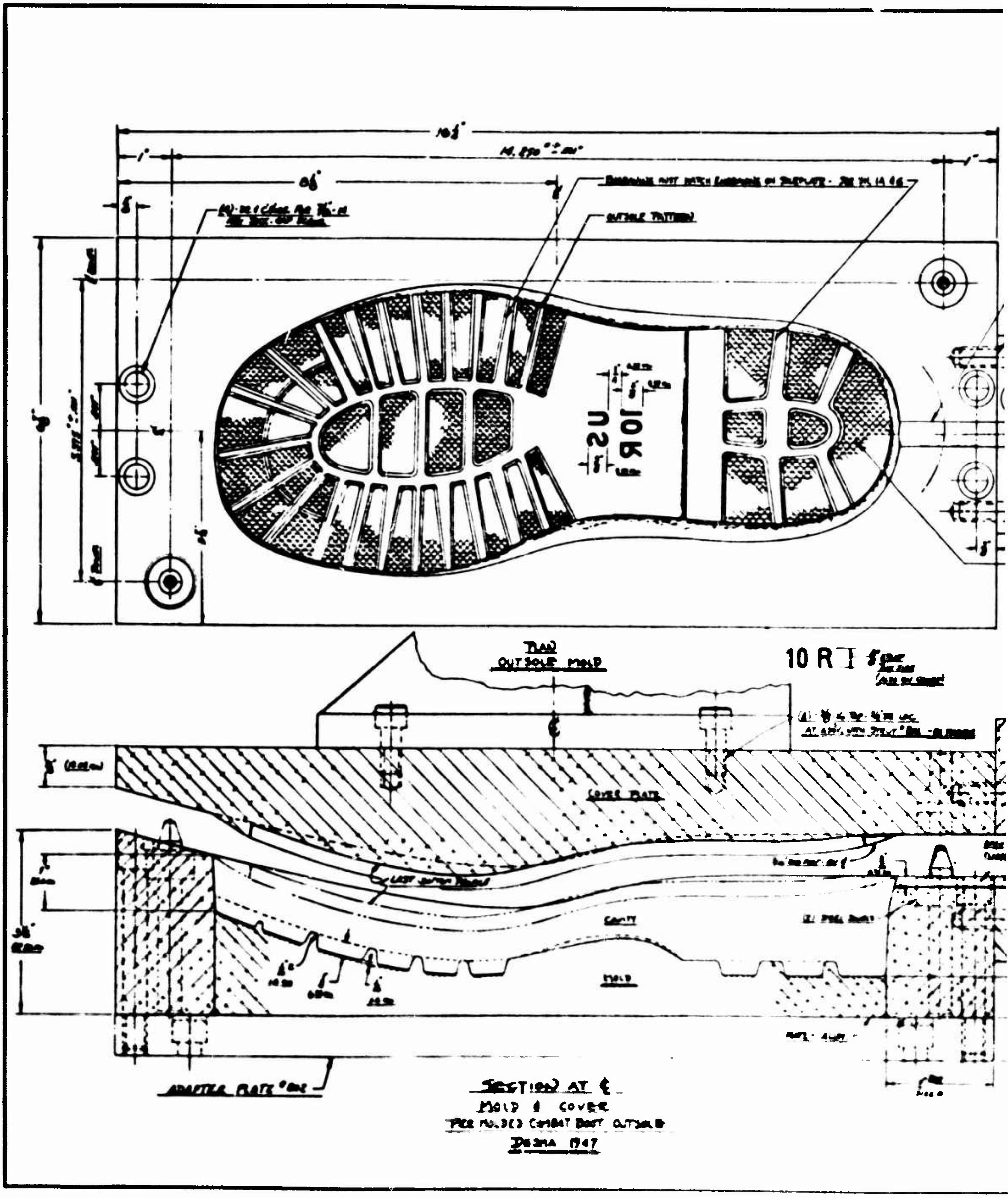
SIZE [illegible] LAST [illegible]

SCALE [illegible]

SHEET NO. 6

DWG. NO. D-3222

2


1"
1"
OUTSOLE PATTERN
10 R
US
PLAN
OUTSOLE MOLD
10 R
COVER PLATE
CAVITY
MOLD
ADAPTER PLATE
SECTION AT ℄
MOLD & COVER
PRE MOLDED COMBAT BOOT OUTSOLE
DESMA 1967

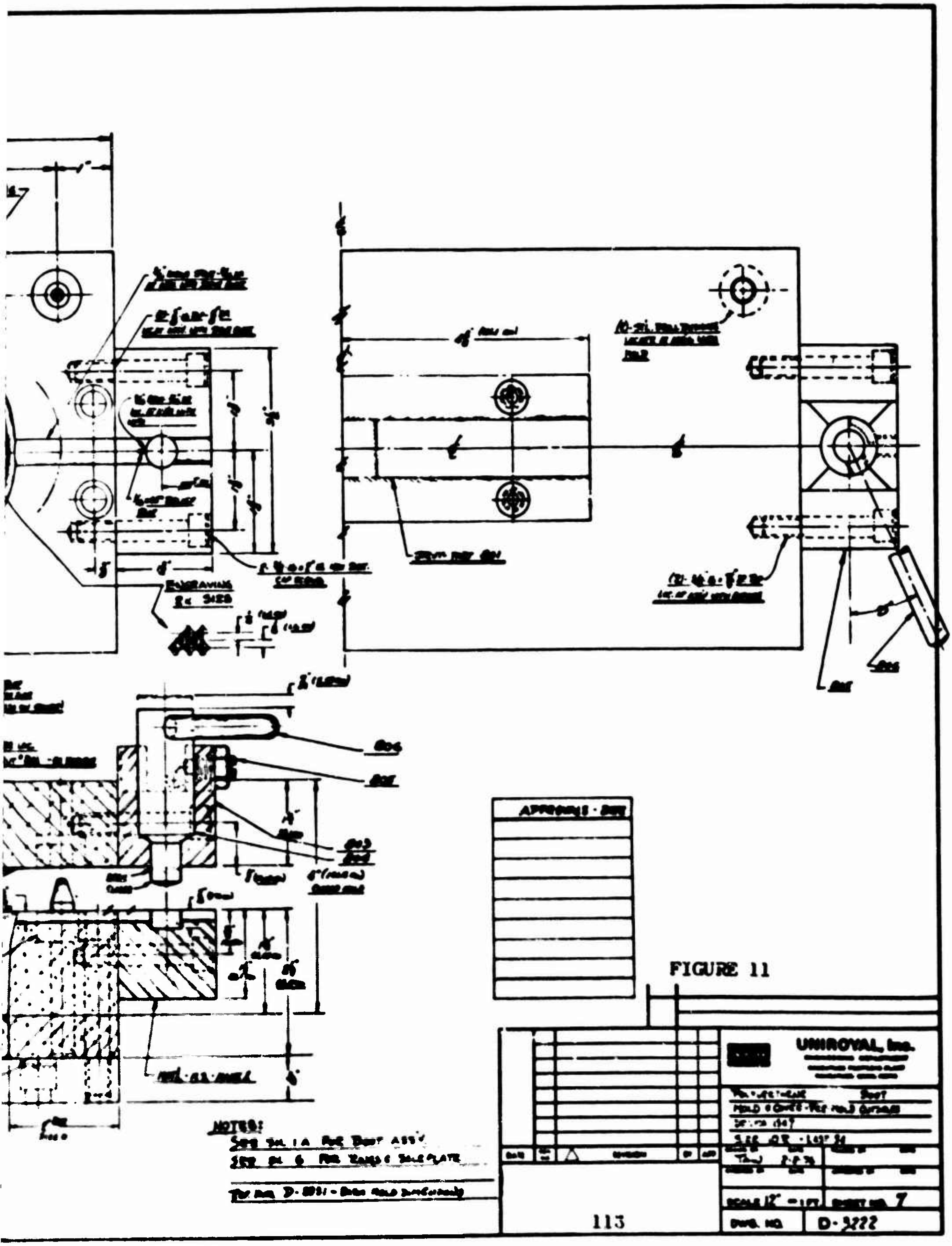
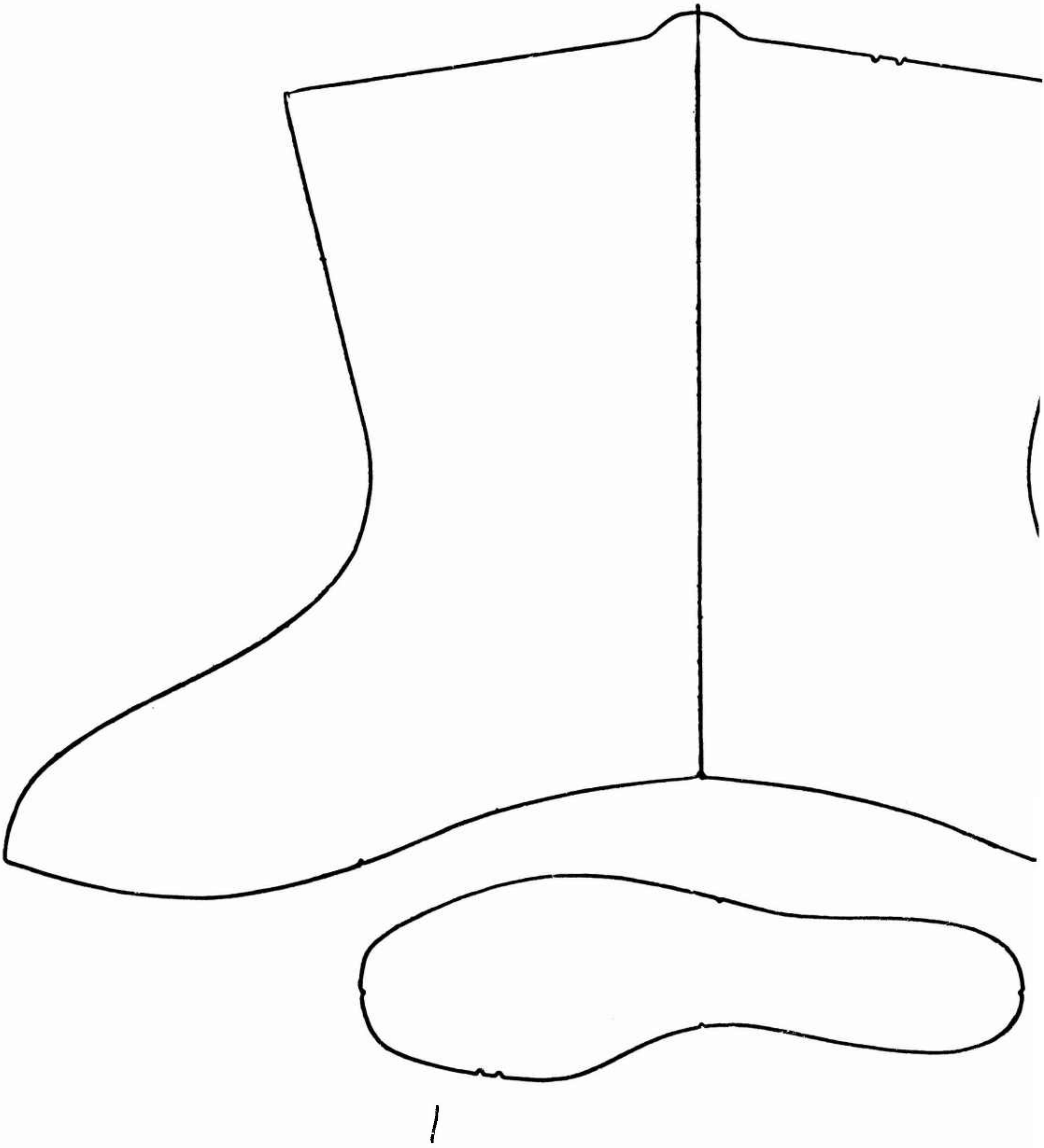

ENGRAVING
APPROVALS
UNIROYAL, Inc.
MOLD & COVER
SCALE 12" = 1 FT
SHEET NO. 7
DWG. NO.
D-3222
NOTES:
SEE SK. 1 A FOR BOOT ASS'Y
SEE SK 6 FOR

FIGURE 11

2



#6

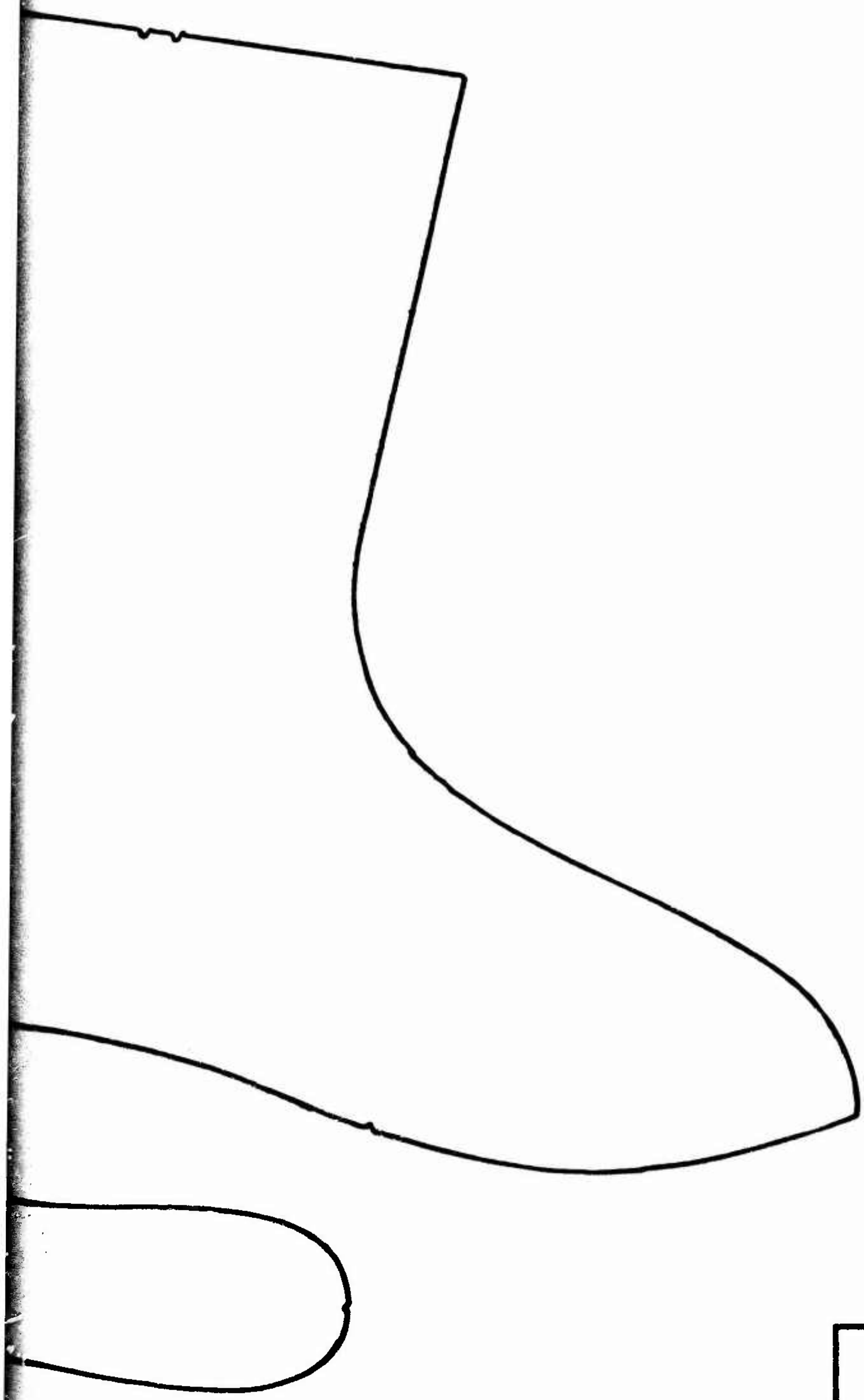
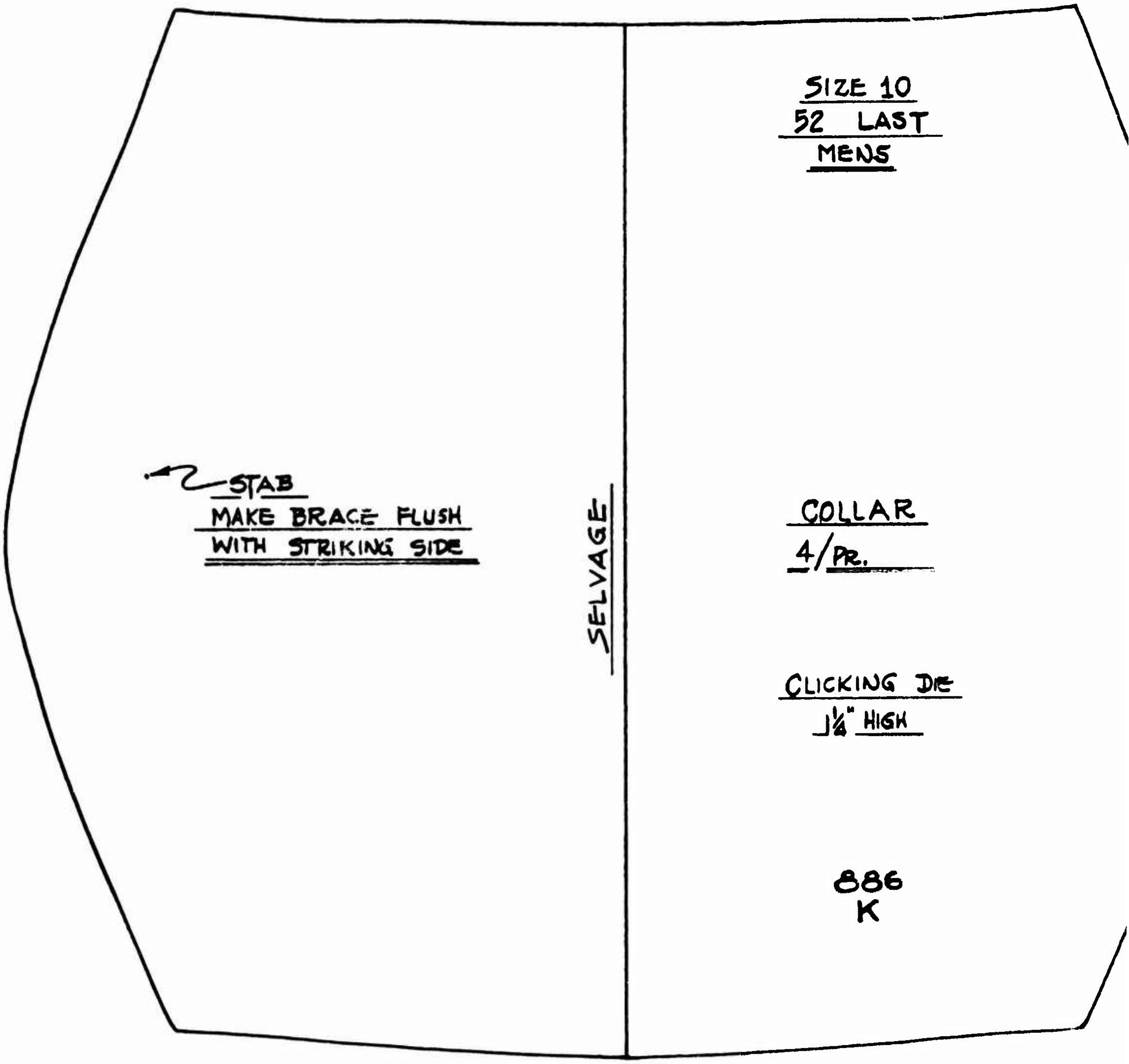


FIGURE 12

2


SIZE 10
52 LAST
MENS
STAB
MAKE BRACE FLUSH
WITH STRIKING SIDE
SELVAGE
COLLAR
4/PR.
CLICKING DIE
1¼" HIGH
886
K

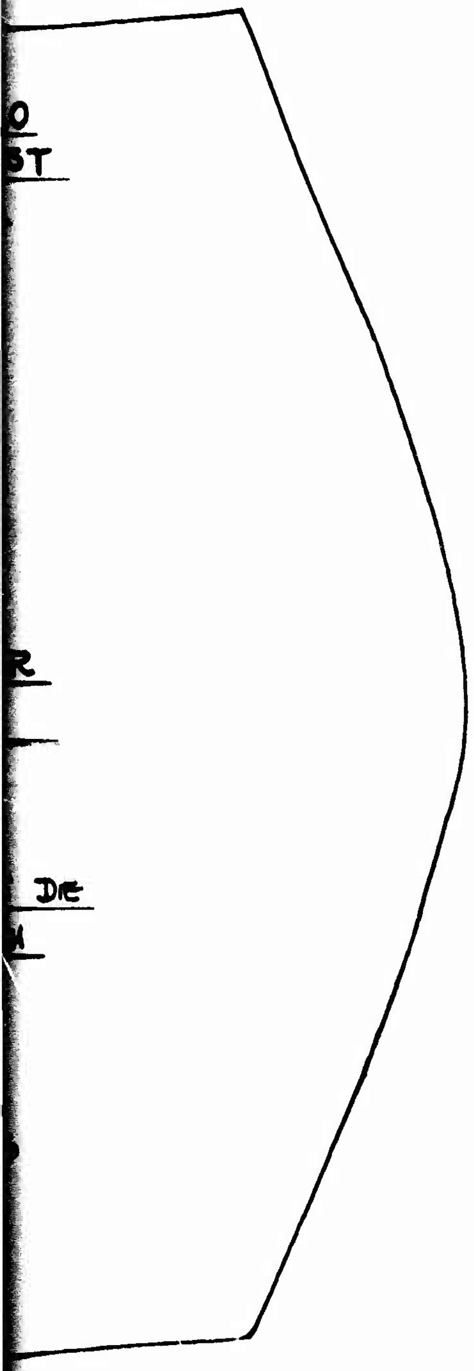


FIGURE 13

UNIROYAL, Inc.
ENGINEERING DEPARTMENT
NAUGATUCK FOOTWEAR PLANT
NAUGATUCK, CONN. 06770

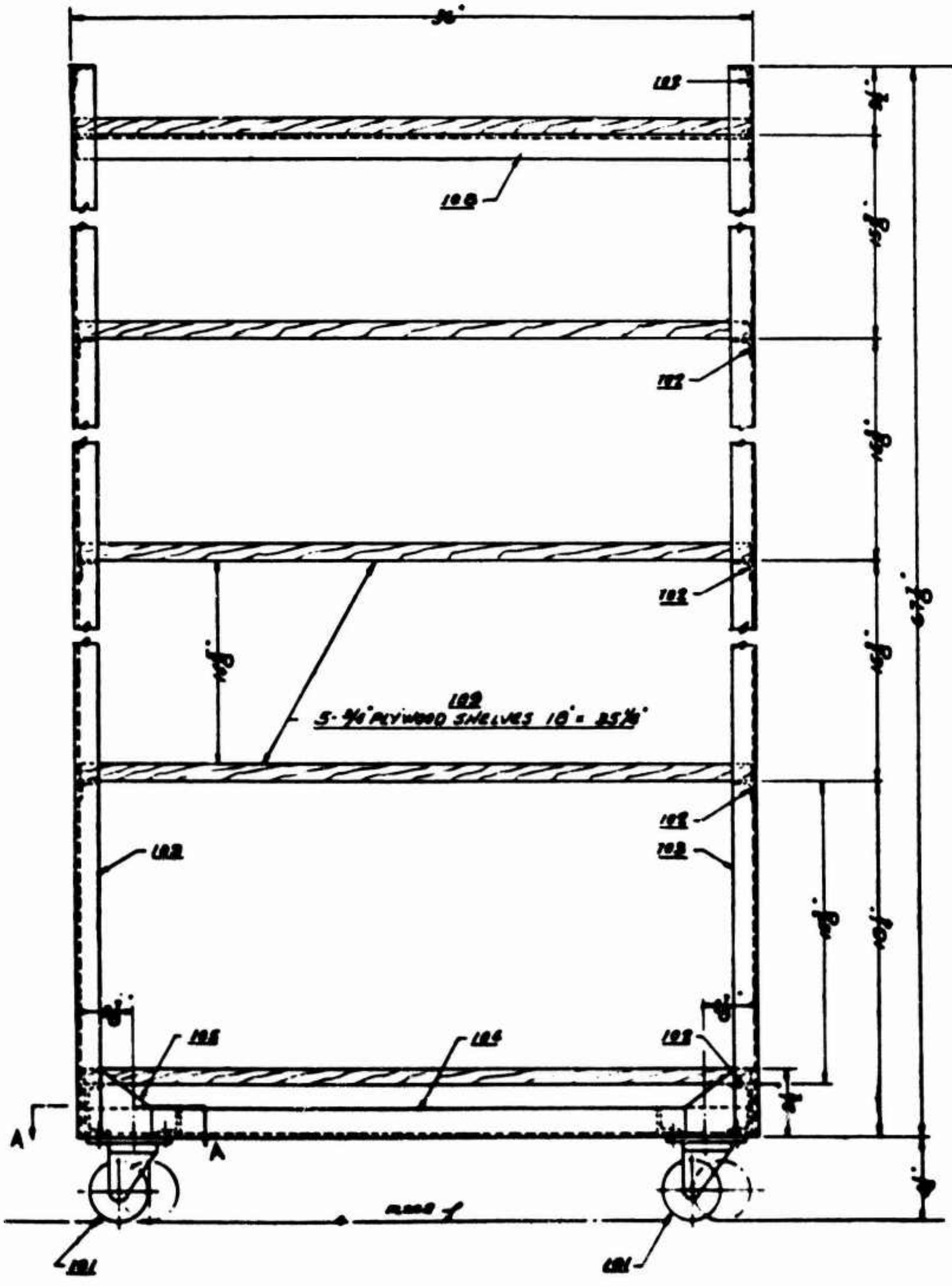
INSULATED BOOT
"SNOW COLLAR" CUTTING PATTERN

DRAWN BY	DATE	APPROVED BY	DATE
TAW	8-30-77		

SCALE 12" = 1 FT.
SHEET NO. 2

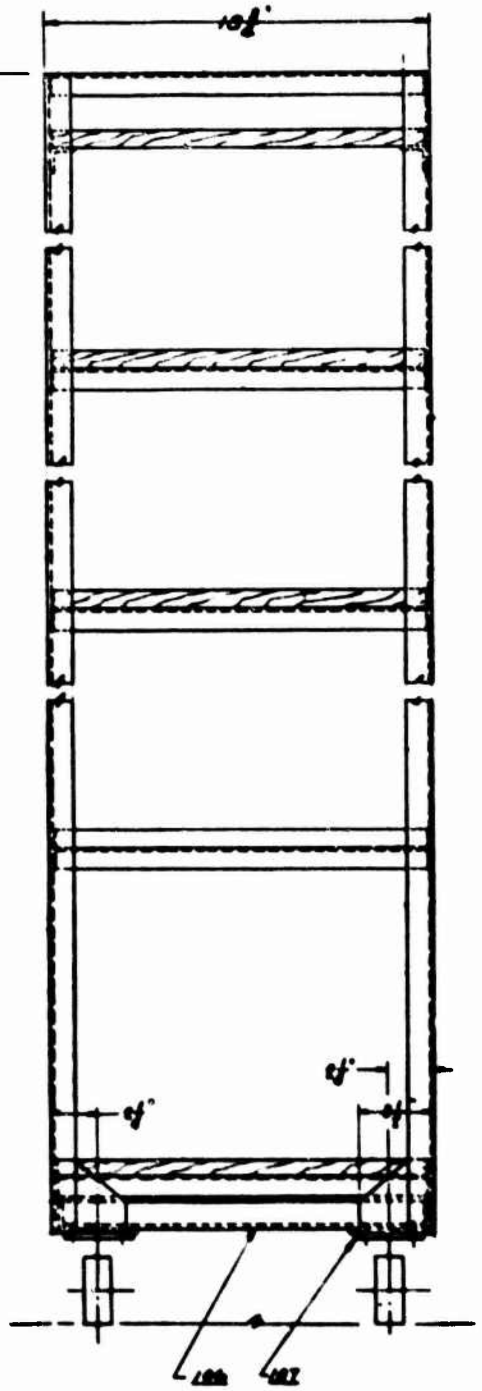
DWG. NO. D-052777

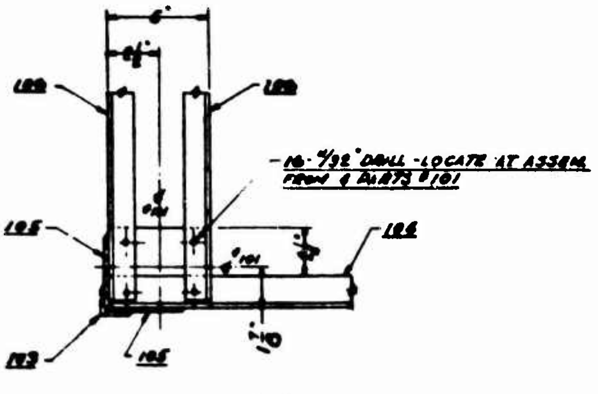
DATE	ECN NO.	REVISION	BY	APP.



109
TRUCK FOR CUT PARTS
(STRUCTURAL STL. - WELDED

16- 5/16"-18 HEX HD SCRS. 1" LG, NUTS & LOCK WAS.





SECTION A-A

T PARTS
- WELDED

FIGURE 14

108	2-1½"x1½"x3/16" L-IRONS 33[illegible]" LG
107	4-3½"x3½"x3/16" PLATES
106	4-1½"x1½"x3/16" L-IRONS 17[illegible]" LG
105	8-3½"x3½"x3/16" GUSSETS
104	8-1½"x1½"x3/16" L-IRONS 33[illegible]" LG
103	4-1½"x1½"x3/16" L-IRONS 67[illegible]" LG
102	10-1"x1"x3/16" L-IRONS 17[illegible]" LG
101	4-BASSICK [illegible] SWIVEL CASTERS #[illegible] WITH 3" DIA WHEELS

UNIROYAL, Inc.

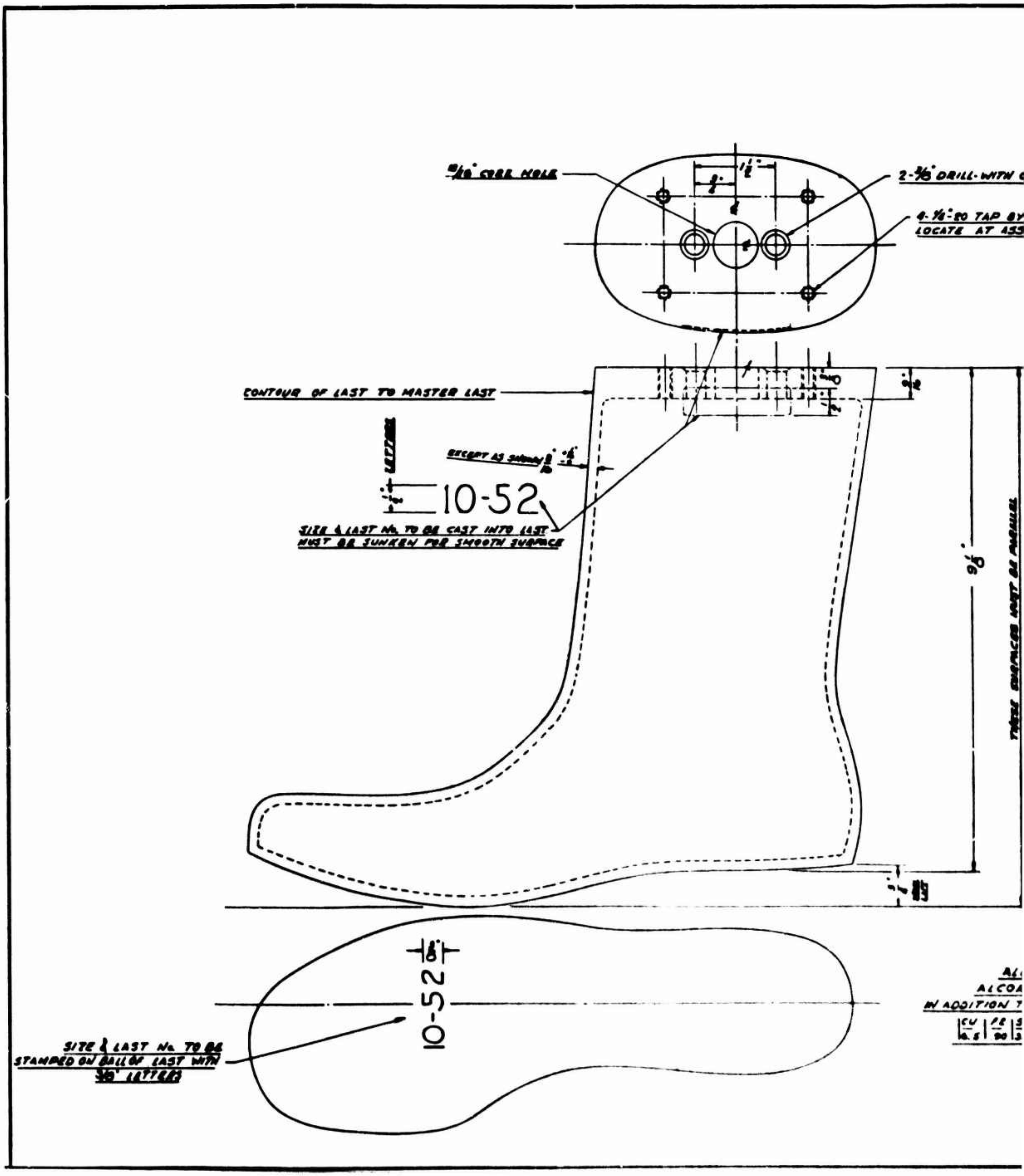
TRUCK
FOR CUT PARTS & QUENCHING
BASKET

DATE		△	REVISION	BY	APP

G.N.K. 3-8-77

SCALE 3" = 1 FT.
SHEET NO. 1
DWG. NO. D-3290

2


⁵⁄₁₆" CORE HOLE
1½"
⅞"
2-⅜" DRILL-WITH C
4-⅛"-20 TAP BY
LOCATE AT ASS
CONTOUR OF LAST TO MASTER LAST
⅜"
LETTERS
EXCEPT AS SHOWN
10-52
SIZE & LAST No. TO BE CAST INTO LAST
MUST BE SUNKEN FOR SMOOTH SURFACE
9⅝"
THESE SURFACES MUST BE PARALLEL
10-52
⅛"
SIZE & LAST No. TO BE
STAMPED ON BALL OF LAST WITH
⅜" LETTERS
AL
ALCOA
IN ADDITION T
CU
10.5
FE
20

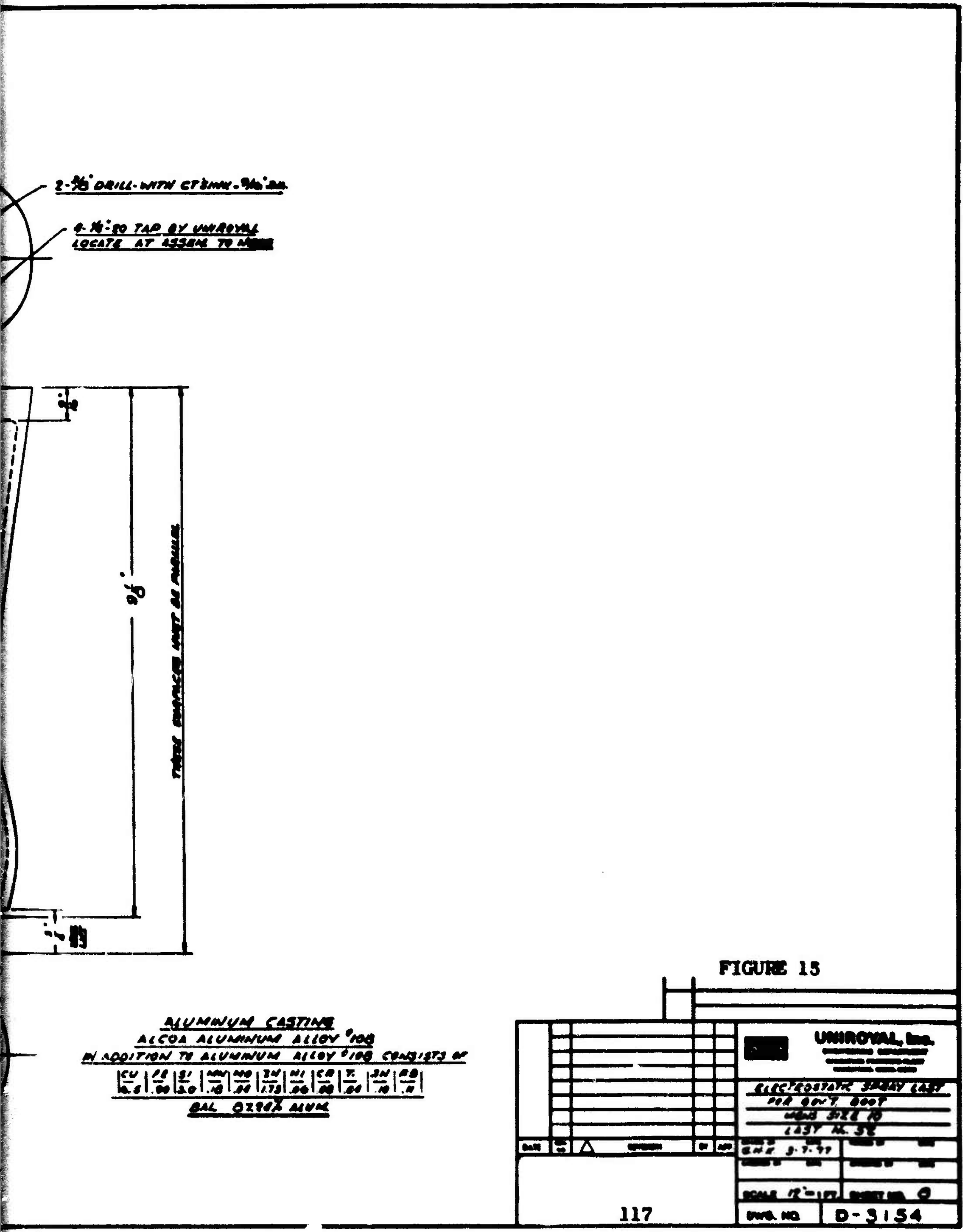
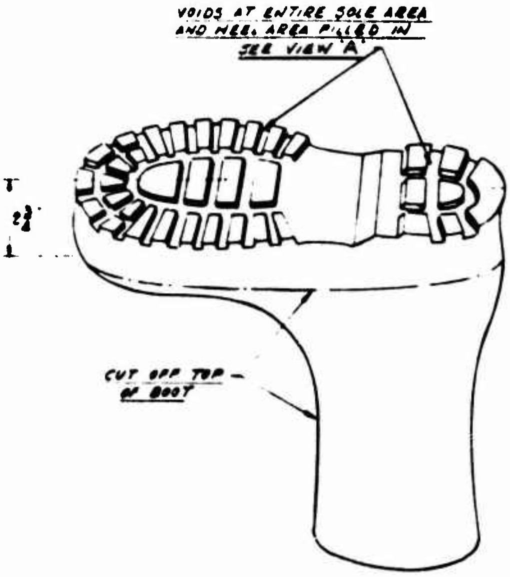
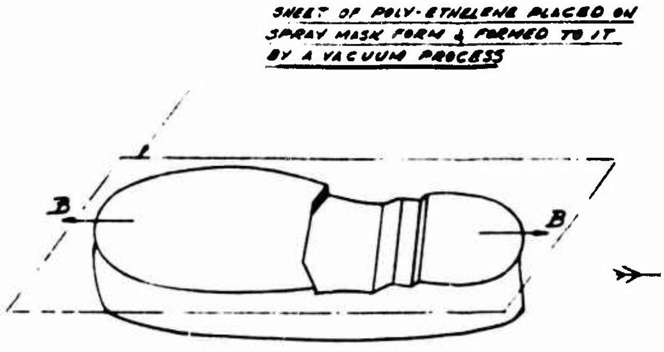

2-3/8" DRILL-WITH CTSINK-9/16" DIA.
4-1/4"-20 TAP BY UNIROYAL
LOCATE AT ASSEM. TO MATE
9 1/8"
THESE SURFACES MUST BE PARALLEL
ALUMINUM CASTING
ALCOA ALUMINUM ALLOY #108
IN ADDITION TO ALUMINUM ALLOY #108 CONSISTS OF
CU 4.5 | FE .90 | SI 3.0 | MN .10 | MG .04 | ZN 1.75 | NI .00 | CR .00 | TI .00 | SN .10 | PB .11
BAL 02.96% ALUM.
UNIROYAL, Inc.
ELECTROSTATIC SPRAY LAST
FOR GOV'T. BOOT
MENS SIZE 10
LAST No. 38
3-7-77
SCALE 12"=1FT
SHEET NO. 0
DWG. NO.
D-3154

FIGURE 15

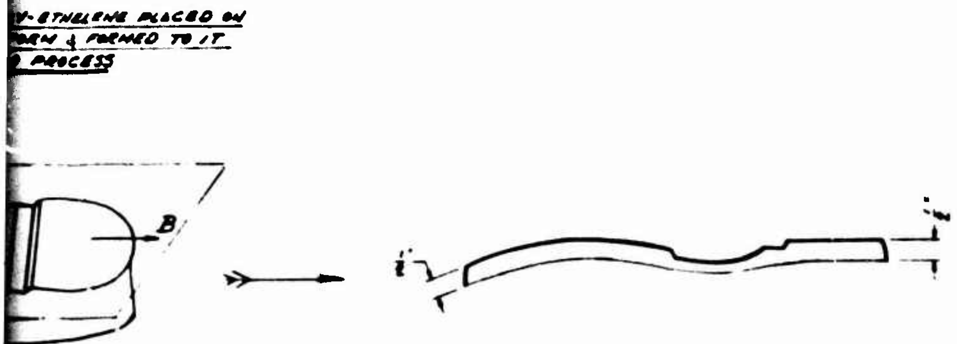
7



SPRAY MASK FORM
CREATED FROM A BOOT



VIEW "A"



SECTION B-B
POLY-ETHELENE SPRAY MASK

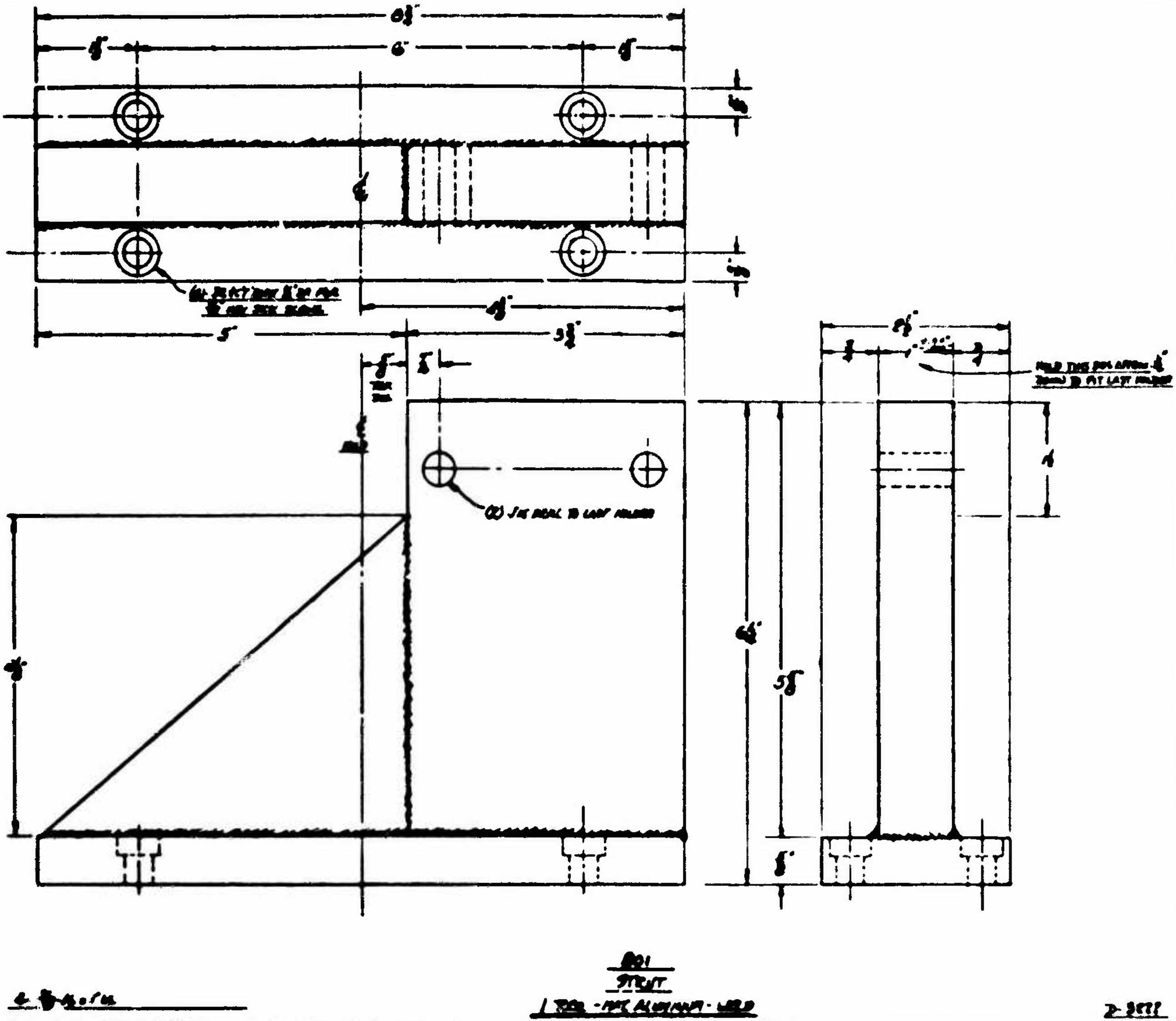
SIZE 10 TO BE USED FOR SIZES
8½ - 9 - 9½ - 10 ETC.

PLACE & TACK (2) TO BOOT BEFORE
SPRAYING

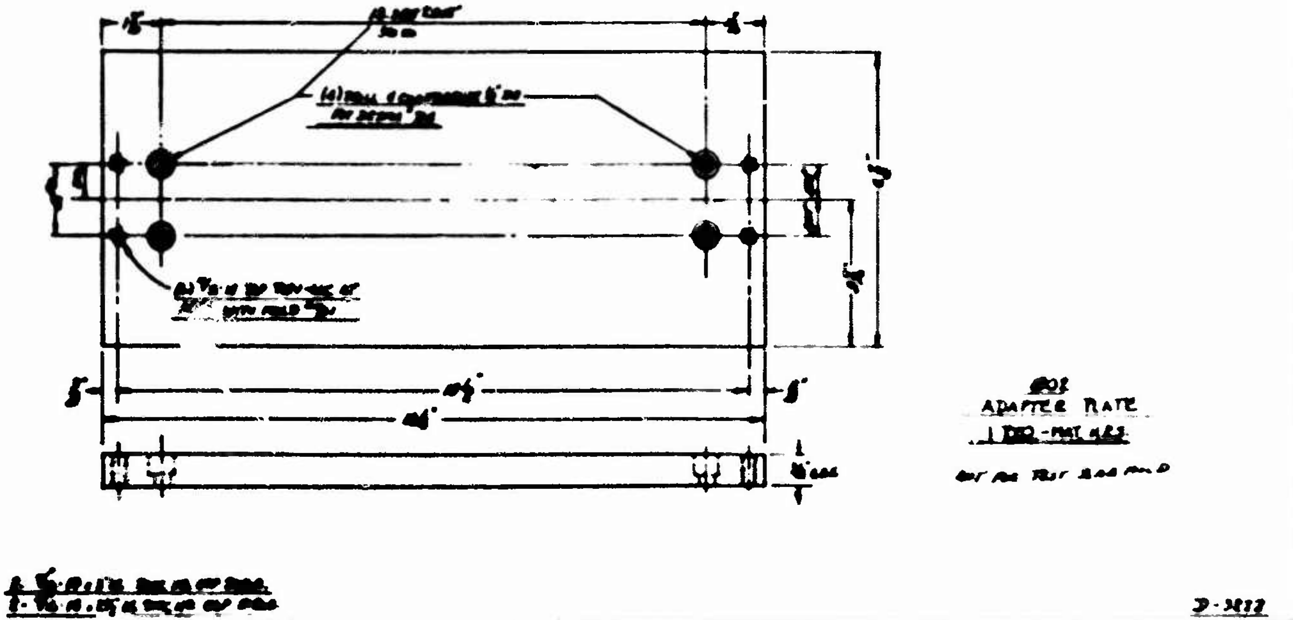
FIGURE 16

UNIROYAL, Inc.

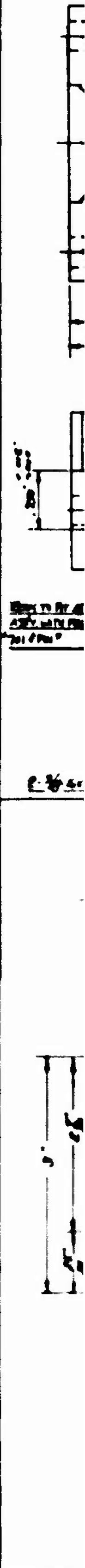
SCALE
SHEET NO 1
DWG NO D-32



6"
5"
801
STENT
1 REQ - MAT ALUMINUM - WELD
D-3872



802
ADAPTER PLATE
1 REQ - MAT. H.R.S.
D-3872



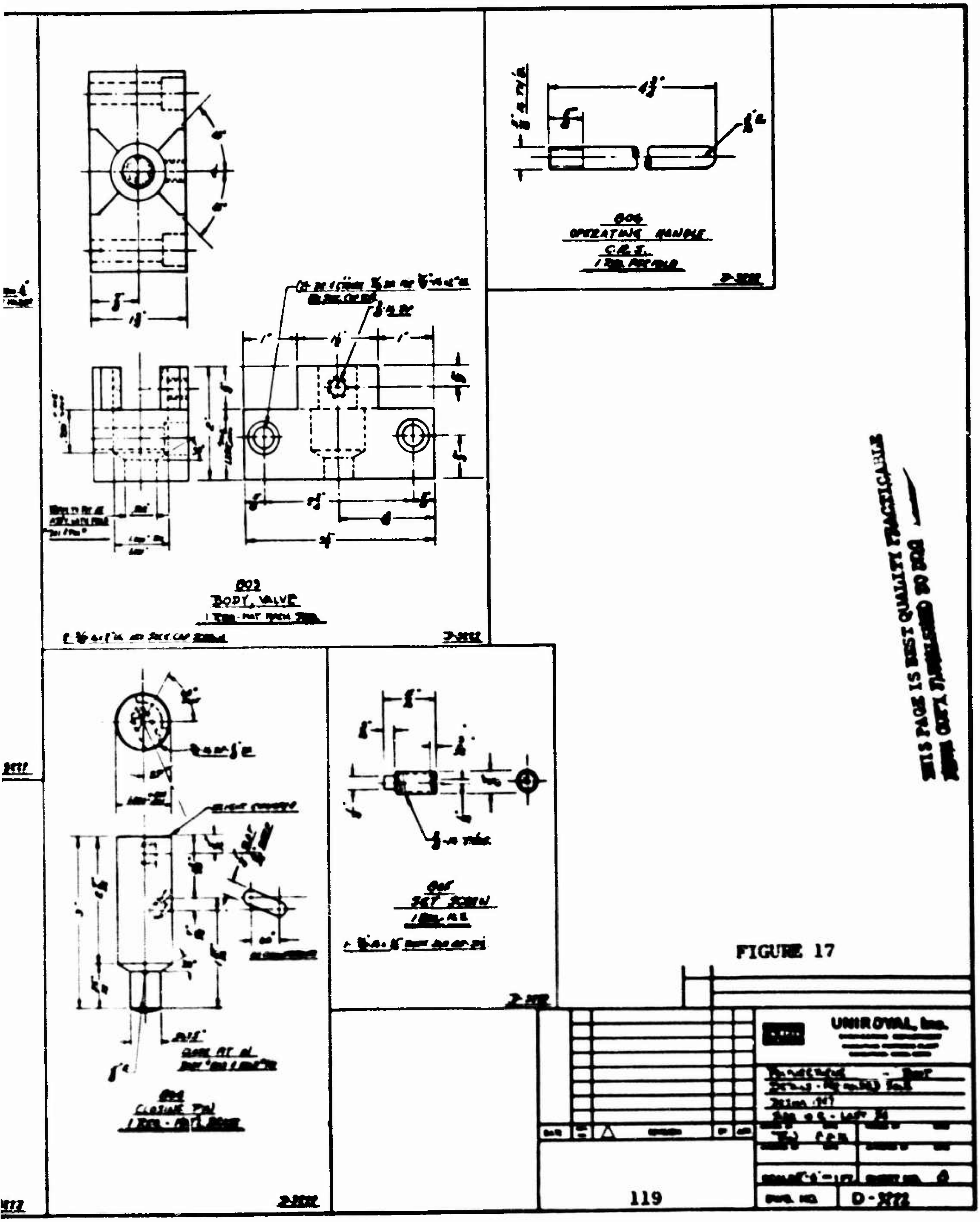
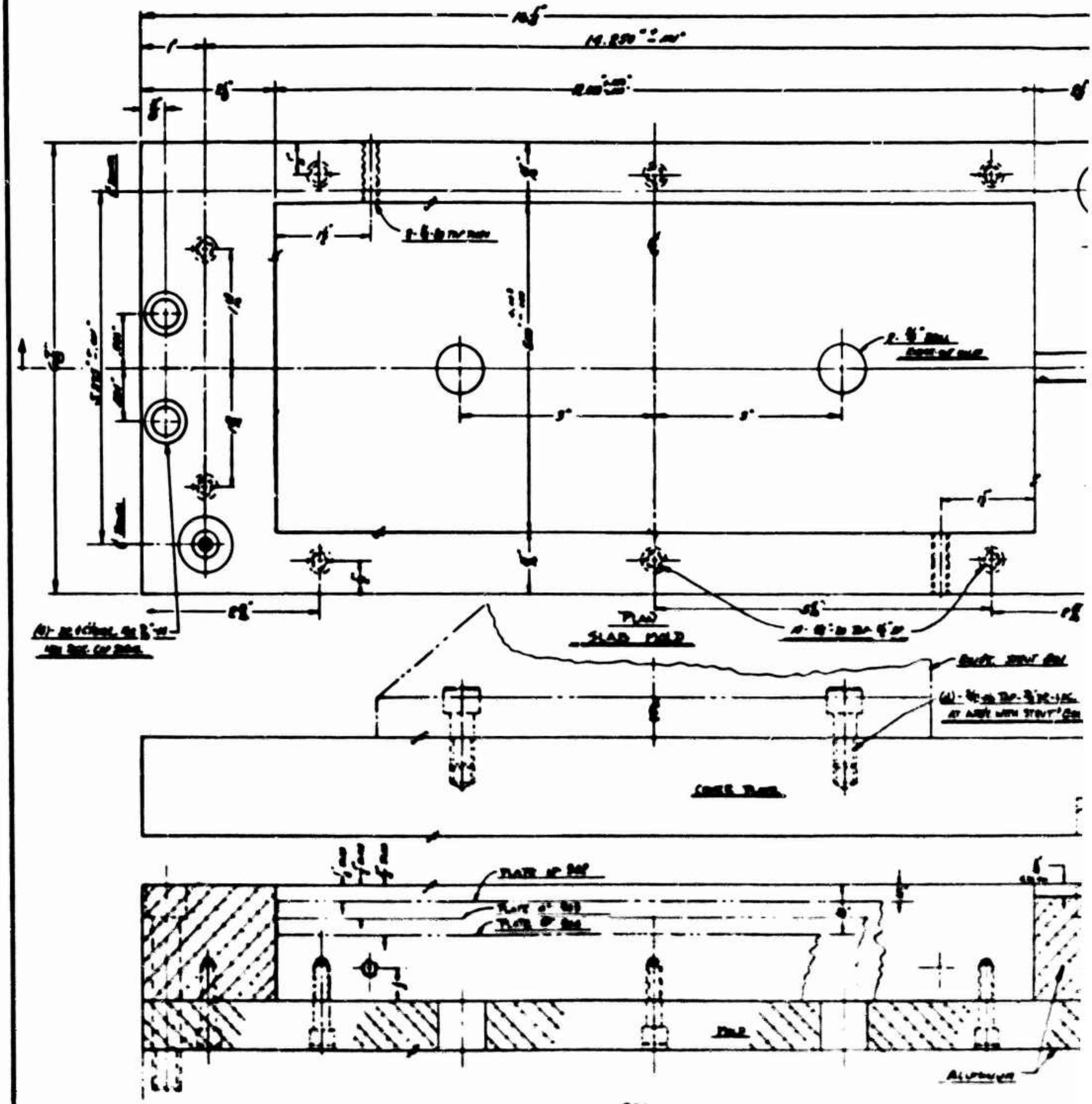

003
BODY, VALVE
006
OPERATING HANDLE
C.R.S.
004
CLOSURE PIN
005
SET SCREW
UNIROYAL, Inc.
DWG. NO.
D-3772

FIGURE 17

2



901
SECTION AT ℄
MOLD & COVER
TEST SLABS
DESIGN 1947

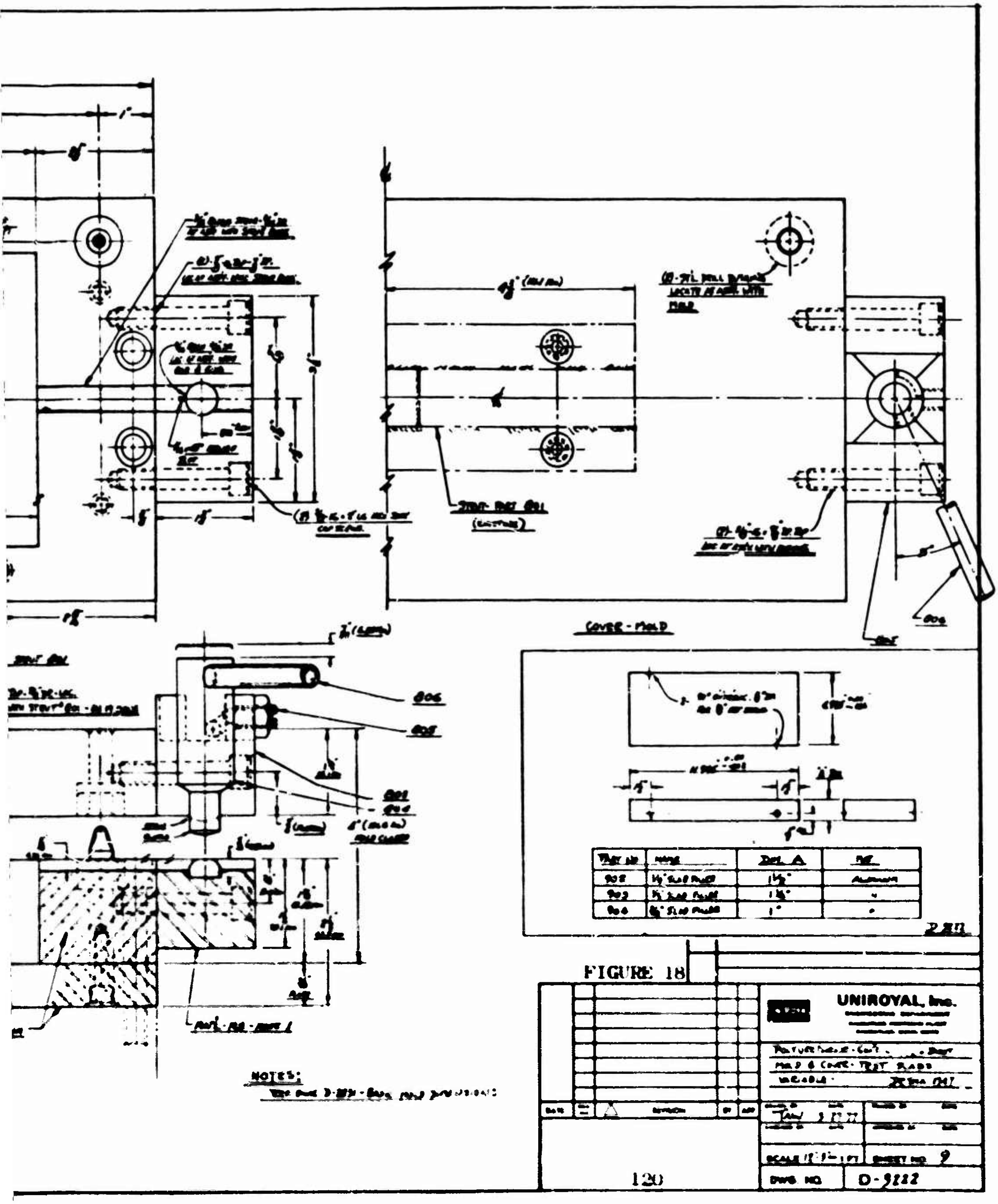
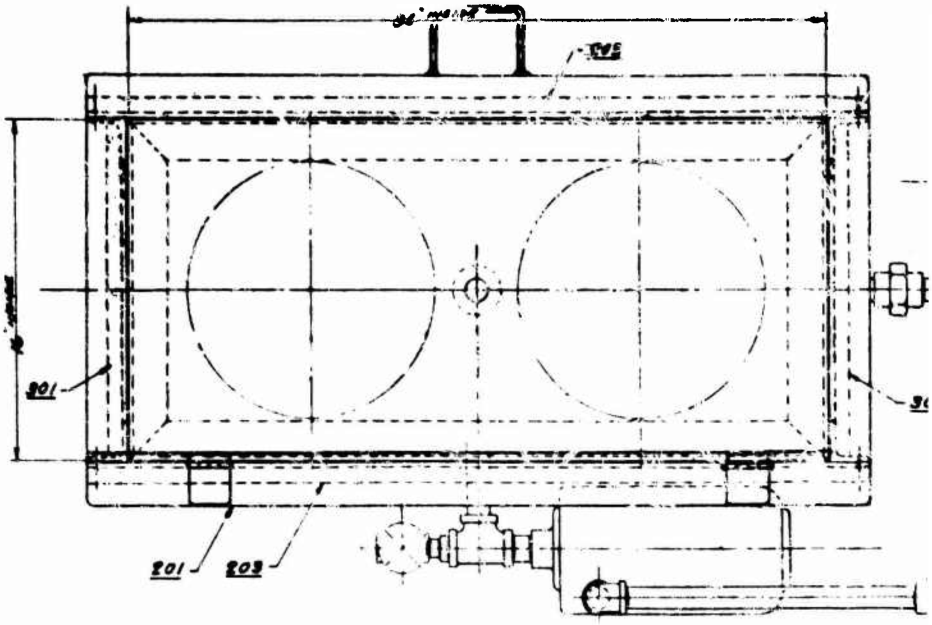
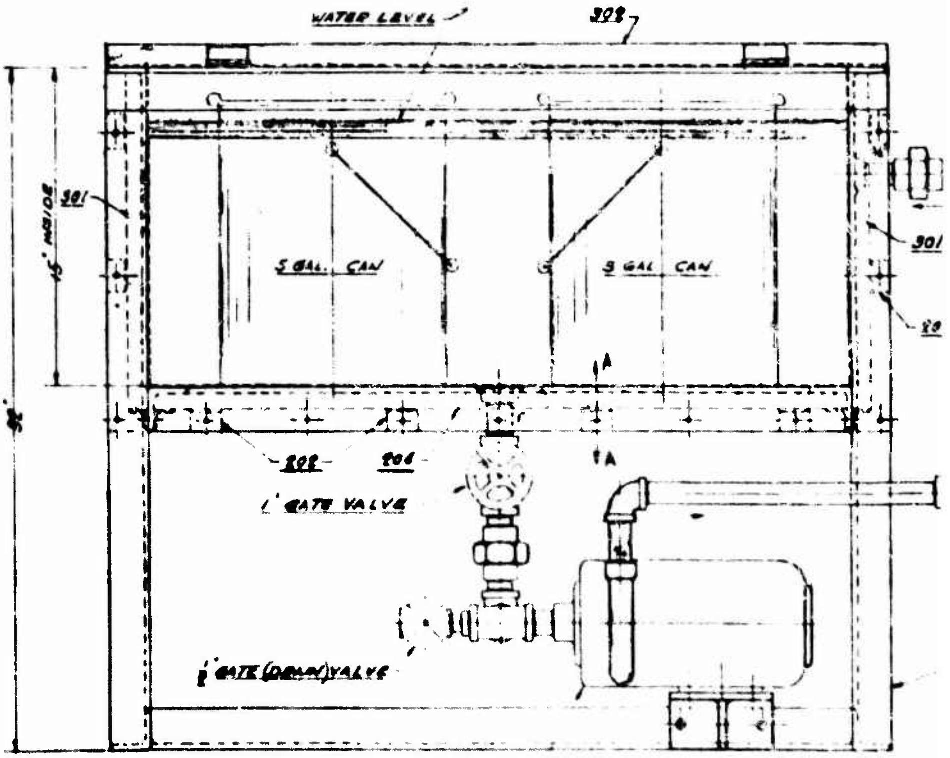
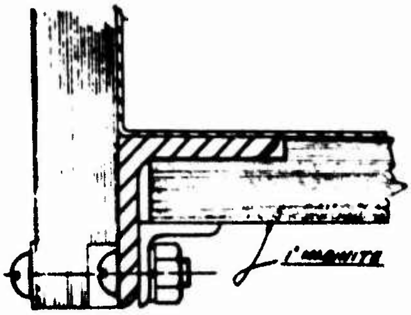

COVER - MOLD
NOTES:
UNIROYAL, Inc.
MOLD & COVER - TEST SLABS
SCALE
SHEET NO. 9
DWG. NO.
D-9222

FIGURE 18



TOP VIEW SHOWN WITHOUT COVER #302 HARWITE IN PLACE





SECT. A-A

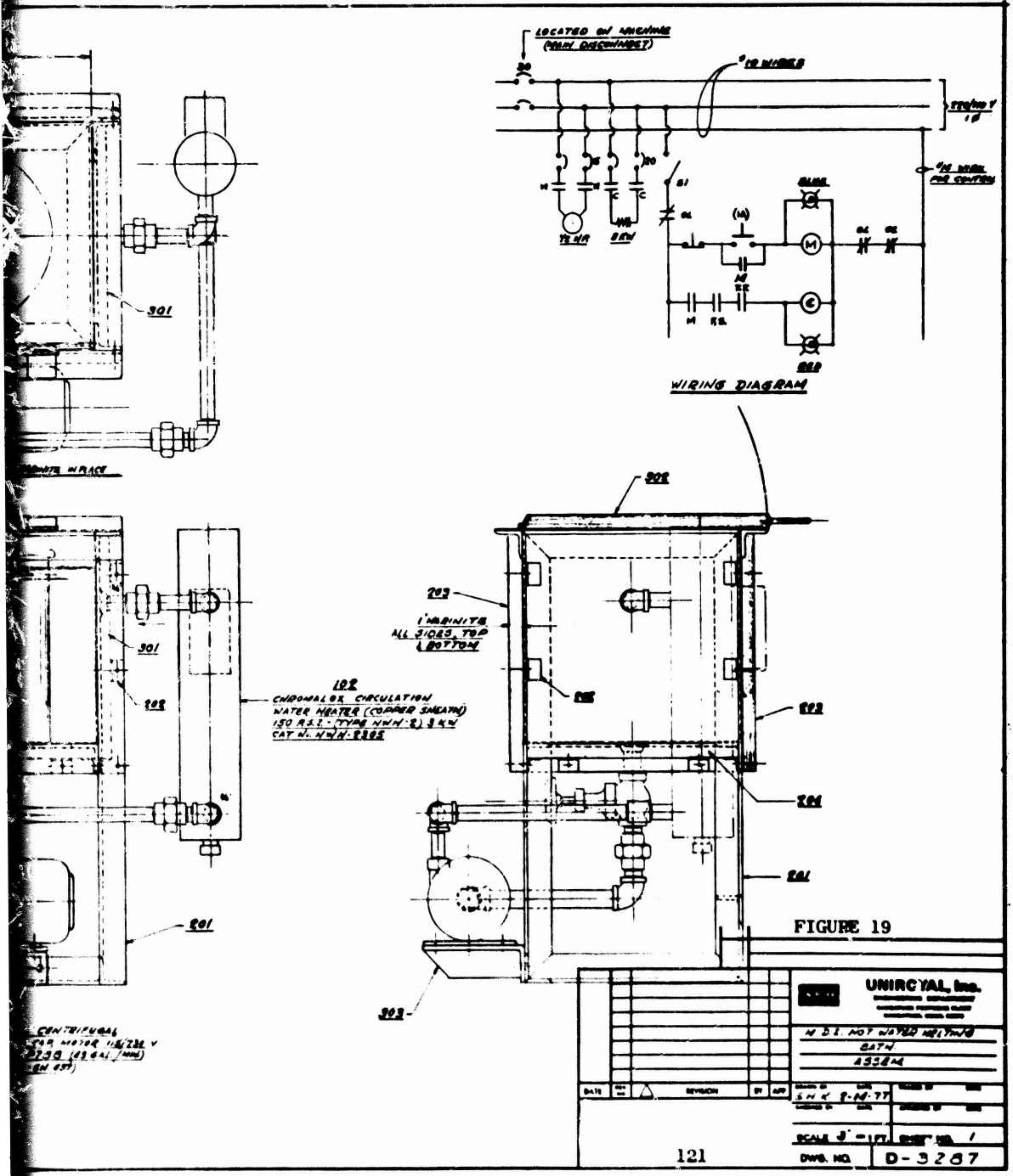
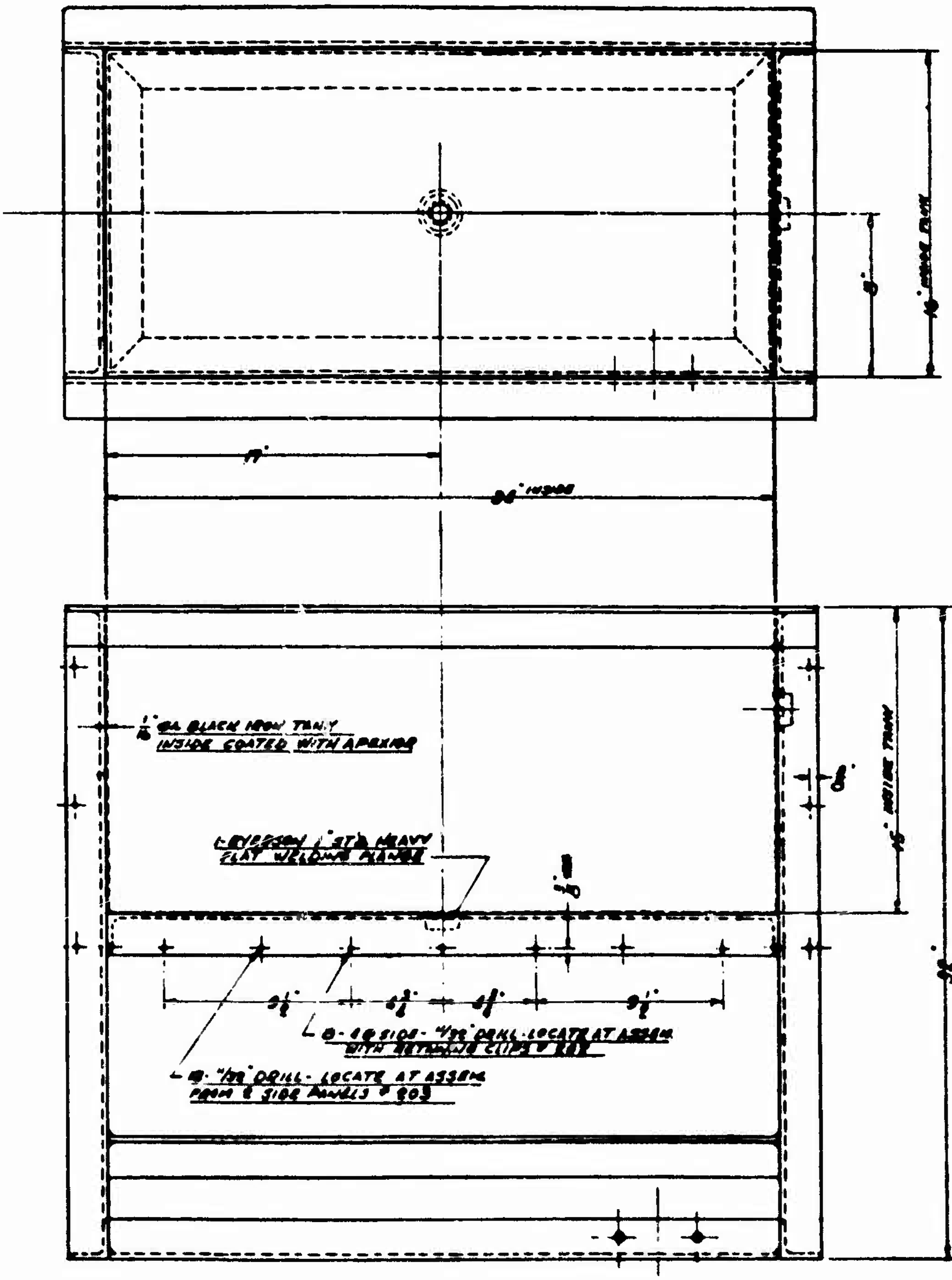
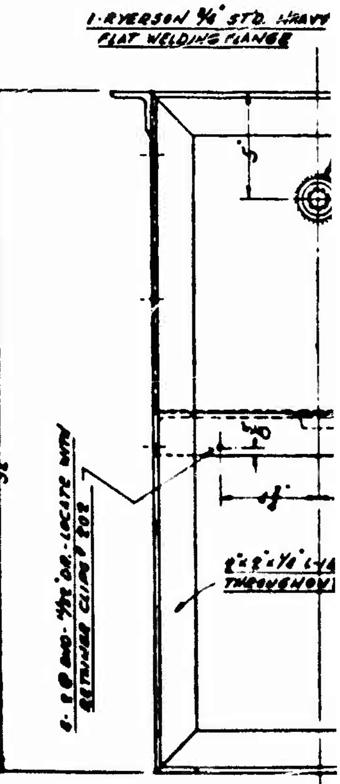
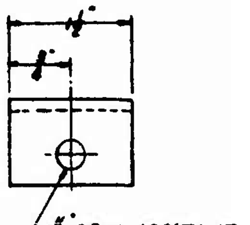

LOCATED ON MACHINE
(MAIN DISCONNECT)
#10 WIRES
220/110 V
1 Ø
#14 WIRE FOR CONTROL
½ HP
3 KW
S1
OL
(M)
M
M
C
BLUE
RED
OL
OL
M
RS
RS
WIRING DIAGRAM
301
301
202
102
CHROMALOX CIRCULATION
WATER HEATER (COPPER SHEATH)
150 P.S.I. - (TYPE NWH-2) 3 KW
CAT No. NWH-2305
INFINITE IN PLACE
201
CENTRIFUGAL
MOTOR 115/230 V
(12 GAL./MIN)
202
203
1" INFINITE
ALL SIDES, TOP
& BOTTOM
202
202
204
201
303
UNIROYAL, Inc.
N.D.I. HOT WATER MELTING
BATH
ASSEM
DATE
REVISION
BY
APP
S H K 8-14-77
SCALE 3" = 1 FT.
SHEET NO. 1
DWG. NO.
D-3287

FIGURE 19





201
MELTING TANK
1-STEEL-WELD CONST.



202
RETAINING CLI
20- 1"x1"x1/8" ANGLE I

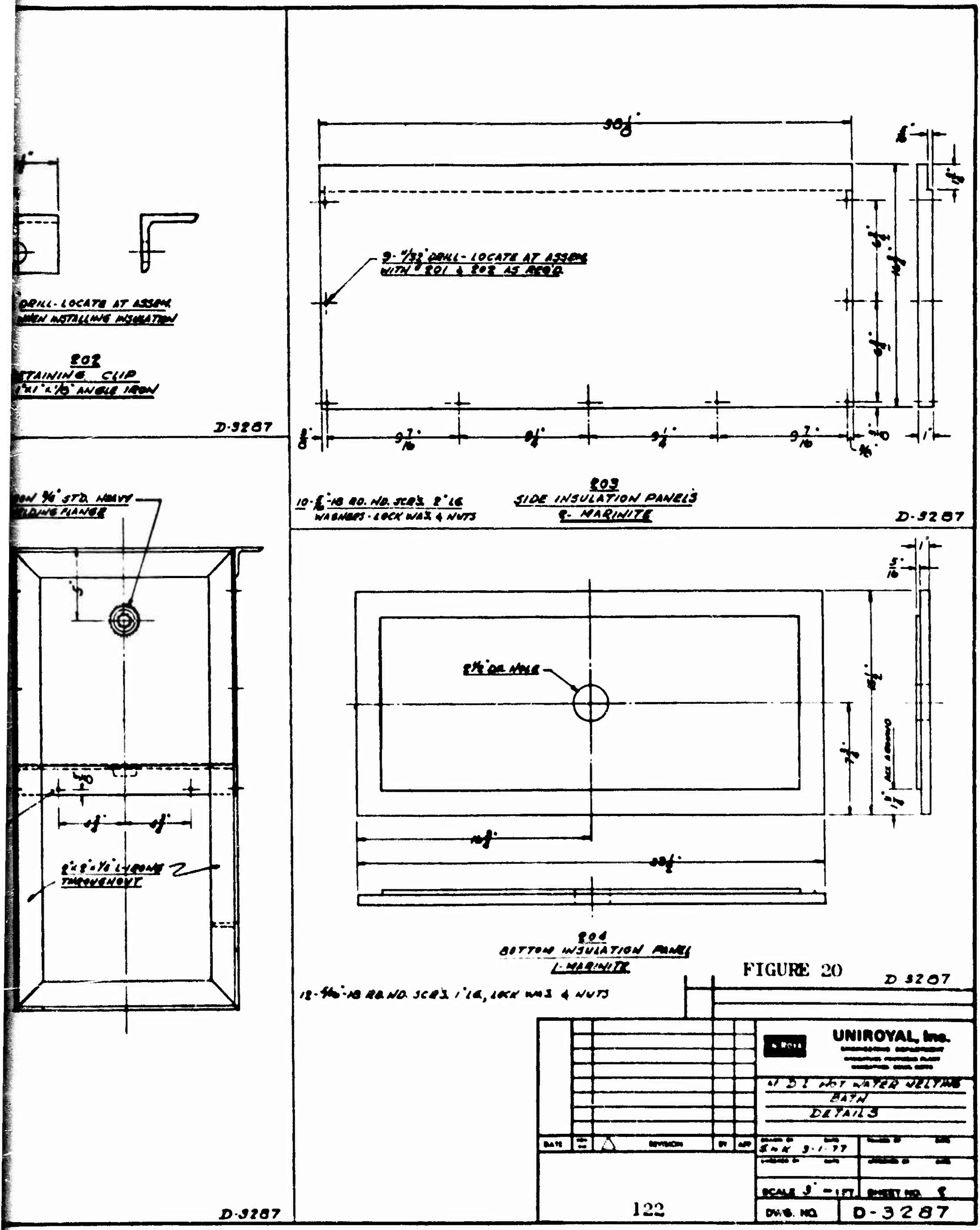
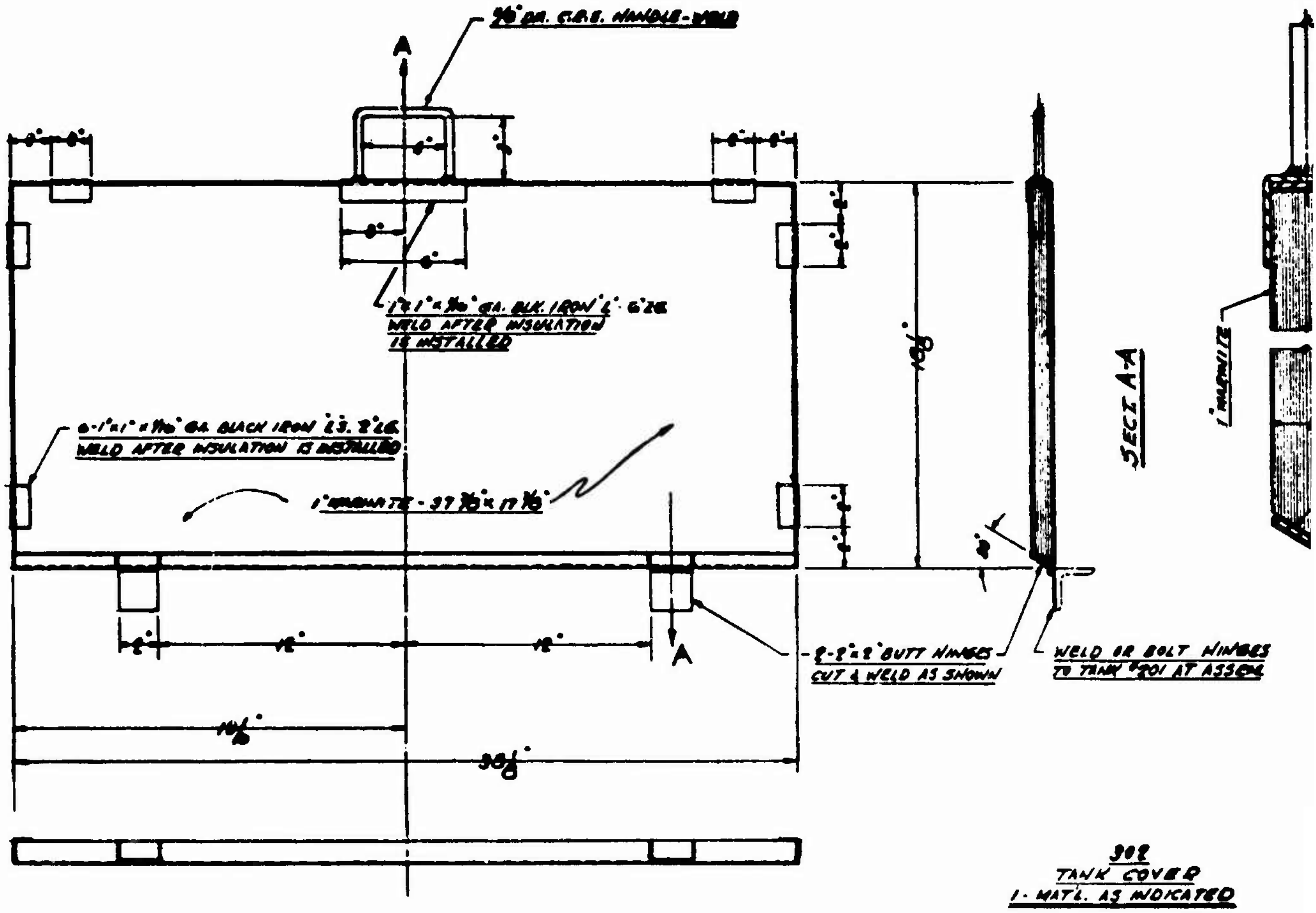
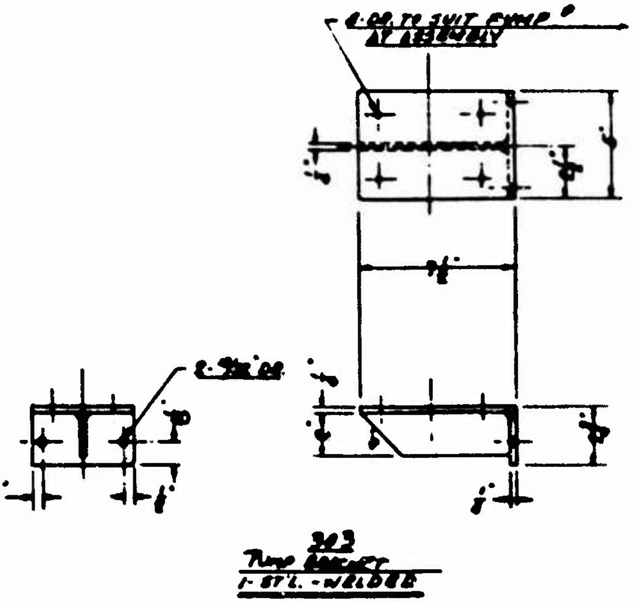

DRILL - LOCATE AT ASSEM. WHEN INSTALLING INSULATION
202
TAINING CLIP
1"x1"x1/8" ANGLE IRON
D-3287
9 - 11/32" DRILL - LOCATE AT ASSEM. WITH 201 & 202 AS REQ'D.
30 1/8"
9 7/16"
9 1/4"
9 1/4"
9 7/16"
10-5/16"-18 RD. HD. SCRS. 2" LG. WASHERS - LOCK WAS. & NUTS
203
SIDE INSULATION PANELS
2- MARINITE
D-3287
ON 3/4" STD. HEAVY WELDING FLANGE
2"x2"x1/4" L-IRONS THROUGHOUT
2 1/2" DIA HOLE
15 1/4"
30 1/4"
204
BOTTOM INSULATION PANEL
1- MARINITE
12-5/16"-18 RD. HD. SCRS. 1" LG., LOCK WAS. & NUTS
D-3287
UNIROYAL, Inc.
D I HOT WATER MELTING
BATH
DETAILS
S.W.K. 3-1-77
SCALE 3" = 1 FT.
SHEET NO. 2
DWG. NO.
D-3287

FIGURE 20



302
TANK COVER
1 - MAT'L. AS INDICATED



303
PUMP BRACKET
1- STL. - WELDED

D-3787

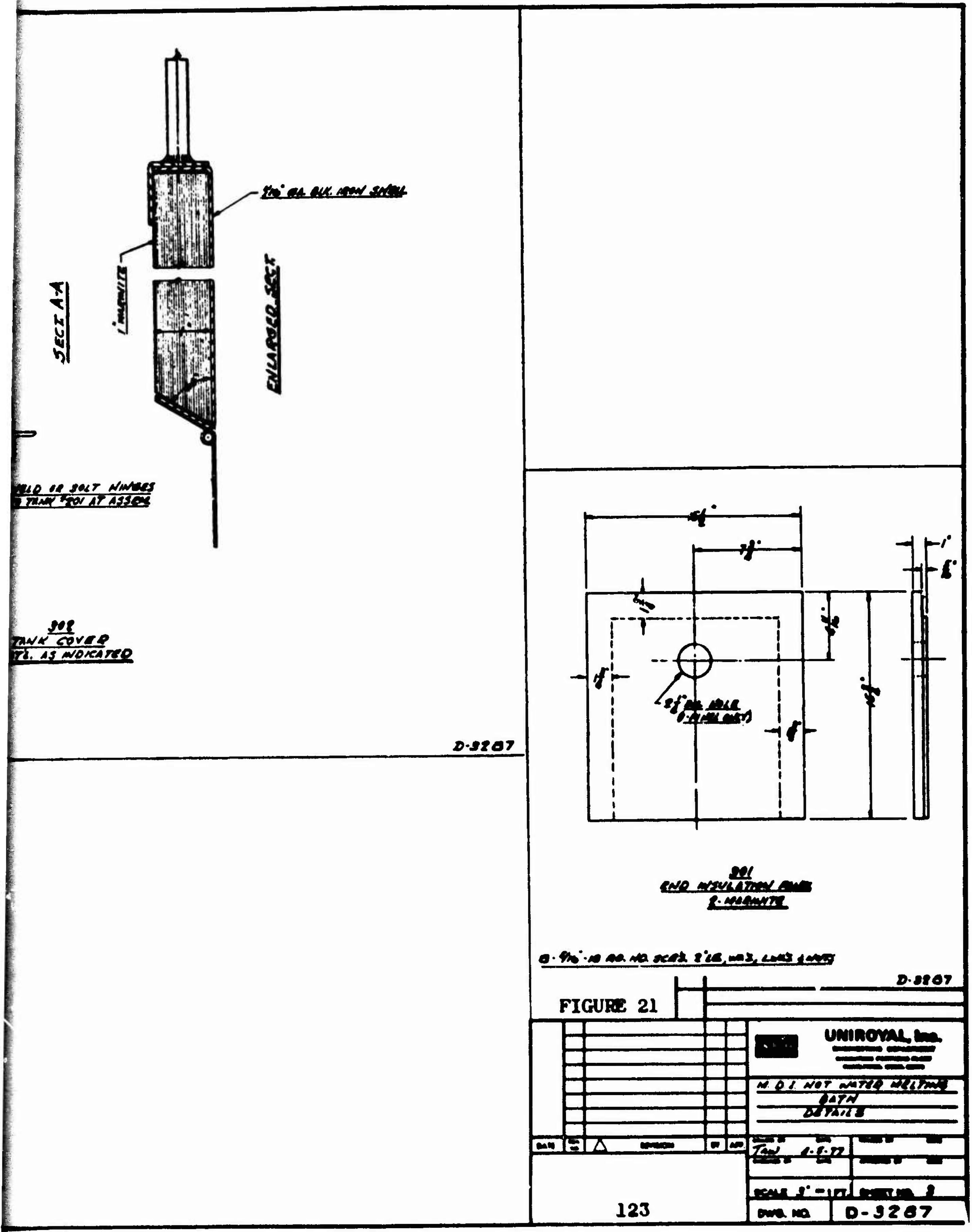
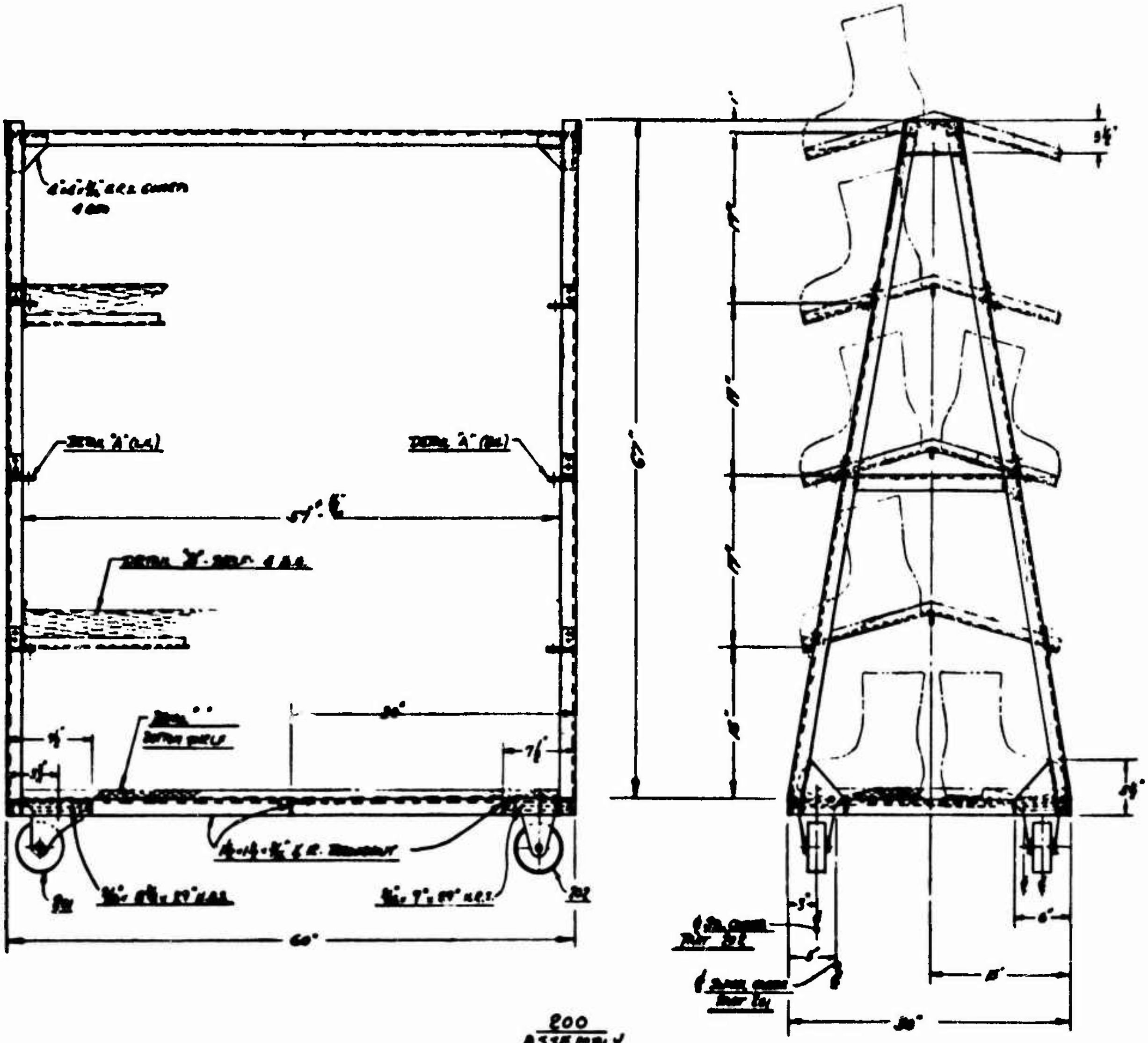

5/16" DIA. BLK. IRON SHELL
1" MARINITE
SECT A-A
ENLARGED SECT
WELD OR BOLT HINGES
TO TANK #201 AT ASSEM
302
TANK COVER
AS INDICATED
D-3287
301
END INSULATION PLATE
2-MARINITE
D-3287
UNIROYAL, Inc.
M.D.I. HOT WATER MELTING
BATH
DETAILS
SCALE 3" = 1 FT
SHEET NO. 2
DWG. NO. D-3287

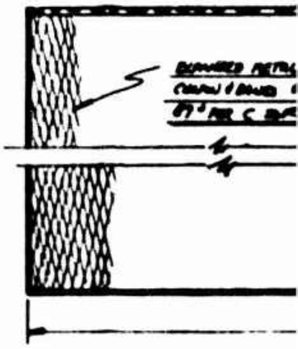
FIGURE 21

7



[illegible]
[illegible]

200
ASSEMBLY
DRYER TRUCK, GOV'T BOOT
1 REQ.- MAT. SHOWN
WELD



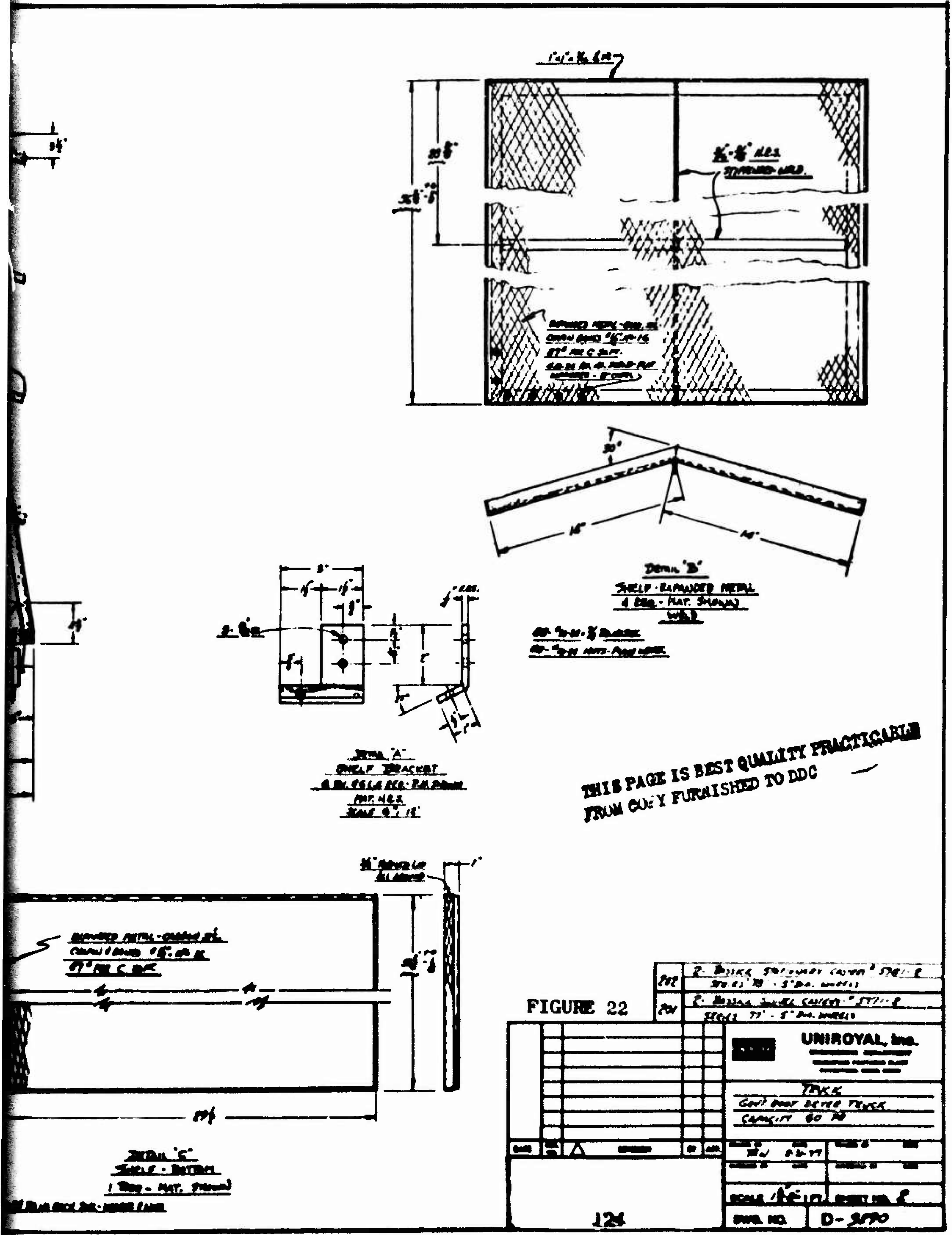

DETAIL 'B'
SHELF - EXPANDED METAL
4 REQ. - MAT. SHOWN
WELD
30°
16"
DETAIL 'A'
SHELF BRACKET
MAT. H.R.S.
DETAIL 'C'
SHELF - BOTTOM
1 REQ. - MAT. SHOWN
UNIROYAL, Inc.
TRUCK
GOV'T BOOT DRYER TRUCK
CAPACITY 60 PR
SCALE
SHEET NO. 2
DWG. NO.
D-3790

FIGURE 22

2

APPENDIX "A"

UNIROYAL, Inc.
Naugatuck Footwear Plant

TRIP REPORT

RANSBURG CORPORATION
339 WEST 56TH ST.
INDIANAPOLIS, IND. 46208

by

Richard J. VanTwisk
August 10 - 12, 1976

DISTRIBUTION

D. C. Narducci
E. C. VanBuskirk
T. A. Pietraszek
A. B. Brazdzionis
W. C. Delatore
F. C. Cesare
J. H. Flood
J. C. Gaynor
F. R. Prekosovich
J. H. Hubbard

September 8, 1976

RVT - 9/8/76

TRIP REPORT

RANSBURG CORPORATION
339 WEST 56TH ST.
INDIANAPOLIS, IND. 46208

Date: August 10, 11, 12, 1976

I. PERSONNEL: A. B. Brazdzionis
W. C. Delatore
R. J. VanTwisk

II. CONTACTS: William W. Smith - Manager-Sales Engineering
Jack Stauffer - Moeller Eng. & Sales Co.

III. PURPOSE:

A. The primary purpose was to make compound and equipment trials, using electrostatic disc spraying, to determine the necessary equipment specifications, in order to complete Phase II, Government Contract DAAG 17-76-C-0016.

Specifically, it was necessary to determine:

1. Compound formulations, preferably utilizing one with the most acceptable solvent system for allowable parts/million vented to the atmosphere.

2. The quantity and solvent types to be exhausted at the various points of the process, including spraying, flash-off before cure, over cure, cool-down, and the bank before finishing operations.

3. Coating questions:

   a. Could the coating be applied continuously for 12 minutes without air and solvent entrapment causing blistering during cure, as opposed to the original thinking of using three passes of 4 minutes each with a 4-minute flash-off time between passes?

   b. Could the desired coating be applied in 12 minutes without scars or sags?

c. If the method of masking the bottom of the outsole with a vacuum formed mask would be feasible?

d. If 24 minutes flash-off would be sufficient to avoid blisters during cure?

e. If 24 minutes cure time at 240°F would be sufficient to cure the coating?

f. How long a cool-down period would be required before boot could be stripped from the last?

g. If the size of the aluminum last (that is electrically grounded) would make a noticeable difference in the attraction of the electrically positive charged spray in various areas of the boot?

h. Boot spacing on the conveyor.

i. Boot rotation rate.

j. Pump delivery rates to disc.

k. Speed and height of the vertical reciprocating of the rotary disc.

l. Size and RPM of disc.

IV. CONCLUSIONS:

A. Five separate trials were made, each trial requiring 3 to 4 hours to complete, including analyzing the data in order to design the next trial. The details of the trials are included in the R&D trip report.

The final trial made (#5) produced excellent results. Analyzing the trial data, we can conclude the following.

1. A two-component urethane spray of the desired polyurethane formulation, 45% total solids, using a solvent system comprised of 36% Perchloroethylene, 55% Tetrahydrofuran, and 9% Diisobutylketone, can be continuously sprayed for 12 minutes; solvent flash-off for 24 minutes; cure for 24 minutes; cool-down for 16 minutes before stripping; depositing 109 grams on boot after complete solvent evaporation, with an absolutely smooth surface. Gauge distribution as follows:

a. One inch down from top of boot, 0.037 inches.

b. Six inches down from top of boot, 0.043 inches.

c. Vamp, mold parting line, 0.030 inches.

d. Toe, half-inch up from outsole/upper line, 0.049 inches.

e. Heel, half-inch up from outsole/upper line, 0.049 inches.

2. The gauges can be altered slightly in relation to each other by:

a. Using a shorter aluminum last so that the top of the last is one-half inch below trim line of boot (2 inches below top of sock lining), giving less attraction in this area. In addition, the top of the sock lining extending 2 inches above the last will protect the hanger from being coated where it is attached to the last.

b. Altering the degree of tilt. The boot was tilted 12° toe down. Final design will include 4 holes in which to place the 1/8" diameter metal hanger to provide 8°, 12°, 16° and 20° tilt, so that optimum results can be obtained by trial and error.

c. Changing the vertical reciprocating pattern of the disc.

Note: It will not be possible to appreciably increase the gauge in the vamp area without increasing the gauge in the heel area to the same degree.

3. A vacuum formed polyethylene mask can be formed, which when attached to the outsole (by means of two thumb tacks), will form a shield to permit the coating to taper off to a point 1/32 inch above the bottom of the outsole.

V. SPECIFICATIONS:

A. Based on successful trials made and the data collected, the following are the specifications to be used to design the complete electrostatic spray system.

1. A layout (copy attached) details the room size, conveyor length and speed, cure oven, evaporation oven, etc.

    a. Area of room, including ovens 44 ft x 24 ft - 1056 sq ft.

    b. Total length of conveyor 80 ft - 48 boots (24 pair) required to fill on 20-inch centers. Conveyor speed 10 inches/minute (adjustable from 8 inches to 14 inches/minute). Diameter of loop in booth - 60 inches.

2. The solvent evaporation rates in the various areas are as follows:

Area	Calculated Grams Per Hour	Design Grams Per Hour (Approx. 50% Safety Factor)
Spray Booth	2400	3600
Flash-off Area	210	300
Cure Oven	690	900
Cool Down	270	350
Final Evaporation Oven	510	700
	4080 grm	5850 grm
	or 9.1 lb/hr	or 12.9 lb/hr

3. Cure oven explosion-proof electric heat source and controls to provide temperature from 180°F to 260°F ± 10°F.

4. Final evaporation oven to provide temperature from 150°F to 180°F ± 10°F.

5. Sufficient exhaust (CFM) to be provided to completely exhaust all solvent fumes. Heating of make-up air (BTU's required) to be provided for 0°F outside air.

6. Final exhausted fumes to meet EPA and State of Connecticut regulations for the solvent system as used.

7. The basic standard Ransburg equipment to be used with the following modifications.

    a. Barmag gear pumps to be 0.5 cc/revolution, and 1 cc/revolution in place of the 1.2 cc used in the trials.

b. Polyethylene hoses from feed tank to suction side of pumps, and from discharge side of pumps to static mixer to be 1/4" I.D., rather than the standard 1/2" I.D.

c. The static mixer used should be sized to properly mix a flow rate of 180 grams to 250 grams per minute.

d. The vertical reciprocating action of the disc need be only 20 inches maximum, with adjustable settings, to achieve a minimum of 10 inches. In addition, two additional micro switches on the reciprocating control that can be adjusted to any point between the top and bottom stroke controls will be required. While the cam will pass over and mechanically activate the "middle" micro switches, it will only stop the stroke at this point when these switches are electrically activated. They are to be electrically activated by means of a percentage timer. This will permit directing the spray toward a certain section of the boot (as example, the vamp area) for a time percentage of 0% to 100% of the 12 minutes the boots are sprayed. The reciprocating speed should be adjustable from 10 ft. to 20 ft. per minute.

e. The disc should be of the type where the material enters the well through the bottom. Diameter 15". RPM variable from 600 to 1200 revolutions per minute.

f. The boot rotation speed to be variable from 3 RPM to 9 RPM.

g. The compounds to be fed to the pumps from a 5 gallon and 20-gallon pressure tank. The air source to pressurize the tanks must be dry air provided by a commercial air dryer.

8. The room must be humidity controlled to 50% humidity, + 10% - 20%. The incoming make-up air temperature can be figured at 90°F maximum. No cooling of air is required.

VI. GENERAL PLANNED OPERATING PARAMETERS

A. Last sizes can be two sizes smaller than the boot being sprayed. This will facilitate mounting and removing from the last. A removable toe will be required. The lasts can be made at our Wellman facility. Costs quoted effective to January 1, 1977 are as follows:

Special tooling for casting 2-piece mold ...	$680.
Core box charge per size	$550.
Lasts per pair............................	$ 75.

The lasts will be of a thinner wall thickness to reduce weights - as thin as possible in relation to suitable strength. The costs include fabricating and welding a strip of aluminum with holes for hanging the last on the hangers. The final design of this strip will depend on last weight to determine hole placement to give the desired tilt.

The conveyor will require 24 pair of lasts to fill. It is possible to run three sizes at one time at a given material through-put setting. Therefore, 8 pair of lasts for each whole size will be required (widths will not affect requirements). If ten whole sizes are to be run, storage area and racks for 80 pair of lasts will be needed.

B. The total through-put of the material in grams per minute is calculated by multiplying the desired dry weight per boot by 222% (to account for 45% total solids); multiplying by seven (7 boots in booth); and dividing by 12 minutes (spray time). This result multiplied by 112% to account for 90% spray efficiency. Example: 100 grams dry weight desired.

x 222% = 222 grams
x 7 = 1554 grams
÷ 12 = 130 grams/minute
x 112% = 156 grams/minute total through-put

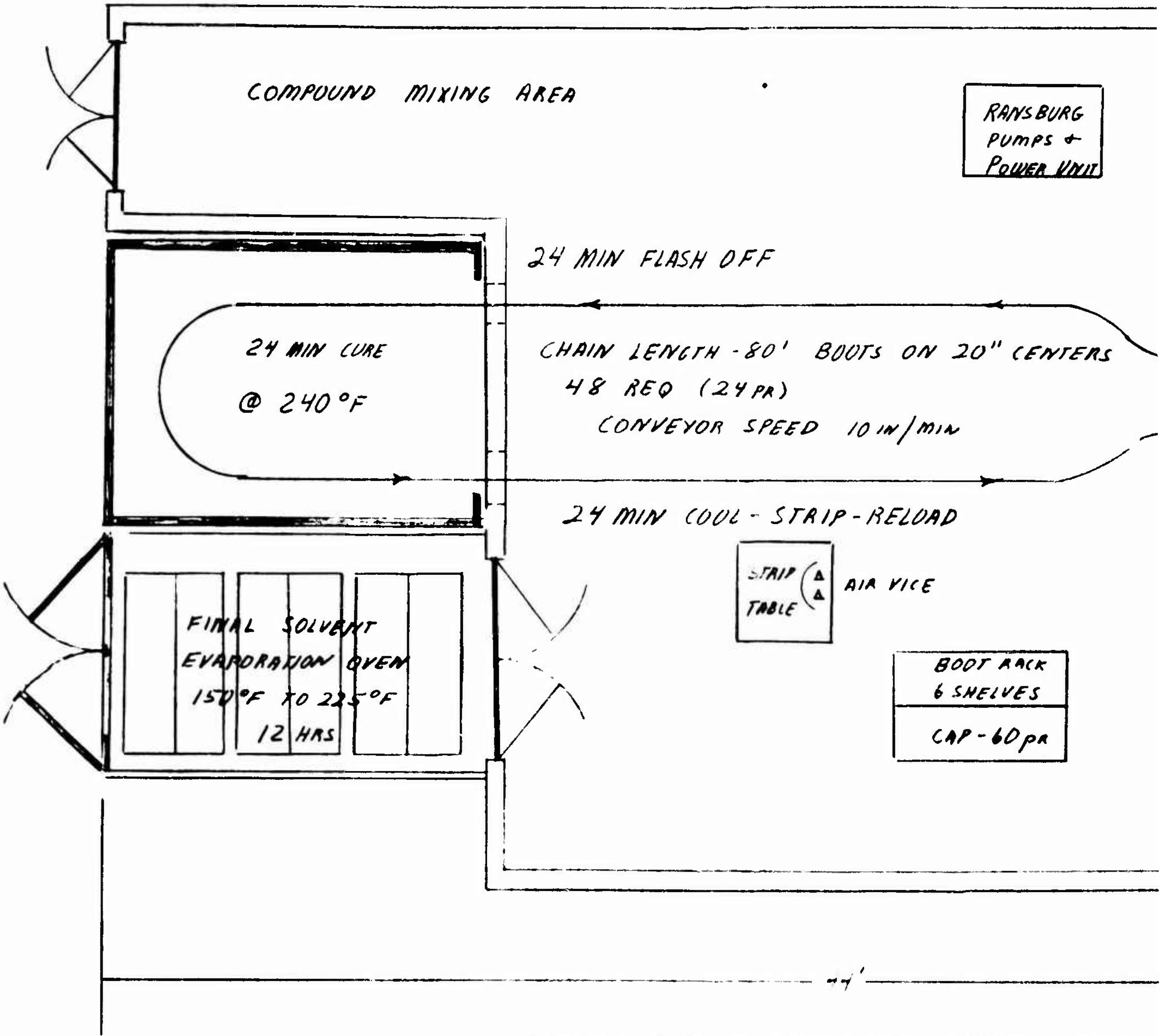
The total through-put is the material delivered by both pumps, and must also be in the proper ratio dictated by the formulation. To obtain the same gauge of coating on a size 5 boot (run with size 4 and size 6) as on a size 13 boot (run with size 12 and size 14), it will be necessary to calculate the surface area of the upper and adjust the through-put accordingly. On a percentage comparison basis the through-put of each pump can be controlled by the RPM speed by means of a dial setting. The actual grams per minute is checked through a petcock at the delivery end of the hose by running for 1 minute into a paper cup and weighing. Additional adjustment to pump speed can then be made to provide the exact delivery rate required.

C. With a production rate of 30 boots per hour, one operator is all that is required to remove last, relast another boot, wipe boot with solvent and place mask. However, for safety reasons, (one operator working alone in a closed room)two should be figured in the manning table. The second operator can mix compounds, fill supply tanks as needed, service racks in-and-out of final evaporation oven, and remove masks before boots enter oven if necessary (required work time 2 minutes each, 24-minute cycle).

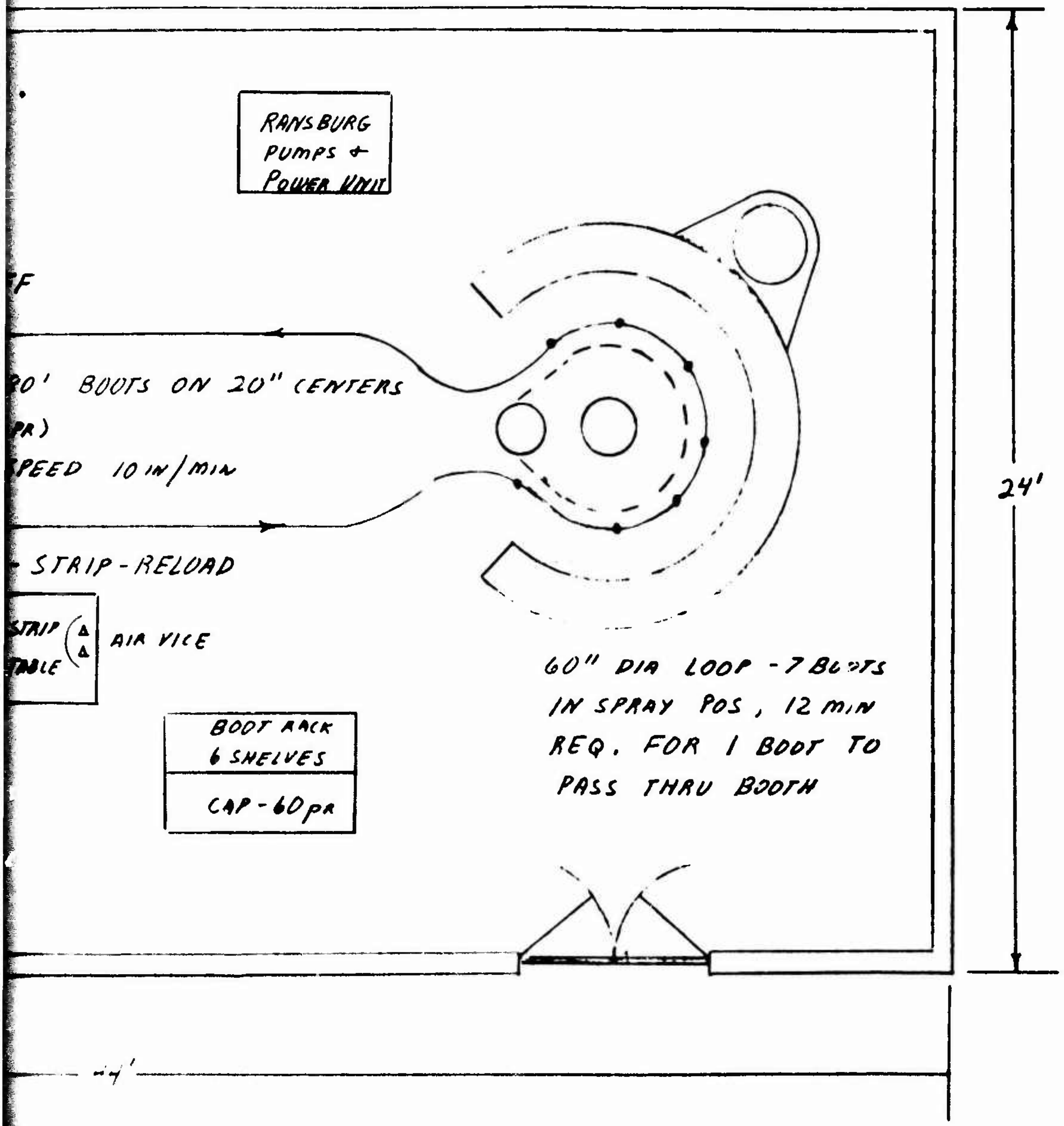
D. The masks used were made in Oxford R&D and the method and equipment used will be covered in a separate report. The masks were removed before cure in the trials. However, since the masks fit the design area perfectly, it may be possible to leave them on during cure. They will soften, but the close fit should keep them to the proper shape. After 16-minutes cool-down, they should be sufficiently stiff to remove and rense. Very little spray is deposited on the bottom of the masks. They can be used continuously for at least one day. Any coating then can readily be peeled off. (After 8-hr air cure).

E. An air operated vice mounted on a table to clamp the hanger strip on the top of the last will facilitate removal of last from boot. After 16 minutes cool-down, the boot is about 100°F and can be handled without gloves. However, the last is about 170° due to the insulating qualities of the boot. The last should be water quenched before it is recycled.

F. A rack to hold the boots is shown on the layout. The rack dimension is 5 ft. long x 3 ft. wide x 84 inches high. There are 6 shelves in the rack, each shelf holding 10 pair. These racks will pass through the final evaporation oven, providing 12 hours to drive off any remaining solvent. Boots will then be ready for final operations.



LAYOUT FOR ELECTROSTATIC SPRAY COATING
POLYURETHANE INSULATED BOOTS
PROD RATE 15 PR/HR



ECTRO STATIC SPRAY COATING
NE INSULATED BOOTS
ATE 15 PR/HR

FIGURE A-1

SCALE 1/4" = 1' RVT 8/25/76

APPENDIX "B"

UNIROYAL, Inc.
Consumer Products
Oxford R-1-31
(Location)

August 16, 1976

Trip Report: Polyurethane Army Boots--Electrostatic Spray Trials.
Ransburg Electro-Coating Corporation, Indianapolis, IN.

Contacts: Mr. William Smith--Ransburg Electro-Coating Corporation.
Uniroyal Personnel: Mr. A. B. Brazdzionis
Mr. R. VanTwisk
Mr. W. C. Delatore

Purpose: Evaluate Ransburg's electrostatic spray equipment and determine if it is suitable for coating the Lightweight Polyurethane Arctic Boot.

Conclusion:

1. The Ransburg Electrostatic Spray System worked very well in coating the Arctic Boots. Varying thicknesses of polyurethane coating were deposited as required. Final appearance of the boots was very good.

2. The polyethylene mask developed by Mr. VanTwisk to prevent material from depositing on the bottom of the outsole, as well as to taper material along the sides of the outsole, worked sufficiently well.

3. The process goals set by Mr. VanTwisk--spraying times, material outputs, weight of coating, and drying times--were all achieved.

4. Formula No. 4 showed the best properties when using the Ransburg system. The boots coated well and there were no signs of sagging or imperfections on the finished coating. The coating covered all minor blemishes on the boot.

Discussion:

Equipment time was rented at Ransburg so that electrostatic spray trials for coating an insulated Arctic Boot with a polyurethane coating could be run. The polyurethane compound consists of a two-component system in which the polyether prepolymer is supplied in a solvent as the "A" component and the curative is supplied in a solvent as the "B" component. The components are metered in a predetermined ratio by positive displacement gear pumps to a Ross static mixer and thereafter, as a one component to a well in a spinning disc which atomizes the solution and also imparts an electrostatic charge. The particles are thrown from the disc by centrifugal force and in turn, attracted to the grounded article which is being coated. More detailed engineering information of the various Ransburg Systems can be obtained from Process Engineering, Consumer Products.

I. Formulas

Formula 1

Component A		Component B	
B-602	3000 grams	MDA	220 grams
THF	450 grams	THF	1680 grams
Toluene	450 grams	CT-Black	50 grams

Mixing Procedure:

Component A, 3000 grams of B-602 was dissolved in 450 grams of THF and 450 grams of Toluene. Component B, 220 grams of MDA was dissolved in 1680 grams of THF, 50 grams of CT-Black was then added. Both components were then thoroughly mixed individually using an air stirrer.

Calculated Ratio: (100 index)

A/B; 100/49.91 by weight

Note: Compound viscosity was found to be important as was observed when Formula 1 was run through the pump. Component A of Formula 1 was too viscous and the pump started to cavitate. Component B of Formula 1 had a viscosity that was too low and slippage in the pump occurred. To solve the problem of Component A, the total solids were lowered by the addition of solvents. To increase the viscosity of Component B, a pre-reacted compound was formulated.

Formula 1a

Component A		Component B	
		(B-1)	
B-602	2000 grams	MDA	392.2 grams
Toluene	640 grams	THF	1080 grams
THF	160 grams	CT-Black	50 grams
		(B-2)	
		B-602	900 grams
		Toluene	180 grams
		THF	540 grams

Mixing Procedure:

Component A, 2000 grams of B-602 were dissolved in 640 grams Toluene and 160 grams THF. Component B, was initially mixed into two individual batches (B-1, B-2). While B-1 was being stirred, B-2 was added slowly to B-1 to produce component B. By this process, Component B formed a pre-reacted system with an excess of MDA, and a much higher viscosity than Formula 1, Component B. Another added feature to this process was that the gel time is much faster.

Calculations to Determine Ratio:

The following calculations were used to determine the ratio that Component A and Component B should be mixed at in Formula 1a.

The same steps were also used in calculating the ratios for the remaining formulas.

Equivalent Weights

B-602	1350 equivalent weight
MDA	99 equivalent weight

$$\frac{\text{weight of compound}}{\text{equivalent weight}} = \text{number of equivalents}$$

Component A

$$\frac{\text{2000 grams B-602}}{\text{1350 equivalent weight B-602}} = \text{1.48 number of equivalents of B-602}$$

Component B

$$\frac{\text{394.2 grams MDA}}{\text{99 equivalent weight MDA}} = \text{3.98 number of equivalents of MDA}$$

$$\frac{\text{900 grams B-602}}{\text{1350 equivalent weights B-602}} = \text{0.66 number of equivalent of B-602}$$

Therefore,
3.98 number of equivalents of MDA
- 0.66 number of equivalents of B-602

3.32 number of equivalents of MDA in excess in Component B

Component A
1.48 number of equivalents B-602
2800 total weight of Component A

Component B
3.32 number of equivalents MDA
3144.2 total weight of Component B

(A) $\frac{2800}{1.48}$ = 1891.89 equivalents of A (B) $\frac{3144.2}{3.32}$ = 947.05 equivalents of B

A/B; 1891.89/947.05; 100/50.05 for a 100 Isocyanate Index

Calculated Ratio: (100 index)

A/B; 100/50.05

Note: When Component B was taken off the stirrer, a gel formed. In an attempt to solve this problem, the level of B-602 in Component B was lowered.

Formula 1b

Component B

Component A Not Mixed

(B-1)

MDA	400 grams
THF	1000 grams
CT-Black	50 grams

(B-2)

B-602	400 grams
MEK	180 grams
THF	540 grams

Mixing Procedure:

Same as Formula 1a (with exception of weights). When B-2 was added to B-1, a gel formed again; however, the gel had been diminished greatly.

Note: A new solvent system using only THF was used in the following formula to try to avoid a gel.

Formula 1c

Component B

Component A Not Mixed

(B-1)

MDA	400 grams
THF	1000 grams
CT-Black	50 grams

(B-2)

B-602	400 grams
THF	800 grams

Mixing Procedure:

Same as Formula 1a (with exception of weights). When B-2 was mixed with B-1, again a gel formed and compound was again **scrapped**.

Formula 2

Component A		Component B	
		(B-1)	
B-602	1700 grams	MDA	400 grams
Toluene	1300 grams	THF	1000 grams
THF	466.6 grams	CT-Black	50 grams
		(B-2)	
		B-602	400 grams
		DIBK	300 grams
		THF	500 grams

Mixing Procedure:

Same procedure as Formula 1a.

The addition of DIBK resulted in insignificant gel formation. This and subsequent formulas were used in spray trials.

Calculated Ratio: (100 index)

A/B; 100/24.99, by weight

Formula 2a

Component A

B-602	1530 grams
Toluene	1170 grams
THF	420 grams

Component B

(B-1)

MDA	400 grams
THF	1000 grams
CT-Black	20 grams

(B-2)

B-602	400 grams
DIBK	300 grams
THF	500 grams

Mixing Procedure:

Same procedure as Formula 1a

Calculated Ratio: (100 index)

A/B; 100/24.99, by weight

Formula 3

Component A

B-602	1700 grams
Per. Cl	1300 grams
THF	466.6 grams

Component B

(B-1)

MDA	400 grams
THF	1000 grams
CT-Black	20 grams

(B-2)

B-602	400 grams
Per. Cl	300 grams
THF	500 grams

Mixing Procedure:

Same procedure as Formula 1a

Component B gelled loosely during the spray trials but could still be pumped on ratio.

Calculated Ratio: (100 index)

A/B; 100/24.99, by weight

Formula 4

Component A

B-602	1700 grams
Per. Cl	1300 grams
THF	466.6 grams

Component B

(B-1)

MDA	400 grams
THF	1000 grams
CT-Black	20 grams

(B-2)

B-602	400 grams
DIBK	300 grams
THF	500 grams

Mixing Procedure:

Same procedure as Formula 1a.

Calculated Ratio: (100 index)

A/B; 100/24.99, by weight

ABBREVIATIONS

B-602	Polyether, Urethane Prepolymer
MDA	4,4' - Methylenedianiline
CT-Black	Microlith, Pigment
THF	Tetrahydrofuran
DIBK	Diisobutylketone
MEK	Methyl ethyl Ketone
Per. Cl	Perchloroethylene

II. Processing

1. Description of Trials

A. Three boots were hung on a conveyor in a spray booth (see Diagram 2, points L, C, R). The conveyor did not move forward during spraying. Each boot rotated on its axis at 6 RPM so that all sides of the boot would be exposed to the disc for equal amounts of time. Metal panels were hung at points P-1 and P-2 (Diagram 2) to approximate the electrical attraction of four boots. By the use of these two panels and three boots, it was possible to simulate the spraying of seven boots during each trial.

(A-Continued)

The reciprocating disk rotated at 900 RPM and had a charge of 85 kV, which in turn, charged the coating particles. Two Barmag pumps(1.2 cc/revolution) with variable speed drives were used to pump the components.

B. Metal lasts were used inside the boots to attract the electrically charged particles. Different size lasts were tried in the hope that if a smaller last could be used, the process of de-lasting would be made easier. Results showed that a loose fitting last, two sizes smaller than the boot, works as well as a last the same size as the boot.

Another attempt to improve de-lasting was to remove the toe piece of the last; however, without the toe piece, there was insufficient attraction to the vamp area of the boot. As a result, an unacceptable thinner coating of the vamp area was obtained.

C. The boots hung from the conveyor with their outsoles facing down. The outsole was at an angle, with the toe approximately 2.5 inches lower than the heel. At this angle, the vamp of the boot did not sufficiently coat, so a second attempt at hanging the boot was tried. This time the hanger was attached to the last approximately 2 inches farther back. This lowered the toe another inch resulting in more of the vamp surface facing the disc, which in turn placed more coating on the vamp. However, the coating was thicker than desired at the lower heel and upper front (shin area) and was rather thin in the upper back. The first angle gave the better overall results.

D. The reciprocator stroke which is the up and down movement of the disc has three variables:

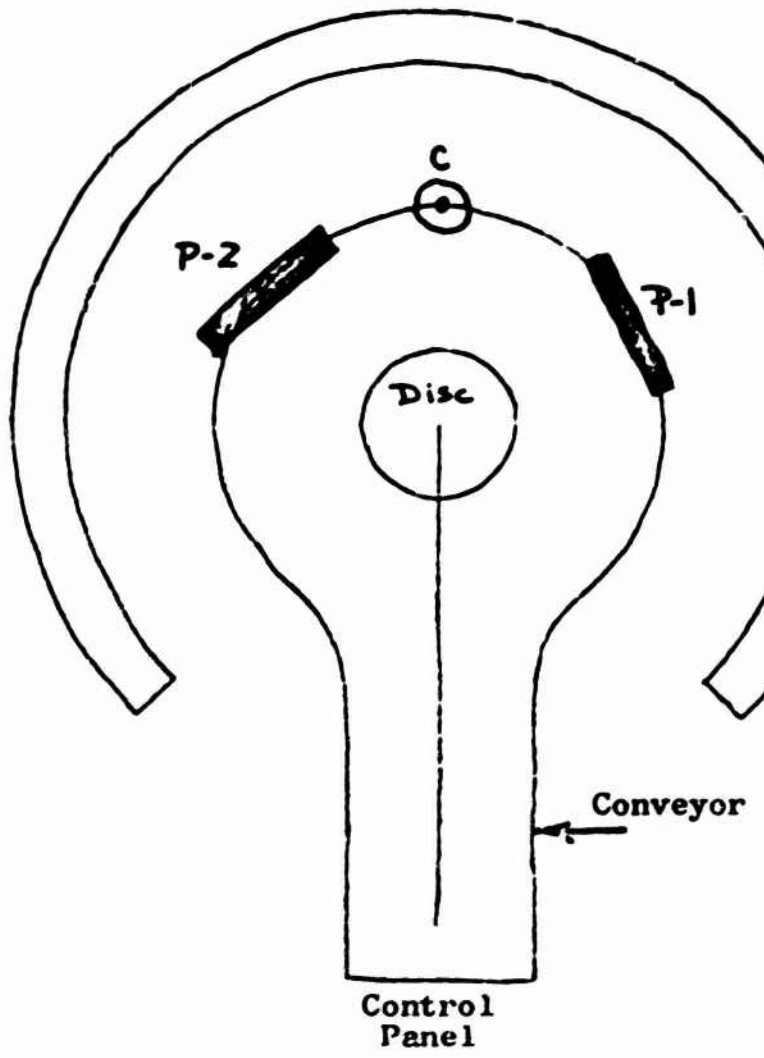
1. The distance it travels up and down
2. The speed at which it travels up and down
3. A hesitation, such that part of the total stroke can be run at a slower speed.

The two best results were obtained using the following reciprocator strokes:

1. A total reciprocator stroke of 15 inches starting 1.5 inches below the outsole with a slow hesitation at the lower 8.5 inches of the total stroke.

2. Partial stroke with no hesitation, starting 1.5 inches below the bottom of the outsole and rising a total of 8.5 inches.

In both of these variations, more coating was deposited on the lower portion of the boot. The second trials which had no hesitation worked slightly better. This was due to the limited control of the hesitation cycle, resulting from the inability of the controls to be set for such a short hesitation within a small stroke.

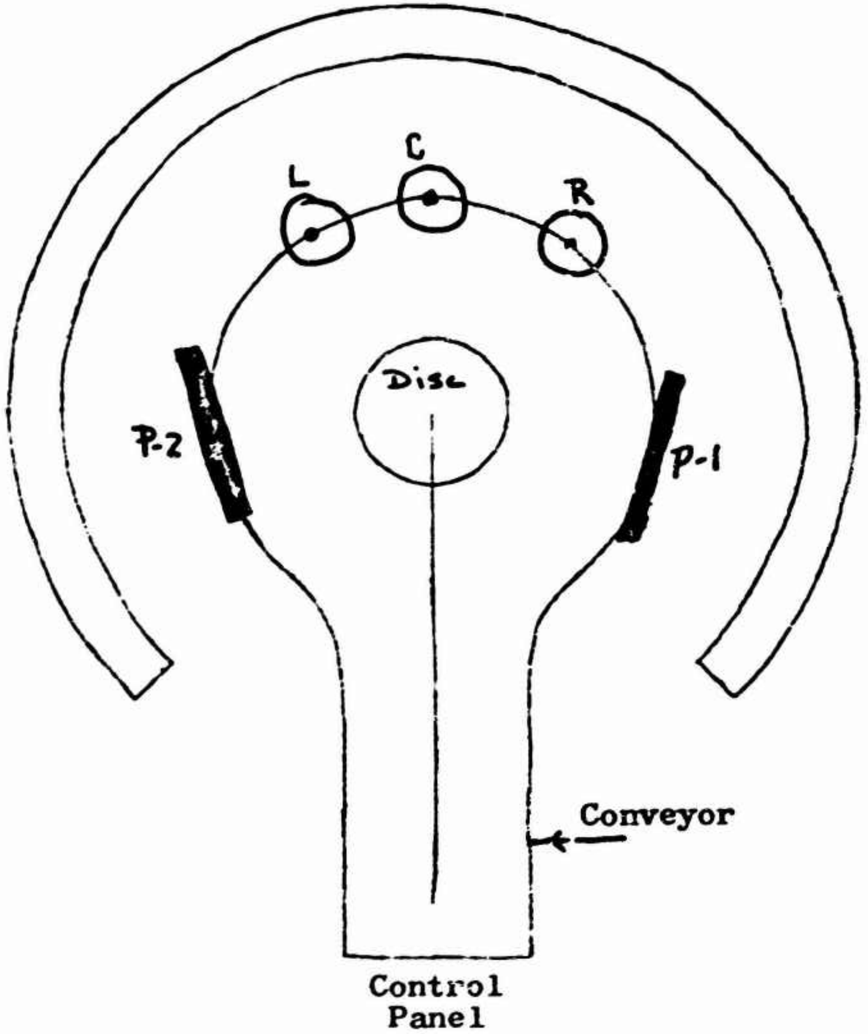


85 K.V. to Disk.
Boot Rotation 6 RPM
Conv. Speed zero ft./min.
Disc 900 RPM
Boots: C
Panels: P-1, P-2
Two Barmag pumps, 1.22cc/rev.

Diagram 1
For Lab Test No. 1 only

FIGURE B-1

Not to scale



85 K.V. to Disk.
Boot Rotation 6 RPM
Conv. Speed zero ft./min.
Disc 900 RPM
Boots: L, C, R
Panels: P-1, P-2
Two Barmag pumps, 1.22cc/rev.

Not to scale

Diagram 2
For Lab Tests 2 through 5

FIGURE B-2

III. Spray Trials

Lab Test No. 1

One boot sprayed
Formula #2
Machine throughput 210 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 2520 grams (calculated)
Total solids: 45%
Two panels used, each representing three boots.
2520 grams sprayed ÷ 7 boots = 360 grams/boot x 45% solids = 162 grams/boot (theoretical dry weight)
Final coating per boot:
(c) center boot weight not recorded, Freon upper. Full last; size 10
Boot rotation: 6 RPM
Total reciprocator stroke: 15 inches
Slow hesitation, lower portion of boot
Pot pressure: 12 psi
Actual Compound Ratio: A/B; 100/24.30, by weight
Comments: Coating was very light in the vamp area (0.02"). Outsole mask was too high and must be cut down if sides of outsole are to be coated.

Lab Test No. 2

Three boots sprayed
Formula #2a
Machine throughput 210 grams/minute (measured)
Spray time: 11.5 minutes
Total grams sprayed: 2415 grams (calculated)
Total solids: 45%
Two panels used, each representing two boots
2415 grams sprayed ÷ 7 boots = 345 grams/boot x 45% solids = 155.25 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left boot 119 grams, Freon upper. Full last; size 7
(C) center boot 142 grams, Freon upper. Full last; size 9
(R) right boot 158 grams, Freon upper. Full last; size 8
Boot rotation: 6 RPM
Total reciprocator stroke: 15 inches
Slow hesitation, lower portion of boot
Pot pressure: 12 psi
Actual compound ratio: A/B; 100/24.30, by weight
Comments: The reason that the spray time was only 11.5 minutes, was due to a leak in the pressure pot which resulted in air bubbles in the feed line. This occurred at about eleven minutes into the coating cycle. Spraying was stopped before any off ratio compound could reach the disc.

The reason for the difference in weights of the three boots was never actually determined but a probable cause could be that the boots were stationary in the booth and were not exposed to all phases of spraying as would be the case

(Lab Test #2 Cont'd)

in production. Another possible cause was the use of the panels to represent boots, thereby having different electrostatic attraction, which would result in uneven coating distribution.

Lab Test No. 3

Three boots sprayed
Fromula #2
Machine throughput: 210 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 2520 gram (calculated)
Total solids: 45%
Two panels, each representing two boots.
2520 grams sprayed ÷ 7 boots = 360 grams/boot x 45% solids =
162 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left boot no weight recorded, Nirtrosan Upper. Full last; size 7
(C) center boot no weight recorded, Freon Upper. Full last; size 8
(R) right boot no weight recorded, Freon Upper. No toe on last; size 8
Boot rotation: 6 RPM
Total reciprocator stroke: 10 inches
No hesitation
Pot pressure: 12 psi
Actual compound ratio: A/B; 100/19.50, by weight

Comments: This was the first test in which there was no hesitation in the reciprocator. The uppermost part of the boot had too heavy of a coating; therefore, in the next test the stroke will be shortened to cover less of the upper. Boot weights were not recorded due to inaccurate records.

This series of boots were hung with the toes approximately 3.5 inches below outsole, as discussed in Processing #1-C.

In addition, the boots in Lab Test #3 were not synchronized such that when the toe of the center boot was facing the disc, the left and right boots were facing 180 degrees away from the disc. In all other Lab Tests, all the boots were synchronized to face the same direction at the same time during rotation.

This Lab Test produced uneven coating distribution between the three boots, due to this non-synchronization. The right boot which contained a last with no toe, had very poor coating on the vamp. As a result, all additional trials contained full lasts.

Lab Test No. 4

Three boots sprayed
Formula #3
Machine throughput: 160 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 1920 grams (calculated)
Total solids: 45%
Two panels, each representing two boots.
1920 grams sprayed ÷ 7 boots = 274.28 grams/boot x 45% solids = 123.42 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left boot 123 grams, Freon upper. Full last; size 8
(C) center boot 106 grams, Freon upper. Full last; size 7
(R) right boot 143 grams, Freon upper. Full last; size 8
Boot rotation: 6 RPM
Total reciprocator stroke: 8 inches, stopped 5 inches from top of boo
No hesitation
Pot pressure: 12 psi
Actual ratio: A/B; 100/24.19, by weight
Comments: The change in reciprocator stroke from Lab Test #3 improved the amount of coating deposited on the uppers.

Lab Test No. 5

Three boots sprayed
Formula #4
Machine throughput 169 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 2016 grams (calculated)
Total solids: 45%
Two panels, each representing two boots
2016 grams sprayed ÷ 7 boots = 288 grams/boot x 45% solids = 129.6 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left no weight recorded, Lucel upper. Full last; size not recorded
(C) center 109 grams, Freon upper. Full last; size not recorded.
(R) right no weight recorded, Lucel upper. Full last; size not recorded
Boot rotation: 6 RPM
Total reciprocator stroke: 9 inches
No hesitation
Pot pressure: 12 psi
Actual compound ratio: A/B; 100/24.30, by weight
Comments: The center boot was the best overall coated boot and would seem to be the most representative of the ability that the Ransburg System could produce under the available conditions.

IV. Coating Thicknesses

Measurements taken from Lab Test No. 5, center boot:

1. One inch down from top of boot, 0.037 inches.
2. Six inches down from top of boot, 0.043 inches.
3. Vamp, mold parting line, 0.030 inches.
4. Toe, half-inch up from outsole/upper line, 0.049 inches.
5. Heel, half-inch up from outsole/upper line, 0.049 inches.
6. No coating on bottom of outsole; Total weight of boot before coating, 802 grams; Total weight of boot after coating, 911 grams; Weight of coating, 109 grams.

W.C. Delatore

W. C. Delatore

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APPENDIX "C"

cc: Joan Callahan (2)
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D. C. Narducci

UNIROYAL, INC.
CONSUMER PRODUCTS DIVISION
58 MAPLE ST.
NAUGATUCK, CT 06770

AUTOMATED PRODUCTION OF INSULATED FOOTWEAR

CONTRACT NO. DAAG-17-76-C-0016

PIRMASENS SHOE SHOW
TRIP REPORT

12 MAY 1976 TO 21 MAY 1976

by

John C. Gaynor

Joan L. Callahan
Contracting Officer
AMXNM - PA
U.S. Army Natick Laboratories
Natick, Mass. 01760

28 May 1976

This report is intended for the internal management use of Uniroyal and the Natick Army Laboratories.

SUMMARY:

The purpose of this trip was to review the latest polyurethane technology as it related to our "Automated Production of Insulated Footwear", contract number DAAG-17-76-C-0016 and, in particular, to review the latest equipment developments for processing polyurethane foams in boot fabrication and discussing mold design and mold fabrication techniques. Towards this end, polyurethane molding operations and mold makers were visited, in addition to the conferences held at the Pirmasens, West Germany Shoe Fair. Polyurethane operations visited were Kommerling-Pirmasens, West Germany; Otterbeck-West Germany; Desma-Hermiseele, West Germany; Romika-Trier, West Germany; Pavi-Vigevano, Italy; Mecap Plant I, Vigevano, Italy; Mecap Plant II-Italy. Mold makers visited consisted of Nova Plant I-Legnano, Italy and Nova Plant II; Zarine Corp.-Mortara, Italy; Omils-Vigevano, Italy; manufacture DeStampi-Vigevano, Italy.

Equipment discussions at the shoe show were held with Antonio Ferrari and Figli. Desma GMBH, Pavi, Vernon, Edmund Dreissig, Bennewart, C.O.I.M.. Bata Engineering, Lorenzin S.p.A., Elastogran Machinenbau, and Gesta. Mold discussions were held with Desma, Nova, Walter Schmidt, Wieser, Ferraris, Apego, Stampi, Bergav and Ottogalli. In conclusion, it was determined that the LIM equipment required in the proposed contract is presently being commercially manufactured by only one company, that company being the Desma GMBH Co. of West Germany. Other companies such as Ferrari feel that they could fabricate this type of equipment, but have not yet done so. Again, concerning the molds, only Desma has had the experience manufacturing molds of the type we require. Based on the interest exhibited at the show in the manufacturing of polyurethane footwear, it is possible that others will enter this field in the near future. The Ferrari Co. reported that they were making boots of polyurethane with a felt liner for the Russian Government, and the Romika Co. plans to come out with their own line of polyurethane boots in the near future.

The latest and most promising development in polyurethane mixing equipment is the use of high pressure impingement mixers (HPIM or RIM units) with footwear compounds. This development could lead to the use of faster reacting polyurethane systems with greatly reduced cure times and better physical properties. This development still appears to be 18 months to two years away from completion.

DETAIL:

Contacts:

Desma-Shoe Show

S. Nadler - Vice President
F. Peyman - Western Hemisphere, Salesmen Manager
A. Wagner - Technical Representative
K. Grosschelleforth - Engineer

Desma - Hermeskeil, Germany

Toni Malburg - Plant Manager
Wolfgang Ranlamo - Plant Superintendent

Bayer Chemical Co. - Shoe Show

Lothar Hille - Chemical Engineer

Satra - Shoe Show

Dr. R. E. Whittaker

Romika - Trier, West Germany

Alfred Hansell - Manager of German Plants

Ulrich Foitzik - Development and Commercialization Mgr.

Hans-Dieter Huttenrauch - Translator

Nova - Legano, Italy

Renzo Nova - Commercial Manager

Oscar Nova - Technical Manager

Roberto Borgo - Salesman, Molds

Franco Olgiati - Salesman, Manager

Ernesto Velardi - Mold Salesman, Milan Italy

USM (Pfaff Stitching Equipment - Shoe Show

Kevin C. Cochrane - Product Manager Pfaff

Bennewart - Pirmasens, West Germany

Werner Bennewart - President

Vernon - Shoe Show

Mr. Raymond Bouquet

Pavi - Vigevano, Italy

Mr. Scavini - Sales Manager

Kommerling - Pirmasens, West Germany

Mr. Wagner

Apego, Stampi - Shoe Show

Franco Massara - Sales Representative

Antonio Ferrari & Figli - Shoe Shoe

Giorgio DiCostola - Manager-Export Division

Elastogram (VTE) - Shoe Show

Dieter Juhnke

Otterbeck, West Germany - Footwear Manufacturer

Mr. Heider - Manager

Zarine Corp. (Mold Maker) Mortara, Italy

Mr. Rizzo

Omils-Viccevano, Italy (Mold Maker)

Mr. Saggatti - Owner

Manufacture De Stampi - Vigevano, Italy (Mold Maker)

Mr. Vincent) Owners
Mr. Peter)

Weiser - Shoe Show (Shoe & Boot Molds)

Ottogalli Spa - Mold & Machine Makers - Shoe Show

Note: Many other mold makers and equipment manufacturers were present at the show, and discussions were held with their representatives, but no results worth reporting were obtained.

DETAIL:

Of the mold makers listed above, only Vernon, Desma, Nova, Weiser, Ottogalli, Ferrari and Zarine Corporation have made boot molds. Ottogalli makes boot molds for Ottogalli machines only, and is not interested in making other molds. Vernon, Nova, Weiser, and Zarine have made boot molds for PVC, but have no experience with boot molds for urethane. Ferrari has reportedly made boot molds for their own use, but not of the type we propose to use. Desma is the only one producing boot molds for urethane on a commercial basis.

Of the equipment manufacturers reviewed, only Desma is commercially producing a machine for polyurethane boot production.

A six-station machine was displayed at the Shoe Show producing polyurethane outsole work boots, and two quality polyurethane riding boots. The Romika Corporation has a Desma 1517 unit presently producing riding boots, and fourteen smaller Desma LIM units producing a variety of footwear. Only the Desma unit displayed at the shoe show had the capability of three stream metering, which would be required to produce the government boot.

1. A review of the equipment displayed or reviewed is as follows:

C.O.I.M. Spa - 10-station two-component LIM unit for shoes

Gesta - 6-station two-component pour machine for shoes

Gesta - 10-station two-component LIM unit for shoes

Elastogran - 30-station two-component pour machine for unit soles

Elastogran - HPIM (RIM) system for rigid P.U. materials

Bata Engineering - two-component pour machine for shoes

Pavi - two-component LIM unit for shoes

Pavi - two-component pour machine for shoes

Ottogalli - two-component pour machine for shoes

Vernon - two-component LIM unit for shoes

C.I.C. Ralphs LTD - two-component LIM unit for shoes

Poliblock - 40-station unit sole machine for pour molding

Secemer - two-component pour machine

Desma - 562 pour machine for unit soles

Desma - 1547 six-station LIM unit for boots

Desma - 1531 RIM unit for polyurethane footwear parts

Desma - 702/12 two-component LIM unit for footwear with 12-station rotary table equipped for PVC

Niagara Lorenzin - two-component pour machine

Note LIM - Liquid Injection Molding
RIM - Reaction Injection Molding

II. A review of the mold makers visited or with displays at the shoe show with whom the boot project was reviewed.

Vernon: Rubber, PVC, & Polyurethane Shoe Molds
PVC Boot Molds

Zarine: Polyurethane unit sole molds

Nova: Shoe molds for polyurethane, PVC, rubber and boot molds for PVC

Schmidt: Unit sole molds for polyurethane, PVC, and rubber

Wieser: Molds for unit soles of PVC, rubber or polyurethane. Molds for polyurethane shoes or leather topped boots, molds for PVC or rubber shoes or boots. Mechanical molds of all types.

Desma: Same as above, but includes boot molds for polyurethane

Ferraris: Unit sole and shoe molds

Bergav: Unit sole, shoe, and mechanical goods molds

Ottogalli: Shoe and boot molds for PVC

Ferrari & Figli: Molds for urethane shoes, unit soles, and boots

III. A review of the polyurethane operations visited.

1. Kommerling Pirmasens, West Germany

This plant has three Desma polyurethane pour machines producing unit soles at the rate of 7300 pr./shift and operates three shifts per day, seven days per week. They have one 21-station Desma unit and two 30-station Desma units.

2. Otterbeck - near Trier, West Germany

This plant has one 18-station Desma LIM unit producing steel toe safety shoes at the rate of 500 pair/shift, three shifts per day, five days per week.

3. Romika - Trier, West Germany

This plant produces polyurethane casual shoes, athletic shoes, work boots, hiking boots and riding boots, as well as PVC and conventional footwear, with a total output of 15,000 pair per day. They have fourteen Desma LIM shoe units and one Desma 1547 LIM boot unit.

4. Mecap Plant #1 - Italy

This plant has nine Pavi LIM shoe units in operation producing women's and men's footwear. This plant is about two years old, and was designed as a polyurethane plant with a central compound distribution system.

5. Mecap Plant #11

This plant is similar to Plant #1, but makes women's fashion shoes and has six units in production.

It was evident from the machines displayed at the footwear shoe and under construction at Desma that the use of polyurethane in footwear articles using packaged material systems is growing.

IV. TESTING EQUIPMENT

Dr. R. E. Whittaker of Satra was contacted at the shoe show to review the latest technology in polyurethane product testing equipment. He is to send us literature on the testing equipment that Satra now uses for testing that would be applicable to our project. This same request was also made of Mr. Lothar Hille of the Bayer Chemical Company.

APPENDIX "D"

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

February 10, 1977

RECEIVED
FEB 11 1977
ENGINEERING DEPT.

Mr. E.A. Melchiori
Uniroyal, Inc.
Oxford Management & Research Center
Middlebury, Connecticut 06749

SUBJECT: Ruling on Compliance with State Regulations - Uniroyal
Contract DAAG-17-76-C-0016 Dept. of Defense - Artic Boots

Dear Mr. Melchiori:

On January 5, 1977 this Department received your request for a ruling on the compliance of the subject production line, as described by the documentation provided. Based on this information, the compliance of this source was evaluated relative to Section 19-508-3 (a)(1), 19-508-18 (e) and 19-508-20 (f), these being respectively permit requirements, particulate emissions from process industries-general, and organic solvents.

The following outlines the compliance determinations by regulation:

Section 19-508-3 (a)(1). The applicable paragraph is 3 (a)(1)(ii). The total quantity of coating material and solvents used is (169 grams/min)(60 min/hr.)(1 lb./454 grams) = 22.3 lbs./hr. This source, as described, is exempt from permit requirements since the total quantity of coating materials and solvents used is less than 30 pounds in any one hour.

Section 19-508-18 (e). The applicable paragraph is 18 (e)(1). This regulations applies to the particulate emissions from the spray booth area of the facility. The particulate emissions at this point are the result of overspray. The total weight of overspray, consisting of solids and solvents, is considered as particulate and in this case is calculated as follows:

(Machine throughput, 169 grams/min)(60 min./hr.) = 10,140 grams/hr. or 10,140 grams/30 boots

(Final Weighed Dry Coat/Boot, 109 grams)(30 boots) = 3,270 grams = 45%

The solvent portion applied to the boot = 55% = 3,997 grams

The total overspray = (10,140 grams) - [(3,270) + (3,997)] = 2,873 grams/hr. or 6.33 #/hr.

Any source with a process weight of from 0 to 50 pounds per hour is allowed an emission rate of 0.36 pounds per hour. To be in compliance with Section 19-508-18 (e), this source would have to demonstrate a 94.3% reduction in particulate emissions which would be quite possible.

Section 19-508-20 (f). The applicable paragraphs are 20 (f)(3), 20 (f)(4) and 20 (i)(1)(iii). In the eventuality that all solvent emissions were to ultimately be ducted to a common stack, this worse case was the one considered. Allowing that the hourly solvent emissions are 55% of 22.3 #/hr. or 12.27 #/hr., there would be no problems unless the DIBK, which is classified R3 photochemically reactive, constituted greater than 20% of the total mixture by volume. DIBK is a photochemically reactive solvent and is limited to 3 lbs. per hour or 15 lbs. per day. THF and PERC are both non-photochemically reactive and are limited to 160 lbs./hr. or 800 lbs./day. As the following table illustrates this proposed facility would be in compliance with Section 19-508-20 (f) and 20 (i)(1)(iii).

	PARAGRAPH	ALLOWABLE	VOL. % OF TOTAL	MAXIMUM PROJECTED
THF	20 (f)(4)	160 #/Hr. (21.6 gal./hr.)	20.14	6.69 #/Hr. (0.90 gal./hr.)
PERC	20 (f)(4)	160 #/Hr. (11.8 gal./Hr.)	27.34	4.95 #/Hr. (0.364 gal./hr.)
DIBK	20 (f)(3) & 20 (1)(1)(iii)	3 #/Hr. (0.44 gal/hr.)	2.88	0.51 #/Hr. (0.08 gal./hr.)

Until an application for a Permit to Construct is submitted, no ruling, as such, can be rendered. However, this source on the basis of the information provided seems perfectly capable of operating in compliance with the DEP Air Quality Regulations. In conclusion, it must be pointed out that when and if this source is constructed in Connecticut, it must be made to comply with all applicable Regulations.

Very truly yours,

Alfred Conklin

Alfred Conklin
Senior Air Pollution Control Engineer

AC/ml

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UNIROYAL, Inc.
Oxford Management & Research Center
Middlebury, Connecticut 06749

February 7, 1977

Mr. Sheton Edwards
Principal Engineer
Air Compliance Engineering
Connecticut Department of Environmental Protection
Room 146
State Office Building
Hartford, Connecticut 06115

SUBJECT: Ruling on Compliance with State Regulations - Uniroyal Contract DAAG - 17-76-C-0016, Department of Defense - Arctic Boots

Dear Mr. Edwards:

As per our telephone conversation of January 28, 1977 regarding the above subject, I am sending you the attached information. The gist of the information concerns Uniroyal's method of meeting Sec 19-508-18 (e) (Control of Particulate emissions from process industries). As you will see from the attached information, Uniroyal intends to filter the gas stream leaving the spray booth. In addition, a large amount of particulate over-spray will be contained within the spray booth, due to the nature of the process ie. electrostatic attraction.

In our best judgement, we feel the process will comply with all State Regulations and is environmentally sound.

Please let me know if you desire further information. We would appreciate your reply as quickly as possible since we must submit our bid to the Army by the end of this month.

Again, your time and effort is greatly appreciated.

Very truly yours,

Edward Melchiori

klc

ESTIMATED UNABATED PARTICULATE EMISSION
FROM ELECTROSTATIC SPRAY BOOTH

See Page 12 of 7/16/76 Evaluation Trials for Ransburg Spray Equipment (attached).

Lab Test #5 Formula #4

Machine Throughput	169 grms/min
Spray Time	12 min
Total Thoughput	2028 grms
Total Boot Throughput 3 Boots + 2 Panels =	7 boots
Laydown/Boot Approx.	290 grms/Boot
Grams Solids	130.5 (45%)
Grams Solvent	159.5 (55%)

Final weighed Dry Coat	109 Grams
Solids Over Spray	130.5 - 109 = 21.5 grms/Boot

Machine Rate 15 pair/hour

Unabated Emission

$$\frac{15\ \text{pair}}{\text{Hr.}} \times \frac{2\ \text{Boots}}{\text{Pair}} \times \frac{21.5\ \text{grms}}{\text{BOOT}} \times \frac{\text{lb}}{459.3\ \text{grm}}$$

= 1.4 lbs. Solids/Hr.

ESTIMATED ABATED PARTICULATE EMISSION

Unabated Rate: 1.4 lbs/Hr.

Control: Reticulated Polyurethane filters at spray booth hood openings. See attached sketch.

Efficiency

It is conservatively estimated that these filters are 90% effective in removing solids. The solids are 0.942% Urethane (see previous submittal for formulation breakdown) and the particulate size will exceed one micron. In addition, two other factors will contribute to the resultant efficiency.

(A) Urethane filters will attract like urethane matter.

(B) A large part of the unabated rate (1.4 lbs/hr) will never reach the filters, but will deposit out on the spray booth walls and contingunous apparatus since this equipment is grounded and the solids are charged.

Therefore, at the conservative estimate of 90% abated emission rate is:

$$1.4 \times .1 = 0.14 \text{ lbs/hr.}$$

The process weight for this process is:

$$\frac{169 \text{ grms}}{\text{Min}} \times \frac{60 \text{ min}}{\text{Hr}} \times \frac{\text{lb}}{459.3\text{grms}} = 22 \frac{\text{lb}}{\text{hr}}$$

$$\frac{22 \text{ lbs}}{\text{hr}} \times \frac{\text{ton}}{2000 \text{ lb}} = 0.011 \text{ Ton/hr}$$

Based on Sec. 19-508-18 (e) (2) the following emission rate is allowable:

$$E = 3.59 (P)^{0.62}$$

where E is the allowable emission rate in lb/hr and P is the process weight in tons/hr.

$$E = 3.59 (0.011)^{0.62}$$
$$E = 0.22 \text{ lbs/hr}$$

therefore, the estimate abated rate of 0.14 lbs/hr meets the regulation.

UNIROYAL, Inc.
Consumer Products
Oxford R-1-31
(Location)

August 16, 1976

Trip Report: Polyurethane Army Boots--Electrostatic Spray Trials.
Ransburg Electro-Coating Corporation, Indianapolis, IN.

Contacts: Mr. William Smith--Ransburg Electro-Coating Corporation.
Uniroyal Personnel: Mr. A. B. Brazdzionis
Mr. R. VanTwisk
Mr. W. C. Delatore

Purpose: Evaluate Ransburg's electrostatic spray equipment and determine if it is suitable for coating the Lightweight Polyurethane Arctic Boot.

Conclusion:

1. The Ransburg Electrostatic Spray System worked very well in coating the Arctic Boots. Varying thicknesses of polyurethane coating were deposited as required. Final appearance of the boots was very good.

2. The polyethylene mask developed by Mr. VanTwisk to prevent material from depositing on the bottom of the outsole, as well as to taper material along the sides of the outsole, worked sufficiently well.

3. The process goals set by Mr. VanTwisk--spraying times, material outputs, weight of coating, and drying times--were all achieved.

4. Formula No. 4 showed the best properties when using the Ransburg system. The boots coated well and there were no signs of sagging or imperfections on the finished coating. The coating covered all minor blemishes on the boot.

Discussion:

Equipment time was rented at Ransburg so that electrostatic spray trials for coating an insulated Arctic Boot with a polyurethane coating could be run. The polyurethane compound consists of a two component system in which the polyether prepolymer is supplied in a solvent as the "A" component and the curative is supplied in a solvent as the "B" component. The components are metered in a predetermined ratio by positive displacement gear pumps to a Ross static mixer and thereafter, as a one component to a well in a spinning disc which atomizes the solution and also imparts an electrostatic charge. The particles are thrown from the disc by centrifugal force and in turn, attracted to the grounded article which is being coated. More detailed engineering information of the various Ransburg Systems can be obtained from Process Engineering, Consumer Products.

Lab Test No. 4

Three boots sprayed ·
Formula #3
Machine throughput: 160 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 1920 grams (calculated)
Total solids: 45%
Two panels, each representing two boots.
1920 grams sprayed ÷ 7 boots = 274.28 grams/boot x 45% solids =
123.42 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left boot 123 grams, Freon upper. Full last; size 8
(C) center boot 106 grams, Freon upper. Full last; size 7
(R) right boot 143 grams, Freon upper. Full last; size 8
Boot rotation: 6 RPM
Total reciprocator stroke: 8 inches, stopped 5 inches from top of
No hesitation
Pot pressure: 12 psi
Actual ratio: A/B; 100/24.19, by weight
Comments: The change in reciprocator stroke from Lab Test #3 improved the amount of coating deposited on the uppers.

*

Lab Test No. 5

Three boots sprayed
Formula #4
Machine throughput 169 grams/minute (measured)
Spray time: 12.0 minutes
Total grams sprayed: 2016 grams (calculated)
Total solids: 45%
Two panels, each representing two boots
2016 grams sprayed ÷ 7 boots = 288 grams/boot x 45% solids =
129.6 grams/boot (theoretical dry weight)
Final coating per boot:
(L) left no weight recorded, Lucel upper. Full last; size not record
(C) center 109 grams, Freon upper. Full last; size not recorded.
(R) right no weight recorded, Lucel upper. Full last; size not record
Boot rotation: 6 RPM
Total reciprocator stroke: 9 inches
No hesitation
Pot pressure: 12 psi
Actual compound ratio: A/B; 100/24.30, by weight
Comments: The center boot was the best overall coated boot and would seem to be the most representative of the ability that the Ransburg System could produce under the available conditions.

* TEST #5 FORMULA #4 IS THE BASIS USED FOR DESIGN OF PROCESS

1150-A-05
Jan.-3-1977
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UNIROYAL, Inc.
Oxford Management & Research Center
Middlebury, Connecticut 06749

January 3, 1977

Mr. Shelton Edwards
Principal Engineer
Air Compliance Engineering
Ct. Dept. of Environmental Protection
Room 146
State Office Building
Hartford, CT 06115

SUBJECT : RULING ON COMPLIANCE WITH
STATE REGULATIONS- UNIROYAL
CONTRACT DAAG-17-76-C-0016
DEPT OF DEFENSE - ARTIC BOOTS

As per our telephone discussion on 12/20/76, I am forwarding the attached documentation which describes the above captioned project. Again, as a brief review, UNIROYAL is seeking an official ruling from D.E.P. as to the compliance or non-compliance of the proposed process with Connecticut regulations. This is not an application for construction or operation. Should UNIROYAL bid on the Phase III - (Implementation and Production) portion of the contract and elect to build the facility within Connecticut, UNIROYAL will follow standard proceedures and request permits.

The documentation, we believe, fully describes the process and the materials used and emitted. UNIROYAL'S interpretation indicates that the process will comply with State Regulations. However, we would appreciate your formal agreement with that conclusion. If you have any questions or require additional information, please call. We will be happy to meet with you, if required, in order to provide any additional data.

Since we must submit this material to the D.O.D. by February of 1977, we would appreciate your ruling as soon as possible.

E.A. Melchiori
E. A. Melchiori

EAM/kab

cc: J. Gaynor - Naugatuck Footwear, w/attach.
J. T. Colombo - Office, w/attach.
R. C. Niles - Office, w/attach.

UNIROYAL, INC.

CONSUMER PRODUCTS DIVISION

NAUGATUCK, CONNECTICUT FOOTWEAR PLANT

POLYURETHANE ARMY BOOT PROJECT

ENVIRONMENTAL CONTROL

1.00 GENERAL BACKGROUND

Uniroyal Inc.'s Consumer Product Division is currently engaged in a development program for the Natick Army Laboratories, Department of Defense (Contract DAAG-17-76-C-0016). The purpose of the program is to develop technology (Phase I), hardware (Phase II) and finally establish a production facility (Phase III) to produce a specialized artic boot for military personnel.

Uniroyal has been awarded the contract for Phases I & II - Technology Development and Hardware Development.

As part of the criterion for complete hardware development, Uniroyal must assure the D.O.D. that the designed facility, when complete, will comply with all local and state environmental regulations, either by use of judicious process control or through the use of suitable environmental control hardware.

The agreement with the Department of Defense, on Phase II (Hardware Development and Design Engineering) calls for the proposed facility to meet the environmental regulations in the State of Connecticut. It must be made clear, however, that the final site for this production facility

1.00 GENERAL BACKGROUND (Cont'd.)

may not be within Connecticut. This will depend on the location of the firm which becomes the successful bidder on the Phase III component of the program.

2.00 PRESENT STATE OF DEVELOPMENT - PHASES I & II

Uniroyal has now reached a point in fulfillment of Phases I & II, whereby the technology and production method for this article has been developed. Trial production runs have been made, and it is believed that a product which meets the contract specifications can be produced. The following briefly describes the production method and the environmental problems associated with the product.

3.00 PRODUCTION METHOD

Unfinished boots are brought into the finishing area. The boots are mounted on a "last" which serves as the conveying mechanism and grounding mechanism for the electrostatic coating process to follow.

The unfinished boot is conveyed to the electrostatic coating machine. Here a two component system, solvent and polyurethane, is applied to the boot under electrostatically charged conditions.

The two component system is as follows:

COMPONENT A	Weight		% of Total
1) Uniroyal Roylar B-602 (Liquid Polyurethane)	1700	Grams	49.04
2) Perchloroethylene (PERC)	1300	Grams	37.50
3) Tetrahydrofuran (THF)	466.6	Grams	13.46
TOTAL	3466.6	Grams	100%

COMPONENT B			
1) Methyldiethanolamine (MDA) Catylst	400	Grams	15.27
2) THF	1500	Grams	57.25
3) B-602	400	Grams	15.27
4) Diisobutyl Ketone (DIBK)	300	Grams	11.45
5) Carbon Black (CT-BLK) Extremely Fine	20	Grams	0.76
TOTAL	2620	Grams	100%

Component A and Component B are mixed together in the following amounts:

A (100%) + B(24.99% by weight) = Coating

By calculating the component mixtures in proportion to the above ratio, the following results:

$\frac{B}{A} = \frac{24.99}{100} \times 3466.6 = 866.3$ grams of component B.

A + B = Coating Weight

3466.6 + 866.3 = 4333 Grams

Individual Weights of Each Component

Item	Wt. (Grams)	Volume (Ft.^{3})
1) B-602 Polyurethane (Solid)		
1700 Grams (A) + (866.3 x .1527)(B) =	1832.3 Grms	0.064
2) THF (Solvent)		
466.6 Grams (A) + (866.3 x .5725)(B)=	962.6 Grms	0.038
3) PERC (Solvent)		
1300 Grams (A) =	1300 Grms	0.028
4) DIBK (Solvent)		
(866.3 x 0.1145)(B) =	99.2 Grms	0.004
5) MDA (Catalyst) (Solid)		
(866.3 x 0.1527)(B) =	132.3 Grms	0.004
6) Carbon Black (Solid)		
(866.3 x 0.0076)(B) =	6.6 Grms	0.001
TOTAL	4333.0 Grms	0.139

This further reduces as follows:

3.00 PRODUCTION METHOD (Cont'd.)

	Solvents by Wt. of Total Formulation		Solvents by Volume in Total Formulation	
PERC	- 30 %	= 1300.0 Grm/4333	20.14%	= 0.028/0.139
THF	- 22.2 %	= 962.6 Grm/4333	27.34%	= 0.038/0.139
DIBK	2.29%	= 99.2 Grm/4333	2.88%	= 0.004/0.139
TOTAL	54.49%			

Solvent Percentages by Solvent Only Mixture

	By Weight	By Volume
PERC	55.04%	54.28%
THF	40.76%	40.00%
DIBK	4.20%	5.72%
	100%	100.00

Once the boot has been electrostatically coated, it is left within the production space for approximately 24 minutes. It is then sent to a hot air drying chamber for another 24 minutes. Finally, it is left in a second drying chamber for 12 hours. The purpose of these last three steps is to promote the evaporation of the solvents used in the two component urethane system. Under ambient conditions, long exposure would be required to evaporate this solvent, which is under a urethane cover; therefore, heat exposure is used to accelerate the process.

Schematic SK-1 illustrates the various steps in the process.

4.00 EMISSIONS TO THE ATMOSPHERE

During the feasibility trials, one of the questions to be answered was the emission rates of solvents at various stages in the process. These trials revealed the following:

A Area	B Grams Solvent Evaporated Per Hour	C Design Rate 1.5 Item B	D Design Rate Lb./Hr.
Spray Booth	2400	3600	7.94
Flash-Off	210	300	0.66
Drying Chamber	690	900	1.98
Cool Down	270	350	0.77
Final Drying	510	700	1.54
TOTAL	4080 Grams	5850 Grams	12.89

Based on trials and production rates, an alternate estimate of solvent emissions can be made to cross check the above.

Boot Size - 10R

Production Rate 30 Boots/Hr. or 15 Pair/Hr.

Laydown Rate (Solids) 109 Grams/Boot

$$109 \frac{\text{Grams}}{\text{Boot}} \times \frac{30 \text{ Boots}}{\text{Hr.}} \times \frac{\text{Lb.}}{453.59 \text{ Grams}} = 7.21 \frac{\text{Lb.}}{\text{Hr.}} \text{ Solids}$$

The total weight of the solvent would equal:

$$\frac{7.21}{x} \times \frac{45.51}{54.49}$$

$$x = 8.63 = \text{Lb./Hr. Solvent}$$

4.00 EMISSIONS TO THE ATMOSPHERE (Cont'd.)

On that basis, the emissions of solvents would break down as follows:

Item	Estimated Rate	Design Rate
Perchloroethylene	4.75 Lb./Hr.	7.125 Lb./Hr.
Tetrahydrofuran	3.52 Lb./Hr.	5.276 Lb./Hr.
Diisobutyl Ketone	0.36 Lb./Hr.	0.543 Lb./Hr.
TOTAL	8.63 Lb./Hr.	12.944 Lb./Hr.

These figures agree very closely with previous rates based on trial runs.

5.00 EMISSIONS TO ATMOSPHERE AND CONNECTICUT AIR QUALITY REGULATIONS

The solvents used in this process would be emitted as a non-condensed hydrocarbon to the atmosphere. The gas stream will be clear, no visible contaminants will be present.

Connecticut regulations, specifically Connecticut Air Pollution Regulation Sec. 19-508-20, govern the emission of volatile organic compound to the atmosphere. Section (f) of 19-508-20 governs organic solvents.

Of prime importance, in the case of this process, is the determination of the photochemical reactivity of the solvents used in compound mixture. Section (i) of 19-508-20 defines those solvent mixtures which may be regarded as photochemically reactive. The State of Connecticut has also, from time to time, published a list of common solvents. This list classifies various solvents into reactive groups (R_1, R_2, and R_3) and a non-reactive

4.00 EMISSIONS TO THE ATMOSPHERE AND CONNECTICUT AIR QUALITY REGULATIONS (Cont'd.)

group (N). An abbreviated copy of this list is attached in the appendix. As can be seen from this list, the solvents used in this process are designated as follows:

Solvent	% in Compound By Volume	Allowable
1) Perchloroethylene	20.14	No Limit
2) Tetrahydrofuran	27.34	No Limit
3) Diisobutyl Ketone	2.88	20% by Volume

As can be seen, this formulation is clearly unreactive as per Section (i) of 19-508-20.

Section (f) (4) of 19-508-20 defines the allowable rate of emission for non-reactive materials. Section (f) (4) limits the emission of organic materials to not more than 800 lbs. in any one day or 160 lbs. in any one hour.

From Section four (4.00), it was determined that total organic emissions from this process will range between 8 to 13 lbs./hour or 192 to 312 lbs. per day, based on 24 hours/day of production.

Thus, Uniroyal respectfully submits that the process and resultant emissions described herein are in compliance with Air Pollution Control Regulations in the State of Connecticut.

UNIROYAL

ENGINEERING DEPARTMENT

LOCATION OXFORD

PROJECT Artic Boot Contract # DAAG17-76-C-0016 – Process Flow Schematic

PAGE 1 of 1
JOB NO. 76-03B
LOC. NO. 5563 Gp 6
DATE 12-21-76
BY E.A.M.

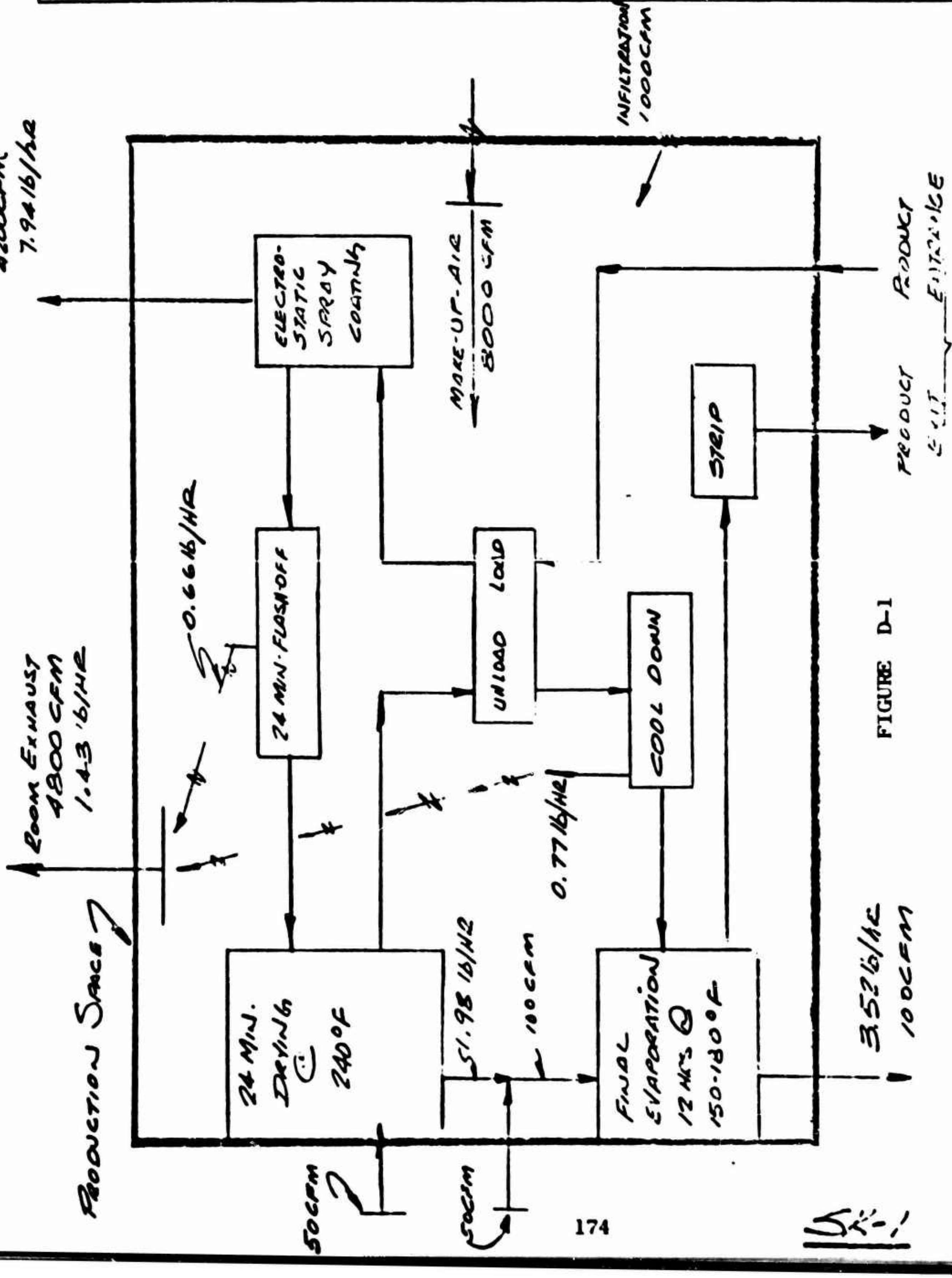


FIGURE D-1

Date: 1/1/7[illegible]

VOLATILE ORGANIC AND SOLVENT DATA

Connecticut DEP

Conn. Regulation 19-508 Section →

(1) Chemical Name	(2) Empirical Formula	(3) lbs./gal.	(4) MAXIMUM ALLOWABLE EMISSIONS WITHOUT CONTROLS 20f2 8# Hr.	Gal.	40# Day	(5) 20f4 16# Hr.	Gal.	800# Day	(6) 20f1 3# Hr.	Gal.	15# Day	(7) "VOLATILE ORGANIC" 1.5 [illegible] ? Temp. °F
1,1-Dichloro-1-Nitropropane	$C_3H_5Cl_2NO_2$	10.9				14.6	N	73.0	0.274		1.37	181
Dichloropentane	$C_5H_{10}Cl_2$	9.31				17.2	N	85.9	0.322		1.61	162
Dichloro-di-iso-propyl Ether	$C_6H_{12}Cl_2O$	[illegible]				17.3	N	86.4	0.325		1.62	227
1,2-Dichloro-1,1,2,2-tetrafluoroethane	$C_2Cl_2F_4$	GAS				USE LBS. ONLY						-51
Dicyclohexyl	$C_{12}H_{22}$	7.37				21.7	N	104	0.407		2.04	279
Dicyclohexyl Amine	$C_{12}H_{23}N$	7.59				21.1	N	105	0.3[illegible]		1.98	315
Diethanolamine	$C_4H_{11}NO_2$	9.15				17.5	N	[illegible].4	0.328		1.64	333
Diethyl Amine	$C_4H_{11}N$	5.92				27.0	N	135	0.507		2.53	39
2-Diethylaminoethanol	$C_6H_{15}NO$	7.37				21.7	N	109	0.407		2.04	214
1,2-Diethyl-benzene	$C_{10}H_{14}$	7.24	1.10	R 2	5.52				0.414		2.07	218
Diethyl Carbitol	[illegible]	7.56				21.2	N	106	0.397		1.98	[illegible]
Diethyl Carbonate	$C_5H_{10}O_3$	8.13				19.7	N	98.4	0.369		1.8[illegible]	139
Diethylene Glycol	$C_4H_{10}O_3$	9.34				17.1	N	85.7	0.321		1.60	34[illegible]
Diethylene Glycol n-Butyl Ether	$C_8H_{18}O_3$	7.96				20.1	N	101	0.377		1.[illegible]8	298
Diethylene Glycol Dibutyl Ether	$C_{12}H_{26}O_3$	7.38				21.7	N	108	0.407		2.03	307
Diethylene Glycol Methyl Ether	$C_5H_{12}O_3$	8.51				18.8	N	94.0	0.353		1.76	26[illegible]
Diethylene Glycol Monoethyl Ether	$C_6H_{14}O_3$	8.52				18.8	N	93.9	0.352		1.76	263
Diethyl Ketone	$C_5H_{10}O$	6.81				23.5	N	117	0.440		2.20	113
Diethyl Oxalate	$C_6H_{10}O_4$	9.00				17.8	N	88.9	0.333		1.67	249
o-Diethyl Phthalate	$C_{12}H_{14}O_4$	9.34	0.85	F 2	4.28				0.321		1.61	402
Di-isobutyl Carbinol	[illegible]	6.78				23.6	N	117	0.442		2.21	239
Di-isobutyl Ketone	[illegible]	6.76	1.83	R 3	5.92				0.444		2.22	221
Dimethyl Acetamide	[illegible]	7.24				22.1	N	110	0.414		2.07	211
Dimethylaminoethanol	$C_4H_{11}NO$	7.18				22.3	N	111	0.418		2.09	171
Dimethyl Aniline	$C_8H_{11}N$	[illegible]	1.00	R 2	5.04				0.378		1.89	237
Dimethyl Cyclohexanol	$C_8H_{16}O$	7.61				21.0	N	105	0.394		1.97	248

Date: 1/ [illegible]

VOLATILE ORGANIC AND SOLVENT DATA

Connecticut DEP

Conn. Regulation 19-5[illegible] Section →

(1) Chemical Name	(2) Empirical Formula	(3) lbs./gal.	(4) MAXIMUM ALLOWABLE EMISSIONS WITHOUT CONTROLS 20f2 8# Hr.	Gal.	40# Day	(5) 20f4 16# Hr.	Gal.	800# Day	(6) 20f1 3# Hr.	Gal.	15# Day	(7) VOLATILE ORGANIC 1.5 [illegible] @ Temp. °F
Propylene Glycol Methyl Ether	$C_4H_{10}O_2$	7.66				25.9	N	104	.372		1.86	147
Propylene Oxide	C_3H_6O	6.92				23.1	N	116	0.434		2.17	-4
Pyridine	C_5H_5N	8.17	0.78	R 1	4.90				0.367		1.84	135
Styrene	C_8H_8	7.57	1.06	R 1	5.28				0.396		1.98	176
Terpineol	$C_{10}H_{18}O$	7.84	1.02	R 1	5.10				0.383		1.91	260
1,1,2,2-Tetrabromoethane	$C_2H_2Br_4$	24.6				06.5	N	32.5	0.122		0.61	324
1,1,2,2-Tetrachloro-1,2-difluoroethane	$C_2Cl_4F_2$	13.7				11.7	N	58.4	0.220		1.09	93
1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	13.2				12.1	N	60.6	.227		1.14	152
Tetrachloroethylene	C_2Cl_4	13.6				11.8	N	58.[illegible]	.220		1.10	1[illegible]3
Tetrahydrofuran	C_4H_8O	7.41				21.6	N	108	.405		2.02	42
Tetrahydrofurfuryl Acetate	$C_7H_{12}O_3$	8.94				18.1	N	90.5	.339		1.70	22[illegible]
Tetrahydrofuryl Alcohol	$C_5H_{10}O_2$	8.76				18.3	N	91.3	0.342		1.71	220
Tetralin	$C_{10}H_{12}$	8.69	0.98	R 1	4.94				0.371		1.85	253
Toluene	C_7H_8	7.24	1.10	R 3	5.52				0.414		2.07	115
o-Toluidine	C_7H_9N	8.34				19.2	N	95.9	0.360		1.80	251
p-Toluidine	C_7H_9N	8.67				18.5	N	92.[illegible]	0.346		1.73	253
Tolylene-2,4-Di-Isocynate	$C_9H_6N_2O_2$	10.1	0.78	R 2	3.93				0.295		1.47	374
Tributyl Phosphate	$C_{12}H_{27}O_4P$	6.29				25.4	N	127	0.477		2.39	451
1,2,3-Trichlorobenzene	$C_6H_3Cl_3$	12.1				13.1	N	65.[illegible]	0.246		1.23	27[illegible]
1,1,2-Trichloroethane	$C_2H_3Cl_3$	12.0				13.3	N	66.6	0.250		1.25	127
Trichloroethylene	C_2HCl_3	12.3	0.64	R 3	3.24				0.243		1.22	64
1,1,2-Trichloro-1,2,2-trifluoroethane	$C_2Cl_3F_3$	13.0				12.3	N	61.2	0.230		1.15	14
o-Tricresyl Phosphate	$C_{21}H_{21}O_4P$	9.84	0.81	R 2	4.07				0.305		1.52	465
Triethanolamine	$C_6H_{15}O_3N$	9.42				17.0	N	84.9	0.316		1.59	570
Triethylamine	$C_6H_{15}N$	6.04				26.5	N	132	0.497		2.48	68
Triethylene Glycol	$C_6H_{14}O_4$	5.82				27.5	N	137	0.515		2.58	397
Triethylene Glycol Dimethyl Ether	$C_8H_{18}O_4$	7.37				21.7	N	109	0.407		2.04	246
	$C_2H_3Cl_3$	12.0				13.3	N	66.6	0.250		1.25	61

NOTE: TETRACHLOROETHYLENE IS A SYNONYM FOR PERCHLOROETHYLENE.

APPENDIX "E"

PAGE NO 1

FLOW PROCESS CHART

SUMMARY	PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
OPERATIONS ○						
TRANSPORTATIONS ⇨						
INSPECTIONS □						
DELAYS D						
STORAGES △						
TOTAL ELEMENTS						
DISTANCE TRAVELED		FT		FT.		FT

CHART SUBJECT: GOVT. CONTRACT POLYURETHANE BOOT

☐ MAN
☐ MATERIAL

DETAILS OF CHART SUBJECT: PREPARE COLLAR

DIVISION CONSUMER PLANT

DEPARTMENT UNIT

INVESTIGATED BY JH HUBBARD DATE 1-5-77

REVIEWED BY DATE

	DETAILS OF ~~PRESENT~~ PROPOSED METHOD	OPERATION TRANSPORT INSPECTION DELAY STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ELIMINATE	COMBINE	CHGE SEQ	SIMPLIFY	NOTES
1	COLLAR STOCK STORAGE	○ ⇨ □ D ▲								REEVES No. 69358-C
2	DELIVER to CLICKER MACHINE	○ ➡ □ D △								
3	CUT COLLAR-CLICKER MACHINE	● ⇨ □ D △								CM DIE #886 FACE STOCK 1/PR.
4	DELIVER to BANK	○ ➡ □ D △								
5	BANK COLLARS FOR STENCIL	○ ⇨ □ ◗ △								
6	STENCIL COLLARS	● ⇨ □ D △								CONTRACT DATA SIZE X WIDTH #244 white INK
7	BANK COLLARS	○ ⇨ □ ◗ △								
8	DELIVER to EYELET MACHINE	○ ➡ □ D △								
9	EYELET COLLAR	● ⇨ □ D △								50036001 BLK. ENML. x 50033416 ALUM. WASH 4/PR
10	BANK COLLARS	○ ⇨ □ ◗ △								
11	DELIVER to SEAM OPERATION	○ ➡ □ D △								
12	SEAM COLLAR	● ⇨ □ D △								SEAM FRONT-BACK 1/8" 69 BLK. NYL. THRD - LOCK ST. 8 ST/INCH
13	BANK COLLARS	○ ⇨ □ ◗ △								
14	DELIVER to BOOT STITCH AREA	○ ➡ □ D △								
15	BANK COLLARS	○ ⇨ □ ◗ △								
16		○ ⇨ □ D △								
17		○ ⇨ □ D △								
18		○ ⇨ □ D △								
19		○ ⇨ □ D △								
20		○ ⇨ □ D △								
21		○ ⇨ □ D △								
22		○ ⇨ □ D △								

[redacted]

FLOW PROCESS CHART

PAGE NO 2

SUMMARY		PRESENT		PROPOSED		DIFFERENCE	
		NO	TIME	NO	TIME	NO	TIME
OPERATIONS	○						
TRANSPORTATIONS	⇨						
INSPECTIONS	□						
DELAYS	D						
STORAGES	△						
TOTAL ELEMENTS							
DISTANCE TRAVELED			FT		FT		FT

CHART SUBJECT Govt. Contract Polyurethane Boot ☐ MAN ☐ MATERIAL

DETAILS OF CHART SUBJECT Prepare Leg and Sock Liners

DIVISION Consumer PLANT

DEPARTMENT UNIT

INVESTIGATED BY J.H. Hubbard DATE 1-5-77

REVIEWED BY DATE

	DETAILS OF ~~PRESENT~~ PROPOSED METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ACTION: ELIMINATE	ACTION: COMBINE	ACTION: CHANGE SEQ	ACTION: SIMPLIFY	NOTES
1	Leg-Sock Liner Stock Storage	○	⇨	□	D	▲								1830½ Coated Nylon Tricot
2	Deliver to Clicker Machine	○	➡	□	D	△								
3	Cut Leg-Sock Liner	●	⇨	□	D	△								CM 1351, 1352
4	Deliver to Bank	○	➡	□	D	△								
5	Bank Sock-Leg Liners	○	⇨	□	◗	△								
6	Deliver to Stitching Area	○	➡	□	D	△								
7	Stitch Leg Liner	●	⇨	□	D	△								Zigzag Mach. K678 - Blk. Nylon Thrd
8	Stitch Sock Liner	●	⇨	□	D	△								"
9	Bank Stitched Liners	○	⇨	□	◗	△								
10	Deliver to Desma #1546 L.I.M. Unit	○	➡	□	D	△								
11	Bank Stitched Liners	○	⇨	□	◗	△								
12		○	⇨	□	D	△								
13		○	⇨	□	D	△								
14		○	⇨	□	D	△								
15		○	⇨	□	D	△								
16		○	⇨	□	D	△								
17		○	⇨	□	D	△								
18		○	⇨	□	D	△								
19		○	⇨	□	D	△								
20		○	⇨	□	D	△								
21		○	⇨	□	D	△								
22		○	⇨	□	D	△								

FLOW PROCESS CHART

PAGE NO 3

SUMMARY		PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
OPERATIONS	○						
TRANSPORTATIONS	⇨						
INSPECTIONS	□						
DELAYS	D						
STORAGES	△						
TOTAL ELEMENTS							
DISTANCE TRAVELED		FT		FT		FT	

CHART SUBJECT GOVT. CONTRACT Polyurethane BOOT ☐ MAN ☐ MATERIAL

DETAILS OF CHART SUBJECT Prepare Outsole

DIVISION CONSUMER PLANT

DEPARTMENT UNIT

INVESTIGATED BY J.H. HUBBARD DATE 1-5-77

REVIEWED BY DATE

	DETAILS OF PRESENT / PROPOSED METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ACTION ELIMINATE	ACTION COMBINE	ACTION CHGE SEQ	ACTION SIMPLIFY	NOTES
1	SERVICE MATL. COMPONENTS	●	⇨	□	D	△								Prepolymer; Nitrosan or
2		○	⇨	□	D	△								Equivalent; PTMG (BD—TMP-SF69 - Catalyst)
3		○	⇨	□	D	△								MIX 30 MIN. Heat to 165°F
4	INJECT - MOLD OUTSOLE	●	⇨	□	D	△								Desma 700 Series SIZE AND US Army molded
5	CURE outsole	●	⇨	□	D	△								IN SHANK. CURE - 15 MIN @ 190°F.
6	Open Mold - STRIP OUTSOLE	●	⇨	□	D	△								
7	TRIM AND BUFF OUTSOLE	●	⇨	□	D	△								
8	INSPECT OUTSOLE	○	⇨	■	D	△								
9	Weigh OUTSOLE	●	⇨	□	D	△								
10	BANK AND PRE-HEAT OUTSOLES	○	⇨	□	◗	△								
11	Deliver to DESMA #1546 L.I.M. UNIT	○	➡	□	D	△								
12	Store outsoles in Heated Rack	○	⇨	□	◗	△								
13		○	⇨	□	D	△								
14		○	⇨	□	D	△								
15		○	⇨	□	D	△								
16		○	⇨	□	D	△								
17		○	⇨	□	D	△								
18		○	⇨	□	D	△								
19		○	⇨	□	D	△								
20		○	⇨	□	D	△								
21		○	⇨	□	D	△								
22		○	⇨	□	D	△								

[redacted]

PAGE NO 4

FLOW PROCESS CHART

CHART Govt. Contract ☐ MAN
SUBJECT Polyurethane Boot ☐ MATERIAL

DETAILS OF CHART SUBJECT: Mold Boot

DIVISION Consumer PLANT
DEPARTMENT UNIT
INVESTIGATED BY J.V. Hubbard DATE 1-5-77
REVIEWED BY DATE

SUMMARY		PRESENT		PROPOSED		DIFFERENCE	
		NO	TIME	NO	TIME	NO	TIME
OPERATIONS	○						
TRANSPORTATIONS	⇨						
INSPECTIONS	□						
DELAYS	D						
STORAGES	△						
TOTAL ELEMENTS							
DISTANCE TRAVELED			FT		FT		FT

DETAILS OF ~~PRESENT~~ PROPOSED METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ACTION ELIMINATE	COMBINE	CHANGE SEQ	SIMPLIFY	NOTES
Service Matl. Components to	●	⇨	□	D	△								MIX "B" COMPONENT 30 MIN. Heat to 220°F
Desma #1546 L.I.M. UNIT	○	⇨	□	D	△								MIX "C" COMPONENT, ADD Blowing Agent, MIX 10 min COOL to 60°F.
	○	⇨	□	D	△								
Hold Liner on Last	●	⇨	□	D	△								
Wash Liner - Vythene	●	⇨	□	D	△								
Apply Tape to Liner Seams	●	⇨	□	D	△								3M Scotch Elec. Tape #29 3/4"x50" per pair
Position Last in Boot Mold	●	⇨	□	D	△								
Place Pre-Heat Outsole in Cavity	●	⇨	□	D	△								
Close Mold	●	⇨	□	D	△								
Inject - Mold Boot	●	⇨	□	D	△								
Cure Boot	●	⇨	□	D	△								Cure time 17 min. Mold: 70°F; Last 230°F
Open Mold - Strip Boot	●	⇨	□	D	△								
Buff Flash	●	⇨	□	D	△								
Deliver to Inspect Station	○	➡	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								
	○	⇨	□	D	△								

FLOW PROCESS CHART

PAGE NO 5

CHART Govt. Contract
SUBJECT Polyurethane Boot

☐ MAN
☐ MATERIAL

SUMMARY		PRESENT NO	PRESENT TIME	PROPOSED NO	PROPOSED TIME	DIFFERENCE NO	DIFFERENCE TIME
OPERATIONS	○						
TRANSPORTATIONS	⇨						
INSPECTIONS	□						
DELAYS	D						
STORAGES	△						
TOTAL ELEMENTS							
DISTANCE TRAVELED			FT		FT		FT

DETAILS OF CHART SUBJECT: INSPECT, Apply Outerskin, STITCH Collar to Boot - Pack

DIVISION Consumer PLANT

DEPARTMENT UNIT

INVESTIGATED BY J.H. Hubbard DATE 1-5-77

REVIEWED BY DATE

DETAILS OF ~~PRESENT~~ PROPOSED METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ACTION ELIMINATE	ACTION COMBINE	ACTION CHGE SEQ	ACTION SIMPLIFY	NOTES
Remove Flash from Boot	●												
Buff Mold Joint Lines	●												
INSPECT Boot			●										
Repair Boot	●												
Bank Boots in Rack				●									
Damp wipe Boots	●												
Apply Vamp Patch	●												Dry 15 min.
Boot on Form; on Conveyor	●	●											
Spray Outerskin on Boots	●					* See attached page							12 MIN. (PTMG; TOLUENE; THF; MBK; MD; SPG-9; [illegible];
Dry Outerskin	●			●									10 min. (Air Dry)
Cure outerskin	●			●									20 min - 250°F (oven)
Cool outerskin	●												10 min (Air Dry)
Solvent Evaporation				●									12hrs @ 150°F - 180°F
STRIP Boot	●												
Deliver to Trim + Pack		●											
Trim Boot	●												
STITCH Collar to Boot	●												zig zag STITCH
Pull out Collar - INSERT LACE	●												
STITCH Collar to outside of Boot	●												zig zag STITCH
Bar Tack Collar	●												Bar Tack Machine
Weigh Boot - Mark Cuff	●												
FINAL INSPECT			●										

[redacted]

FLOW PROCESS CHART

PAGE NO 6

SUMMARY		PRESENT		PROPOSED		DIFFERENCE	
		NO	TIME	NO	TIME	NO	TIME
OPERATIONS	○						
TRANSPORTATIONS	⇨						
INSPECTIONS	□						
DELAYS	D						
STORAGES	△						
TOTAL ELEMENTS							
DISTANCE TRAVELED			FT		FT		FT

CHART ☐ MAN

SUBJECT ☐ MATERIAL

DETAILS OF CHART SUBJECT

DIVISION PLANT

DEPARTMENT UNIT

INVESTIGATED BY DATE

REVIEWED BY DATE

	DETAILS OF PRESENT/PROPOSED METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ACTION: ELIMINATE	ACTION: COMBINE	ACTION: CHGE SEQ	ACTION: SIMPLIFY	NOTES
1	ATTACH INSTRUCTION TAG	●	⇨	□	D	△								
2	INSERT TUBE IN BOOT	●	⇨	□	D	△								
3	Pack in Carton + CASE	●	⇨	□	D	△								
4	STAPLE - Stamp CASE	●	⇨	□	D	△								
5	Deliver to Whse. Area	○	➡	□	D	△								
6	Warehouse Boots	○	⇨	□	D	▲								
7		○	⇨	□	D	△								
8		○	⇨	□	D	△								
9		○	⇨	□	D	△								
10		○	⇨	□	D	△								
11		○	⇨	□	D	△								
12		○	⇨	□	D	△								
13		○	⇨	□	D	△								* OUTERSKIN Components
14		○	⇨	□	D	△								MUST BE MIXED UNDER
15		○	⇨	□	D	△								SPECIAL SAFETY CONDITIONS,
16		○	⇨	□	D	△								IN AN EXPLOSION PROOF,
17		○	⇨	□	D	△								VENTILATED ROOM.
18		○	⇨	□	D	△								
19		○	⇨	□	D	△								
20		○	⇨	□	D	△								
21		○	⇨	□	D	△								
22		○	⇨	□	D	△								

APPENDIX "F"

DESMA PSA-71--URETHANE FOAM MIXING MACHINE

Preliminary trials have been run on the PSA-71 with the Arctic Boot upper foam compound.

This equipment is capable of handling three individual component streams to the mixing head. Two of the components (the prepolymer and polyol master) were heated to 105°C and maintained at that temperature in the supply pots. The third component (blowing agent) was held at 10°C in the supply pot. The three components were controlled by supplying a heat transfer liquid to the jacketed supply pots using an in-line heat exchanger to regulate the temperature.

To further control the compound temperatures, the metering pumps are mounted to metal blocks that have temperature controls and supply lines are insulated. The temperature of the mix head itself can be controlled.

There are agitators in the supply pots to insure a uniform compound composition as well as uniform temperature. The variation in compound temperature in the supply pots was held to approximately ± 3°C.

The ratio of the three components required for the upper foam was attained by proper gear selection and the throughput was also varied depending on the drive gear used.

Repetitive cup shots of foam demonstrated good reproducibility of the weight of compound supplied. Checks to date indicate a variation in the range of ± 1%.

A range of mixing conditions was tried involving changes in throughput, mixing screw settings, valve closing sequence, mixing head temperature, etc. A set of mixing conditions was established that produced reasonably good foam, but more trials are necessary to get optimum mixing conditions and the best possible foam uniformity and structure. With the limited experience to date it is felt that the PSA-71 will be able to produce satisfactory Arctic Boot foams once all processing conditions have been optimized.

APPENDIX "G"

MOELLER
ENGINEERING & SALES INC
1225 E. RAND ROAD, DES PLAINES, ILL. [illegible]
PHONE: [illegible]

March 24, 1977

Uniroyal, Inc.
Naugatuck Footwear Plant
58 Maple Street
Naugatuck, Connecticut

Attention: Mr. John C. Gaynor

Subject: Electrostatic Coating System
Gov. Boot Contract
DAAG-17-76-C-0016

Gentlemen:

In accordance with our proposal No. P-417 dated August 19, 1976, and your Purchase Order No. JCG1150-693072 dated November 16, 1976, we are pleased to submit triplicate copies of engineering drawings and cost estimates covering the equipment requirements for this proposed system.

For purposes of suitable identification we divide the project into:

Section A - Electrostatic Equipment

Section B - All Other Equipment

DRAWINGS

Section A - Electrostatic Equipment

Reference Drawings: By Ransburg Corp.

No. D-24091	Sheet 1, 2, & 3 Enclosure Drawings
No. E-24091	Sheet 1, 2, & 3 Electrical Drawings
No. 7602	Reciprocator Schematic & Connection Diagram
No. EP-24091	Two-Component Pump System
No. 19156 & 19146	Two-Component Pumps
No. A-8744	Edon Variable Stroke Electrical Timer
No. D-6517	Power Rotator
Bulletin	Ransburg No. 2 Process

Section B - Other Equipment

Reference Drawings: By Young & Bertke Company

No. R-35902-1	General Layout, Air Supply & Exhaust Duct Details.
No. R-35902-2	Curing & Drying Ovens
No. R-35902-3	Wiring Schematics
No. R-10317	Conveyor Spinner Detail
Bulletin	Unibilt Conveyor
Bulletin	Associated Equipment

EQUIPMENT

Section A - Ransburg Corp.

All required electrostatic equipment for an overhead mounted reciprocating disk system utilizing a one station - 36" stroke hydraulic reciprocator used in junction with a two-component coating pumping system.

As per their No. 7D22 dated March 22, 1977, copy attached.

Section B - Young & Bertke Company

All other equipment items as shown on general layout drawing with exception of room enclosure, roof openings and provision for adequate supplies of air, water and electrical services.

All as per Young & Bertke No. 3157 dated March 15, 1977.

COST ESTIMATES

Based upon current pricing of materials, labor and purchased accessories, F.O.B Shipping Points:

Section A - Ransburg Corp.	$ 29,144.00
Section B - Young & Bertke Co	$ 42,600.00
Installation of above, including mechanical erection of equipment and all wiring and piping to service connection within 20' of system. Based upon standard working hours and a normal 40 hour week.	$ 26,600.00

RANSBURG®

Date: March 22, 1977

No. 7D22

ELECTROSTATIC EQUIPMENT PROPOSAL

To: Mr. Graf Moeller
Moeller Engineering & Sales, Inc.
1225 East Rand Road
Des Plaines, IL 60016

Plant Location: Uniroyal Inc.
Naugatuck, CT

GENERAL

A Reciprocating Disk System -- for one-station operation with 36" Stroke Overhead Mounted Reciprocator, for Two-component coating pumping system.

2. EQUIPMENT DESCRIPTION

Amount		Part No. & Name
1	--	18100-00 High Voltage Power Supply with CVT & Alarm Bell
1	--	17264-00 Control Panel & Necessary E.P. Switches
1	--	15855-00 Air Motor Disk Rotator Assembly Complete
1	--	17423-00 Air Control Panel
1	--	19115-00 Two-Component Control Panel
1	--	19092-00 Pump Unit - Resin
1	--	19093-00 Pump Unit - Catalyst
2	--	19143-00 DC Pump Controllers
2	--	9799-01 Stepdown Transformers
2	--	3110-01 E.P. Push Buttons
2	--	19099-00 Fluid Metering Pumps
1	--	19102-00 Static Mixer
1	--	Lot of High Voltage Cable, Polyethylene Hose & Fittings
1	--	#3042 Concentric Tube Reciprocator Unit, 36" Stroke for Overhead Mounting.
1	--	#2369 - 20 Gallon Hydraulic Power Unit with 2 H.P., 3 Phase, 60 Hz, 230/460 Volt Explosion-proof Motor.
1	--	#2368 Control Panel Assembly Complete with 4 Limit Switches for two timed adjustable strokes, Pulleys with Brackets & Aircraft Cable.

SPARES:

2	--	15855-00 Air Motor Disk Rotators
2	--	8002-15 Shallow-Well 15" Diameter Disks
2	--	19099-00 Fluid Pumps
2	--	19103-00 Static Mixers

Young & Bertke Co.
DESIGNING • ENGINEERING • FABRICATING • INSTALLING

2118 WINCHELL AVENUE
CINCINNATI, OHIO 45214
AREA CODE 513/241-5565

March 15, 1977
Y & B No. 3157

Moeller Engineering & Sales, Inc.
1225 East Rand Road
Des Plaines, Illinois 60016

Subject: Ancillary Equipment & Services
Uniroyal Project - DAAG 17-76-0016

Gentlemen:

Per discussions of specifications relating to subject project, we will furnish and install equipment items as follows:

Item 1 - Shroud
Item 2 - Ovens
Item 3 - Conveyor
Item 4 - Air Supply System
Item 5 - Exhaust System
Item 6 - Controls
Item 7 - Installation

ITEM 1 - SHROUD

One - 8'0" diameter 8'0" high No. 2 Disk enclosure, including filter equipped bottom exhaust plenum with 4,200 CFM exhaust fan and 1 HP explosion proof motor also 24" diameter stack to 15' above roof line with cap and access door.

ITEM 2 - OVEN

One - electrically heated, 2-compartment cure oven 14'9" wide 14'0" long x 12'4" high with 8,500 CFM - 5 HP recirculating fan, 435 CFM ½ HP exhaust fan, 60 KW capacity finned tubular heaters, all controls, exhaust stack to atmosphere.

DRYING OVENS • SPRAY BOOTHS • CLEANING MACHINES • MAKE-UP AIR UNITS • DUST AND FUME CONTROL SYSTEMS • COMPLETE FINISHING SYSTEMS

ITEM 3 - CONVEYOR

J. B Webb UNIBILT conveyor - 76'8" loneal with attachments to provide work spinners on 20" centers. Power rotation device with double rubber V-belts, tension adjustment, air motor complete with necessary controls for speed variation.

ITEM 4 - AIR REPLACEMENT UNIT

One - Model 1-175-100-1 Young & Bertke 10,000 CFM air replacement unit including intake hood and duct plus filter distribution duct with 16 filters, direct gas-fired - 870,000 BTU maximum and including humidity equipment and controls.

ITEM 5 - EXHAUST SYSTEM

Graduated floor duct system with adjustable slots - 37'8" long with 4,800 CFM fan and 1 HP motor. Stack to atmosphere with cap.

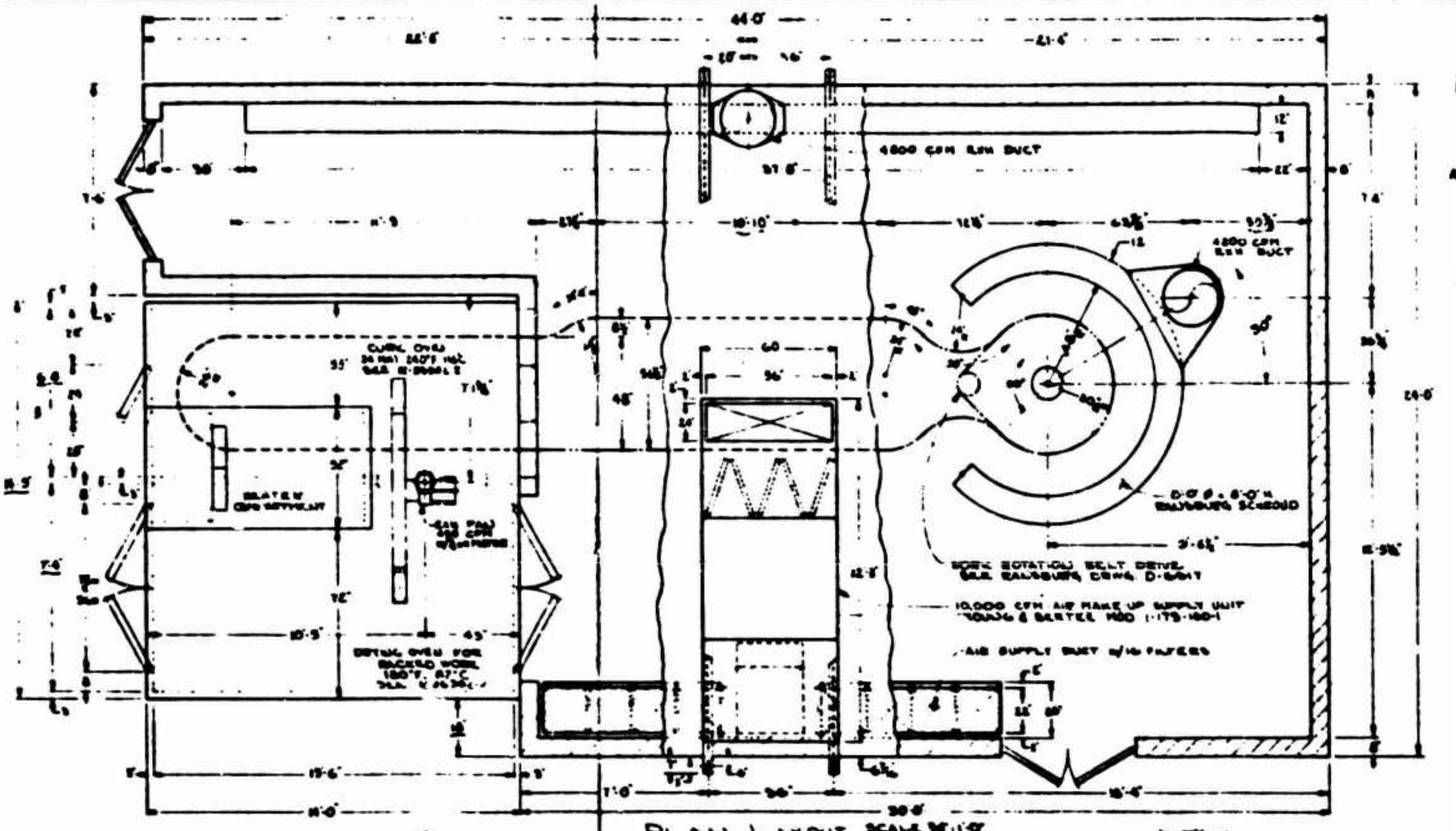
ITEM 6 - CONTROLS

Two-free standing electrical control panels are included with individual main disconnects, push buttons, panel lights, and etc.

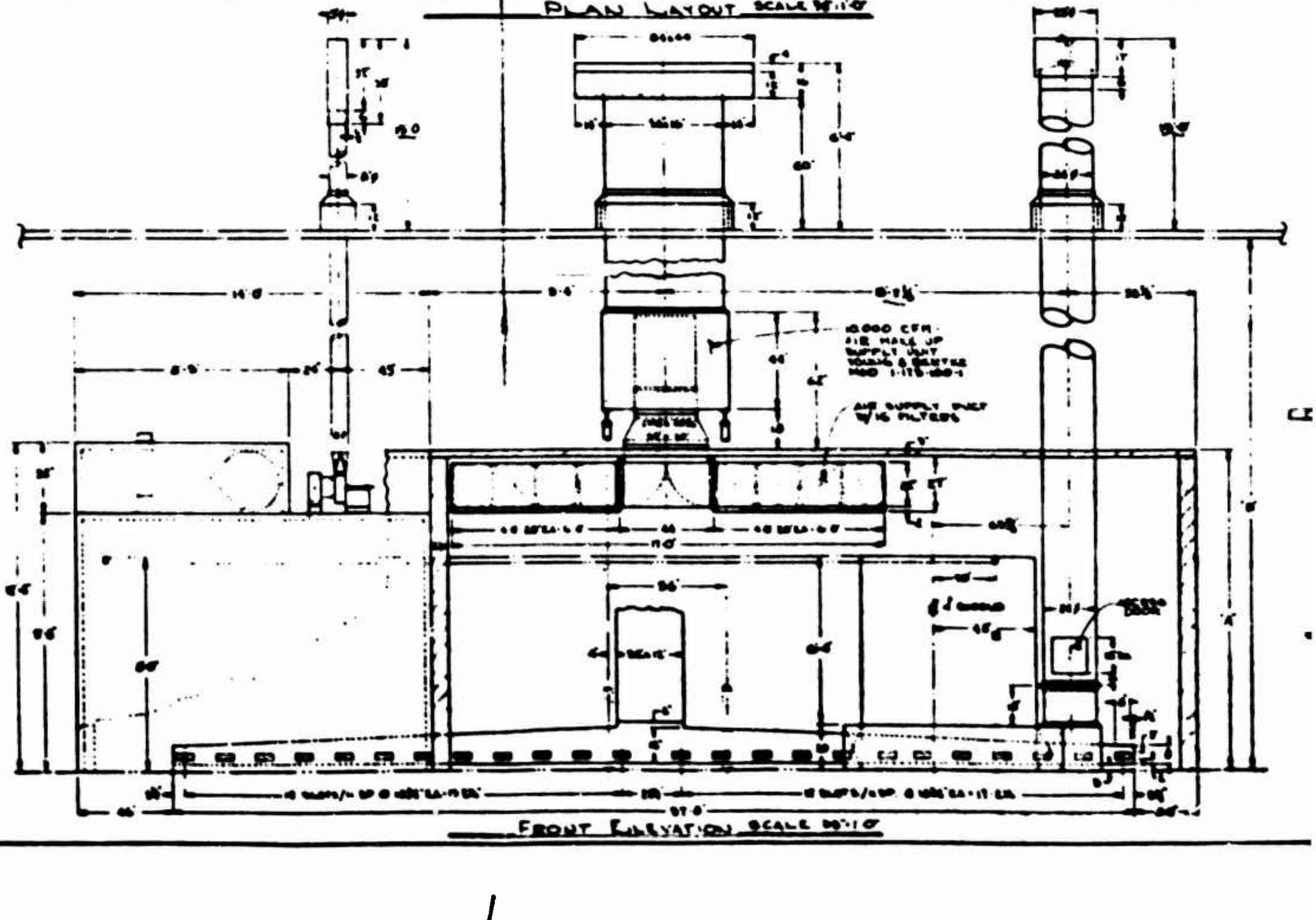
Panel No. 1	For Ovens
Panel No. 2	For all other items including air supply exhaust system, shroud exhaust, hydraulic reciprocator and conveyor.

ITEM 7 - INSTALLATION

Necessary labor, materials and supervision to erect all equipment furnished by Young & Bertke. In addition, we will field wire and pipe same plus the electrostatic equipment furnished by Ransburg. This excludes room enclosure and cutting/repairing of roof openings for stacks.



PLAN LAYOUT SCALE 3/8"=1'-0"



FRONT ELEVATION SCALE 3/8"=1'-0"

1

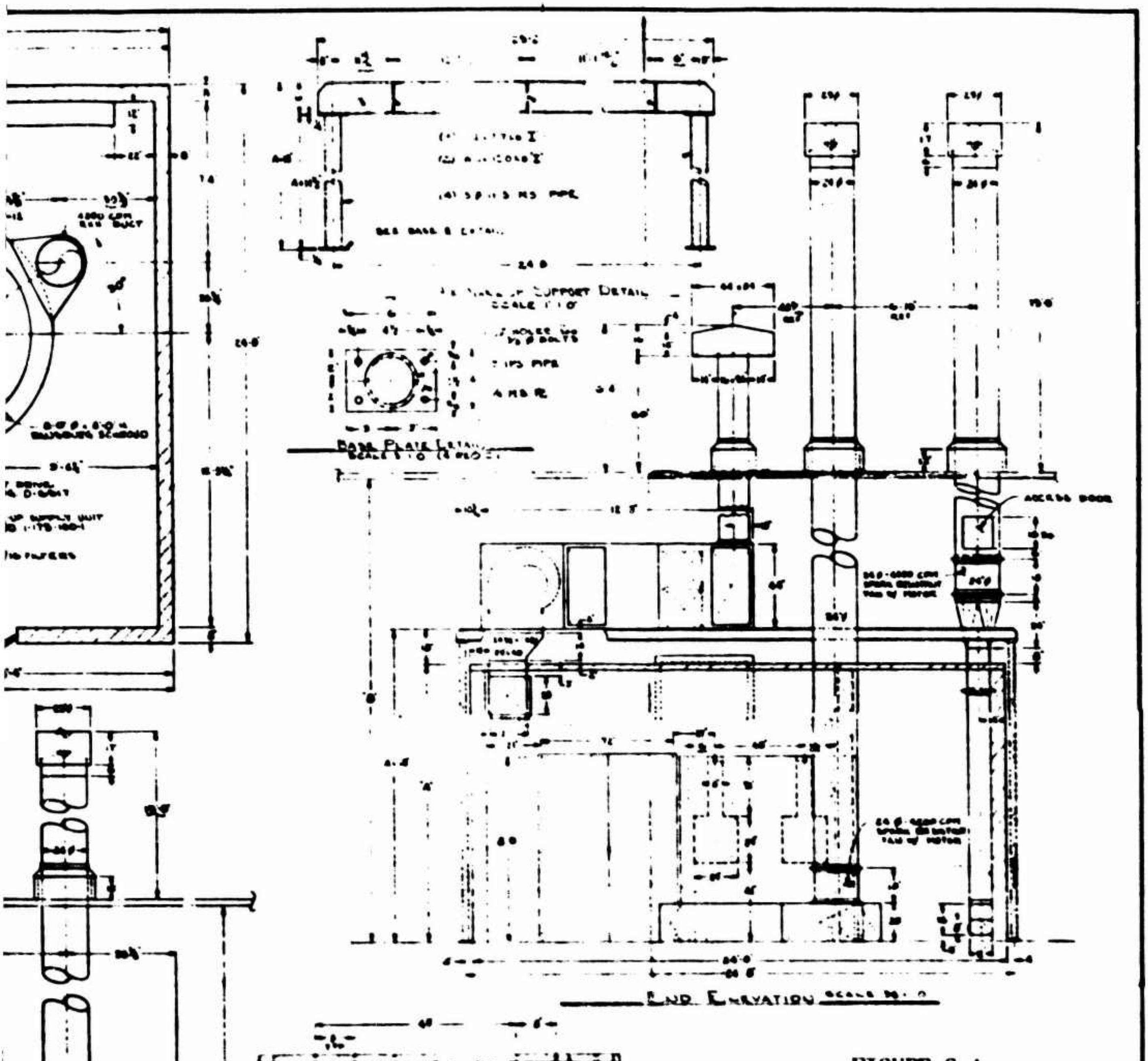


FIGURE G-1

[illegible]	Conv. Sprocket Det.				
[illegible]	[illegible]				
[illegible]	[illegible]				
No.	Title				
Reference Drawings		Revisions			

General Layout - Electrostatic Coating System
Uniroyal, Inc (Naugatuck Footwear Plant) Naugatuck, Conn

SO K-2823

193

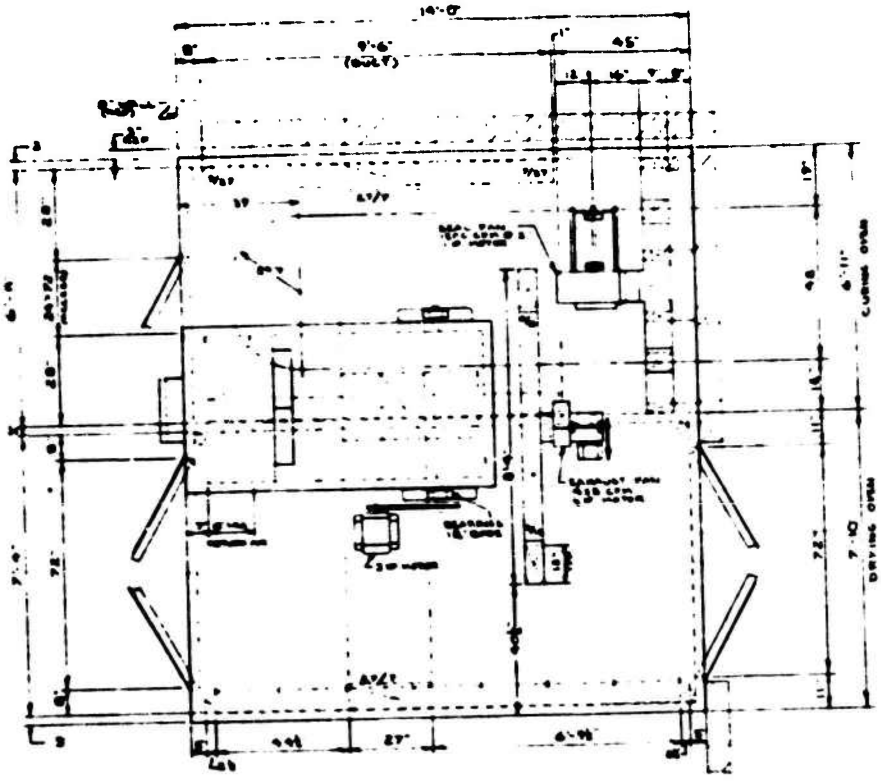
YOUNG & BERTKE CO.
CINCINNATI OHIO

As Noted

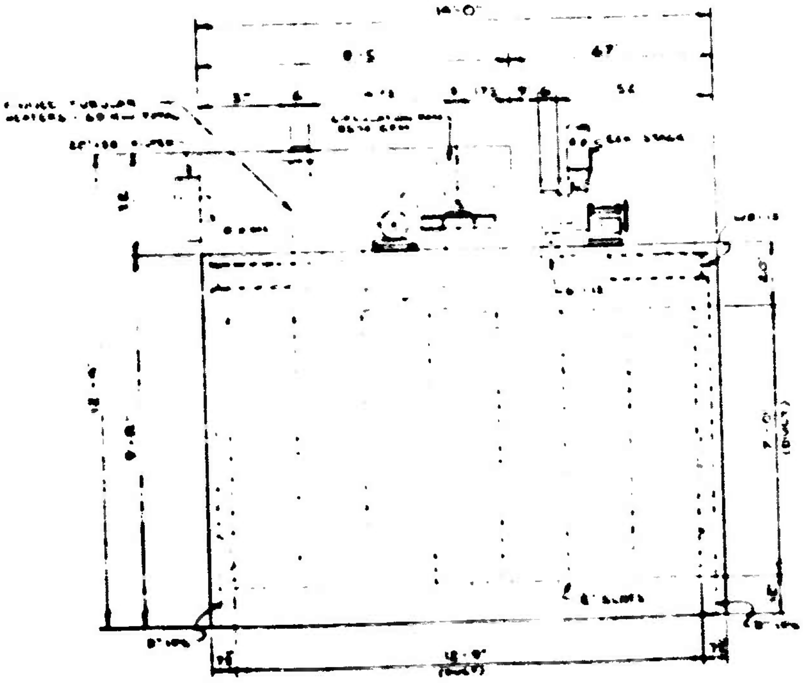
1972

R-35302-1

2

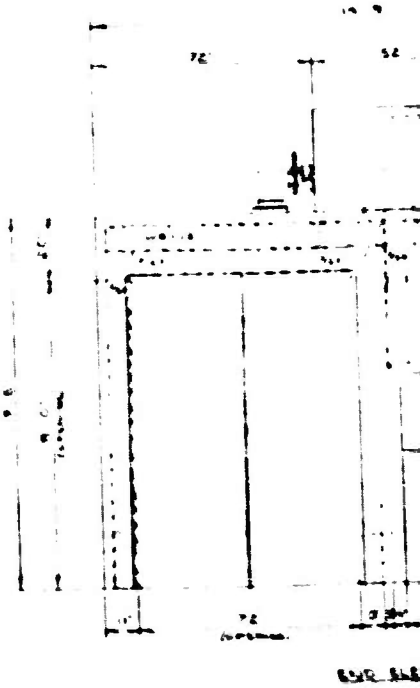


PLAN



SIDE ELEVATION

SE



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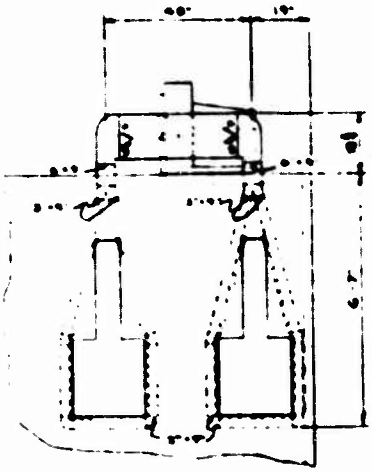
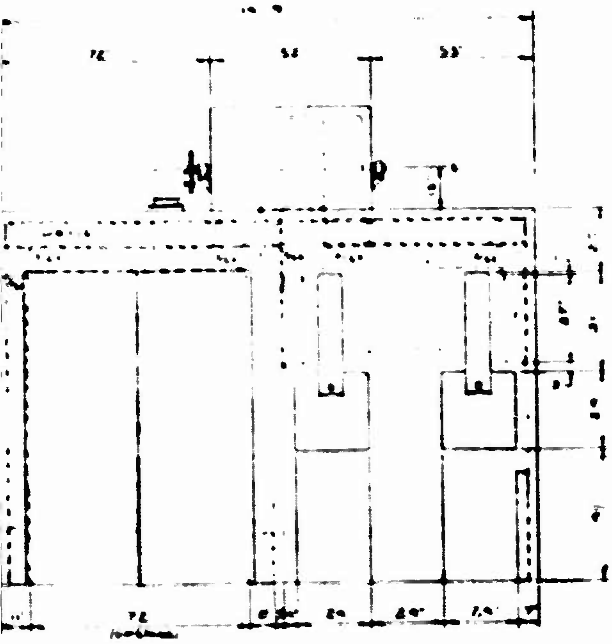


FRONT ELEVATION

SEAL DUCT ARRG



END ELEVATION

FIGURE G-2

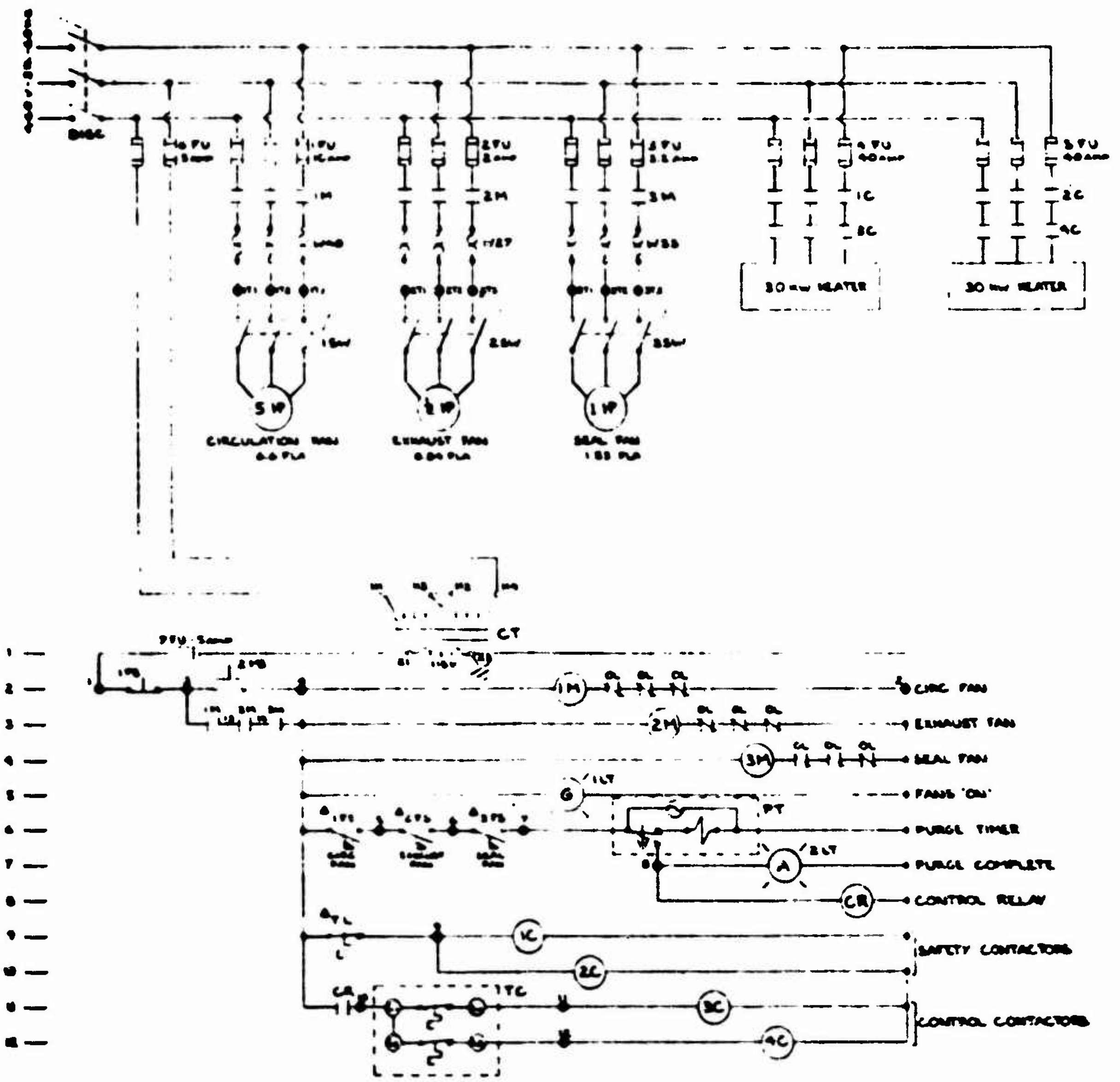
DESIGN OF OVENS TO BE FINALIZED AFTER MEETING WITH CUSTOMER

CURING - DRYING OVENS - LAYOUT
UNIROYAL, Inc
NAUGATUCK, CONN

YOUNG & BERTKE CO.
CINCINNATI OHIO

TH
3-18-77
R-35902-2

2



NOTE:

1) NUMBER AND C
BLACK : W
RED : C
WHITE : W
GREEN : G
2) LAST WIRE NU
3) —◆— DENOTES
4) ▲ REMOTE C
5) ☐ EQUIPMENT

ITEM	DESCRIPTION	MANUFACTURER	CATALOG Nº	QTY
DISC	DISCONNECT	GENERAL ELECTRIC	THC 33-100A	1
CT	CONTROL TRANS	GENERAL ELECTRIC	9T55Y50-62 500V	1
1-3M	STARTERS	ALLEN BRADLEY	509-AOD 51EEO	3
1PB	PUSH BUTTON	ALLEN BRADLEY	800T-B6D2	1
2PB	PUSH BUTTON	ALLEN BRADLEY	800T A1D1	1
1LT	PILOT LIGHT	ALLEN BRADLEY	800T-P16G	1
2LT	PILOT LIGHT	ALLEN BRADLEY	800T-P16A	1
1-3FS	AIR FLOW SWITCH	CHICAGO SAFETY	JD-2	3
PT	PURGE TIMER	EAGLE SIGNAL	HD503-A625	1
CR	CONTROL RELAY	ALLEN BRADLEY	700N 400A1	1
TC	TEMP CONTROL	PARTLOW	2F1S-7665KLF-110	1
TL	HI TEMP LIMIT	PARTLOW	NS 8Y665KBY-110	1
1-4C	CONTACTORS	GENERAL ELECTRIC	CR153DAC02ABB	4
1-3SW	SAFETY SWITCHES	BY OTHERS		3

NOTE:

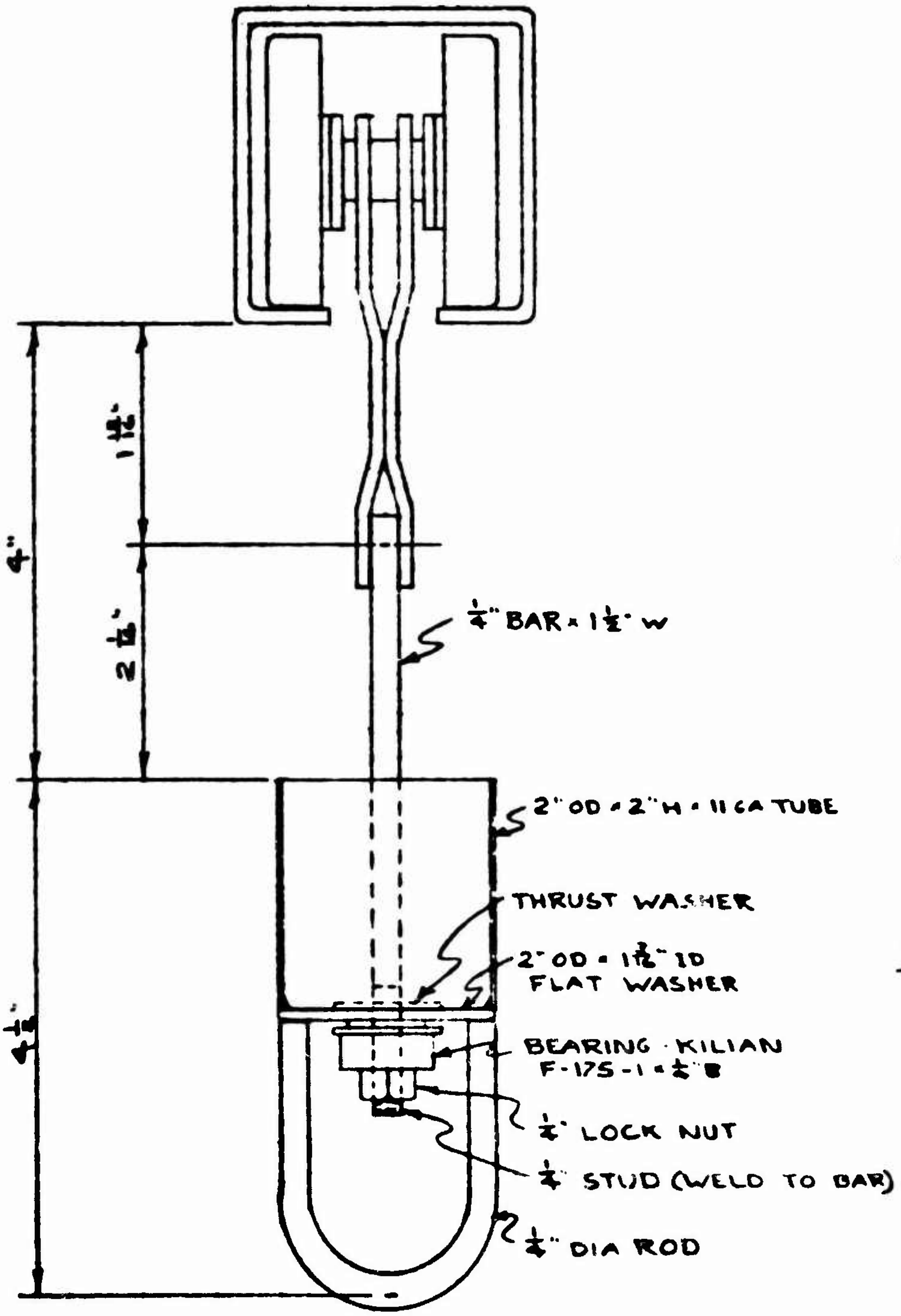
1) NUMBER AND COLOR CODE ALL WIRES
BLACK - POWER
RED - CONTROL
WHITE - NEUTRAL
GREEN - GROUND
2) LAST WIRE NUMBER USED 14
3) -⊘- DENOTES TERMINAL STRIP
4) △ REMOTE FROM PANEL
5) [D] EQUIPMENT TERMINAL

FIGURE G-3

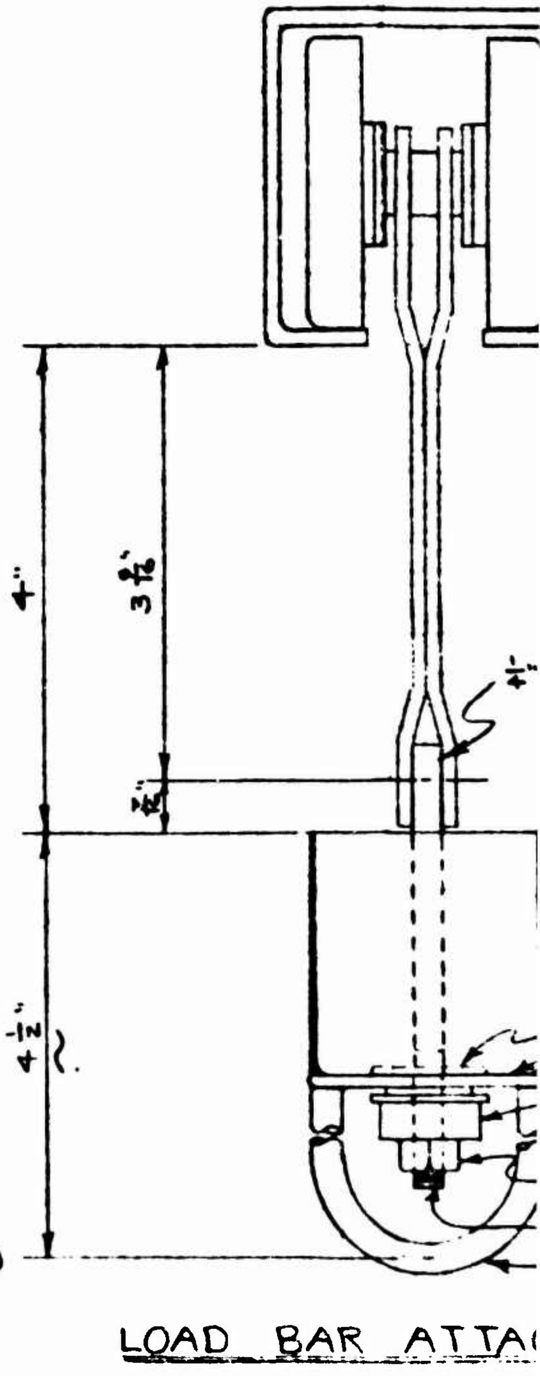
WIRING SCHEMATIC FOR CURING AND DRYING OVENS
UNIROYAL, Inc. NAUGATUCK, CONN.

88 K 2829	**YOUNG & BERTKE CO.** CINCINNATI, OHIO	TH	
		NONE	3-16-77
			R-35902-3
		3	

2



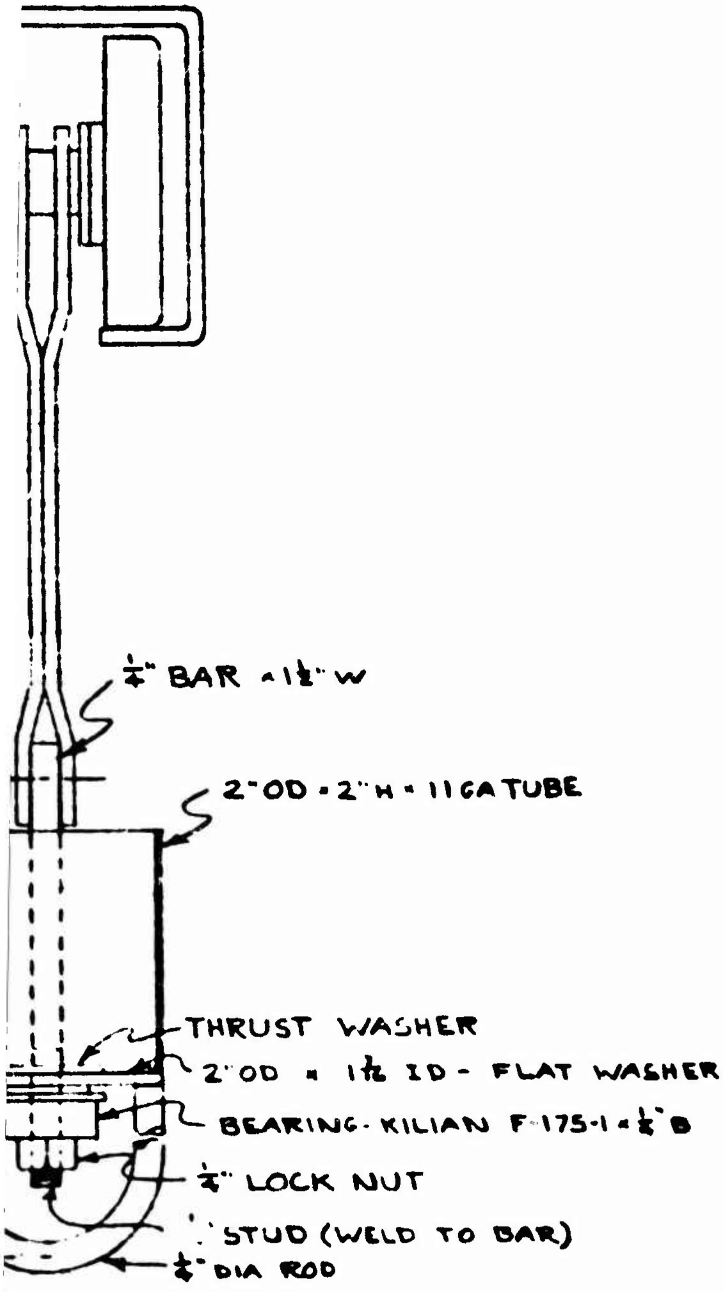
STD "H" ATTACHMENT



LOAD BAR ATTA

UN

S.O.



ATTACHMENT

FIGURE G-4

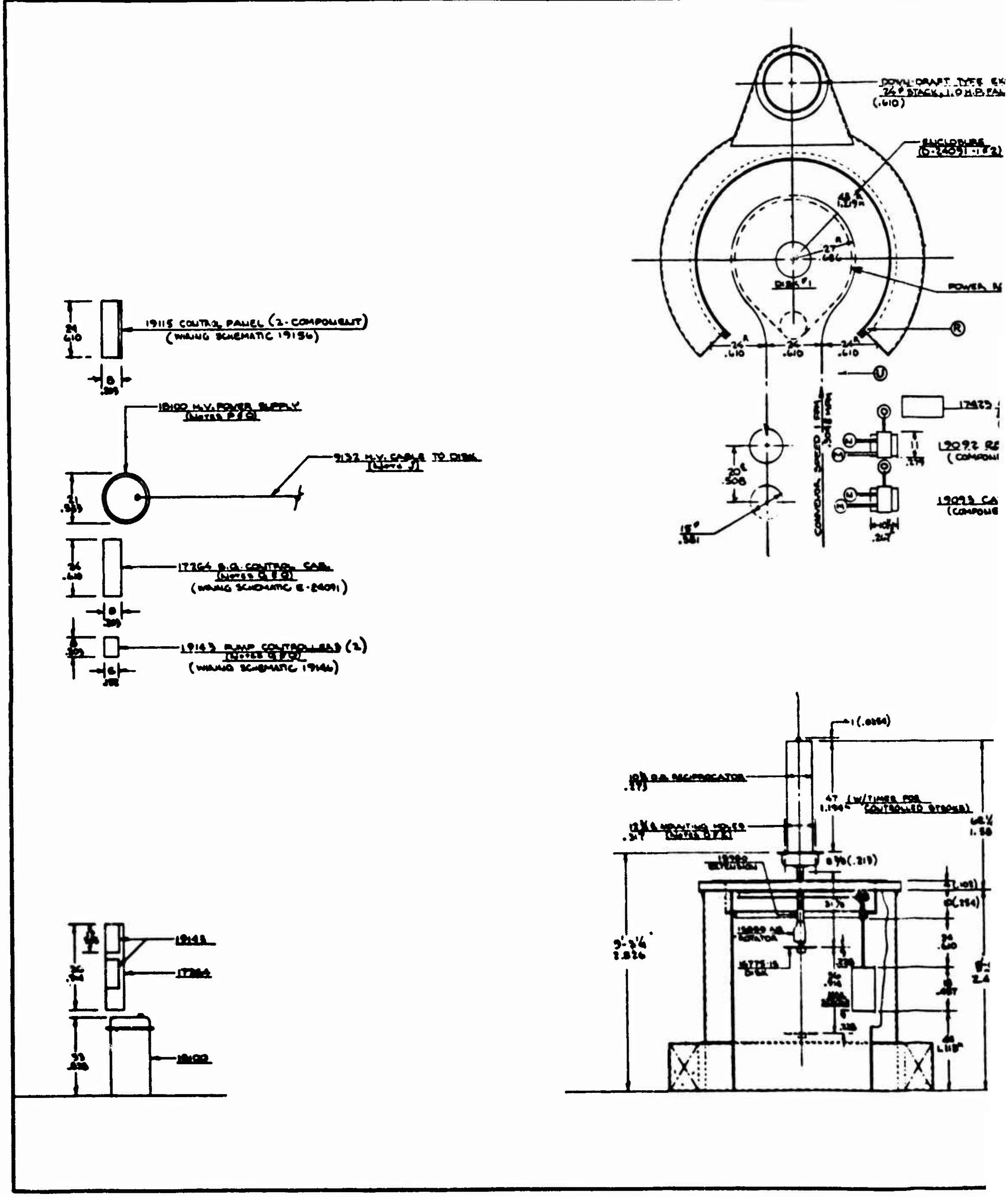
ROTATOR ASSEMBLY

UNIROYAL, INC
NAUGATUCK, CONN.

S.O. K-2829

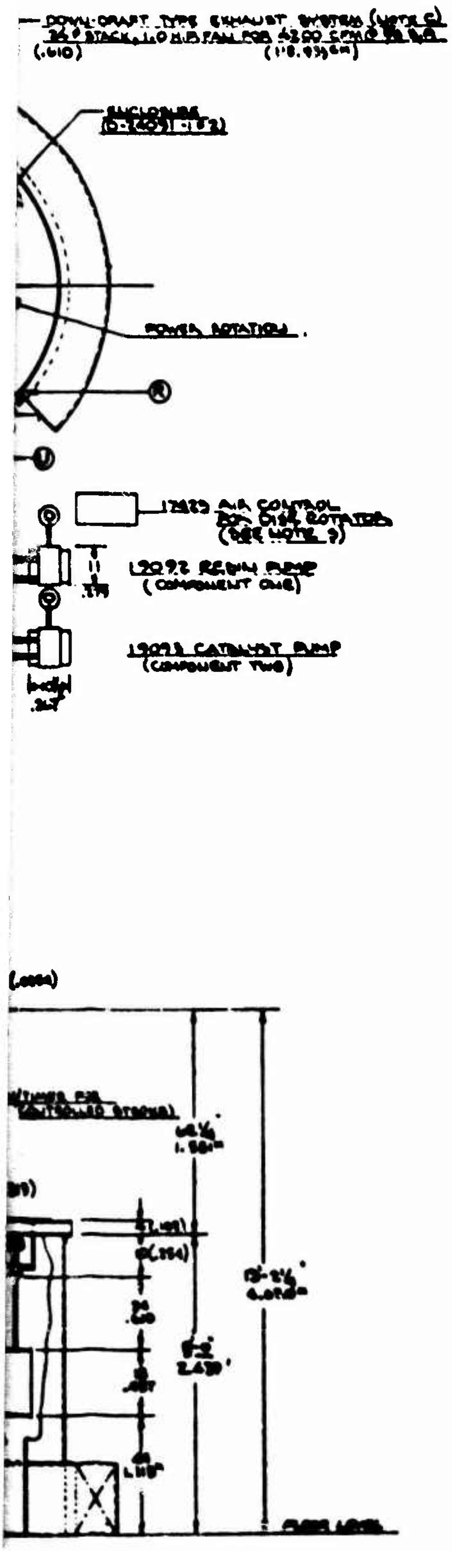
YOUNG & BERTKE CO.
CINCINNATI, OHIO
ENGINEERS MANUFACTURERS

Drawn TH
Chk
Scale 3/4"=0'-1"
Date 3-16-77
Number R-10317


DOWN-DRAFT TYPE EX
24 Ø STACK, 1.0 H.P. FAN
(.610)
ENCLOSURE
(D-24091-1 & 2)
48 R
1.219 R
27 R
.686
DISK Ø 1
POWER IN
R
24 R
.610
24
.610
24 R
.610
U
CONTINUOUS SPEED 1 RPM
.3048 M/M
20
.508
15°
.381
17923
19092 RE
(COMPONE
.279
19093 CA
(COMPONE
.267
1911S CONTROL PANEL (2-COMPONENT)
(WIRING SCHEMATIC 19156)
24
.610
8
.203
18100 H.V. POWER SUPPLY
(NOTES P & Q)
9132 H.V. CABLE TO DISK
(NOTE J)
.533
17264 S.G. CONTROL CAB.
(NOTES Q & Q)
(WIRING SCHEMATIC E-24091)
24
.610
8
.203
19143 PUMP CONTROLLERS (2)
(NOTES Q & Q)
(WIRING SCHEMATIC 19146)
.203
6
.152
19143
17264
36
.914
33
.838
18100
1 (.0254)
10 3/4 O.D. RECIPROCATOR
.273
47 (W/TIMER FOR
1.194 CONTROLLED STROKE)
13 3/4 & MOUNTING HOLES
.349 (NOTES O & R)
8 5/8 (.219)
19780 EXTENSION
19880 AIR ROTATOR
16775-15 DISK
9'-3 1/4"
2.826
4 (.102)
10 (.254)
24
.610
36
.914
68 1/4
1.58
.457
6
.152
.330
44
1.118
2.4

1

A	REDRAWN			



Ⓤ START ROTATION OF 1 TO 2 REV. PER FT. OF TRAVEL THROUGH COATING ZONE.

Ⓣ GENERAL INFORMATION DRAWING REFER GP 24091

Ⓢ AIR REQUIREMENTS FOR EACH AIR MOTOR ROTATOR. (10 CFM AT 95 PSI) .850 CMM @

Ⓡ 15945-85 GROUNDING HOOK TO BE LOCATED AT ENCLOSURE FACE OR OTHER CONVENIENT LOCATION FOR OPERATOR ACCESS.

GENERAL NOTES

Ⓠ RANSBURG CONTROL CABINET AND HIGH VOLTAGE POWER SUPPLY TO BE LOCATED 20 FT. OR MORE FROM SPRAY AREA.

Ⓟ HIGH VOLTAGE POWER SUPPLY MAY BE SUPPORTED OVERHEAD. APPROXIMATE WEIGHT IS 700 POUNDS.

Ⓞ LEADS FROM EXPLOSION-PROOF MOTORS TO EXPLOSION-PROOF JUNCTION BOX.

Ⓝ PAINT LINE TO PAINT SUPPLY.

Ⓜ PAINT LINE TO DISK.

Ⓛ ALL UNINSULATED COMPONENTS AT HIGH VOLTAGE TO HAVE AT LEAST 15 INCHES CLEARANCE FROM ALL GROUNDED OBJECTS EXCEPT ARTICLES BEING SPRAYED

Ⓚ IF ELECTRICALLY CONDUCTING TYPE OF PAINT IS USED, PAINT TANK, SUPPORT, PUMP UNIT AND PAINT LINES MUST BE ADEQUATELY PROTECTED SO PERSONNEL WILL NOT INADVERTENTLY COME IN CONTACT WITH HIGH VOLTAGE.

Ⓙ POLYETHYLENE COVERED HIGH VOLTAGE LEAD NOT TO BE IN CONDUIT AND PREFERABLY NOT OVER 40 FT. IN LENGTH.

Ⓗ EXPLOSION-PROOF SWITCHES TO BE CONVENIENTLY LOCATED IN SPRAY AREA.

NOTES PERTAINING TO MATERIAL AND EQUIPMENT SUPPLIED BY USER

Ⓖ RANSBURG CONTROL CABINET TO BE SUPPLIED WITH 230 VOLT, 60 CYCLE, 2 WIRE, 1 PHASE POWER.

Ⓕ ELECTRICAL DIAGRAMS SHOWING MATERIALS SUPPLIED BY USER FOR RANSBURG EQUIPMENT WILL BE PROVIDED BY RANSBURG PRIOR TO INSTALLATION OR UPON REQUEST E-24091 (1-3), 19156 E-7002, 19196

Ⓔ RECIPROCATOR MUST HAVE SMOOTH MOVEMENT AND AND JERK FREE REVERSAL AT EACH END OF STROKE STROKE SPEED MUST BE ADJUSTABLE AND MUST BE CONSTANT AT ANY SELECTED SPEED

Ⓓ RECIPROCATOR SUPPORT MUST BE LEVEL, RIGID AND FREE OF VIBRATION.

Ⓒ EXHAUST DUCTS TO BE SUPPLIED WITH OPENINGS HAVING ADJUSTABLE LOUVERS OR SLOTS TO PROVIDE A MEANS OF BALANCING THE POSITIVE REMOVAL OF AIR AND SOLVENT VAPORS FROM THE SPRAY AREA. AMPLE VENTILATION TO BE SUPPLIED FOR REMOVING SOLVENT VAPORS FROM SPRAY AREA AND RECIPROCATOR PIT IF PIT IS USED

Ⓑ ISOLATING FENCE AND "DANGER HIGH VOLTAGE" SIGNS TO BE PROVIDED AROUND SPRAY AREA.

Ⓐ APPROVED AUTOMATIC EXTINGUISHING SYSTEM TO BE PROVIDED SUCH AS SPRINKLERS OR CO₂ AND OTHER SAFETY EQUIPMENT REQUIRED BY LOCAL REGULATIONS.

PROPOSAL NO 6759

FIGURE G-5

NOTE: DIMENSIONS SHOWN
INCHES (FOOT & INCHES) TOP FIG.
METRIC (METERS) BOTTOM FIG.

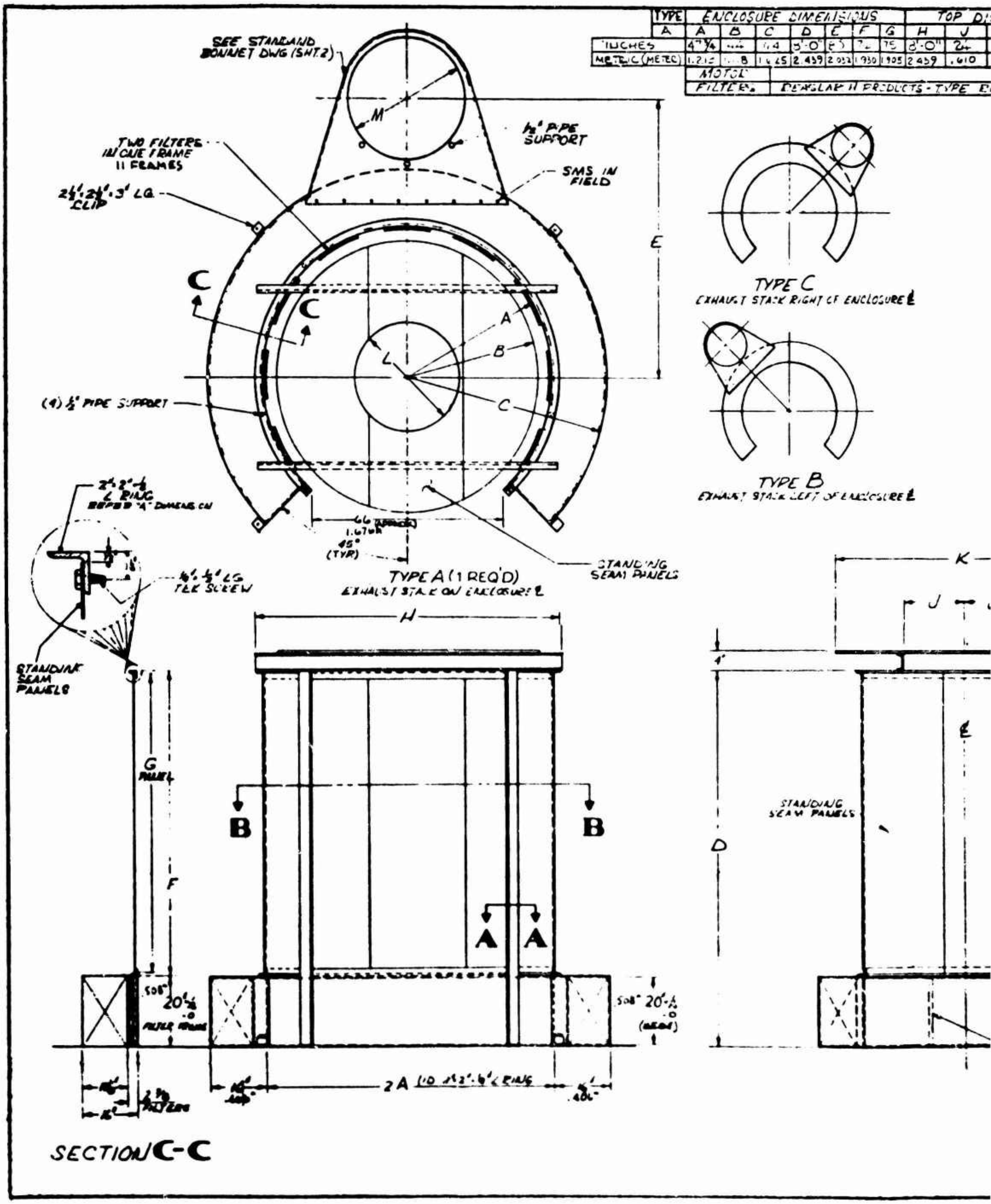
1	18	
DISK NUMBER	16 TYPE DISK DIA INCHES	APPROX. FLUID DEL. CC. MINUTE EA.

RANSBURG CORPORATION
INDIANAPOLIS, IND

UNIROYAL, INC.
NAUGATUCK CONNECTICUT
BAND DISK BOOTS
8-17-76
24091-A
1 of 1

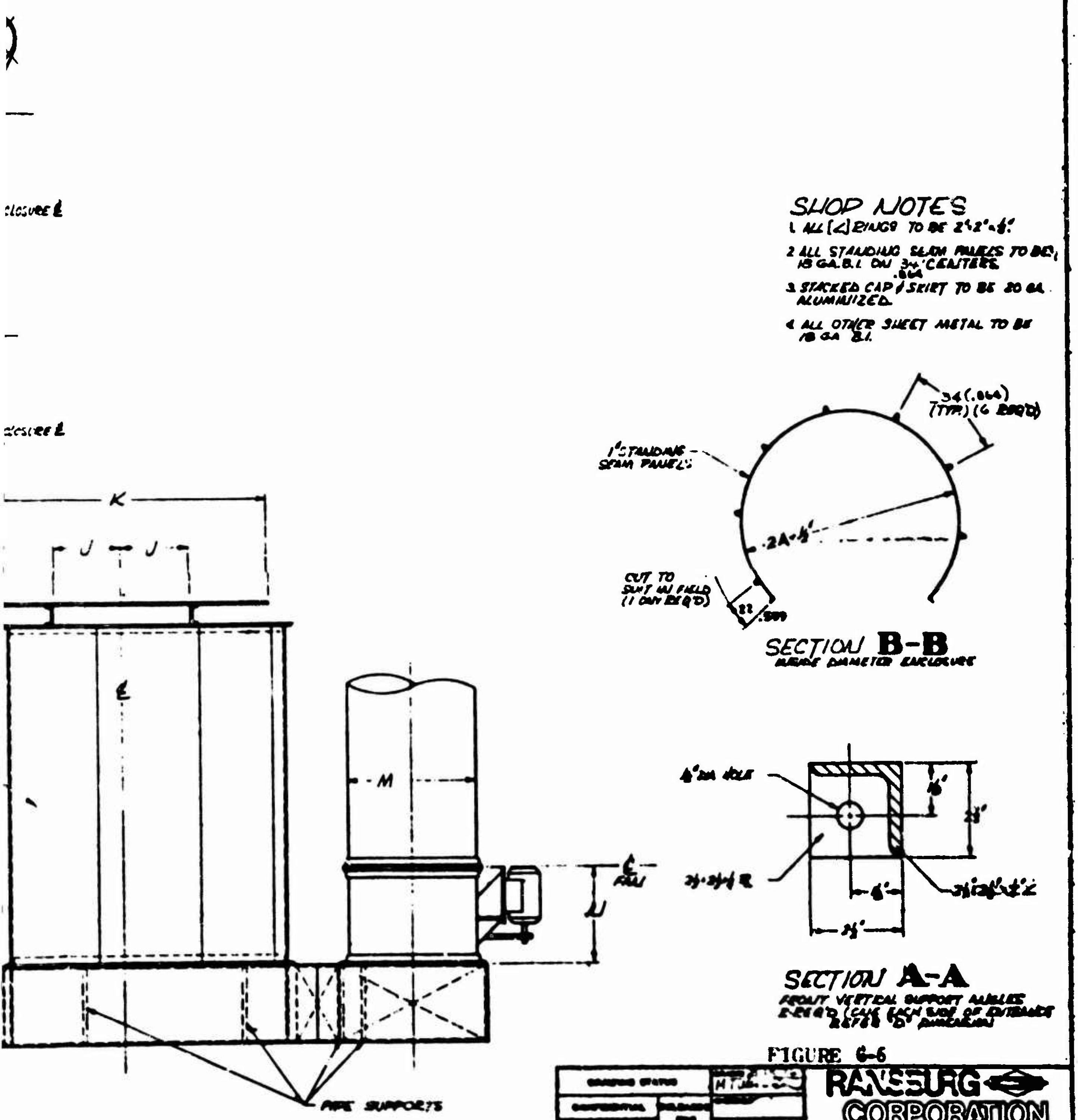
2

	TYPE	ENCLOSURE DIMENSIONS							TOP DI	
	A	A	B	C	D	E	F	G	H	J
INCHES		47¾	44	64	8'-0"	80	76	75	8'-0"	24
METRIC (METERS)		1.213	[illegible]	1.625	2.439	2.032	1.930	1.905	2.439	.610
		MOTOR								
		FILTERS	DEMSLAB II PRODUCTS - TYPE E							



	TOP DISK				STACK	FAN HEIGHT	1750 RPM MOTOR		CFM.	NO. of FILTER FRAMES
G	H	J	K	L	M	N	HP	FRAME NO.	@ 3/4 SP	W/2 FILTERS PER FRAME
75	8'-0"	24	7-4'	36	24	As Req'd.	1.0		4200	11
1905	2.439	.610	2.184	.914	.610				119 CMM	

PRODUCTS - TYPE EP/FRAME DOUBLE FILTER & GRIDS 20"×20"×1" (.508×.508×.0254)



SHOP NOTES

1. ALL [∠] RINGS TO BE 2½×2½×¼".
2. ALL STANDING SEAM PANELS TO BE 18 GA. B.I. ON 34" (.864) CENTERS.
3. STACKED CAP & SKIRT TO BE 20 GA. ALUMINIZED.
4. ALL OTHER SHEET METAL TO BE 18 GA. B.I.

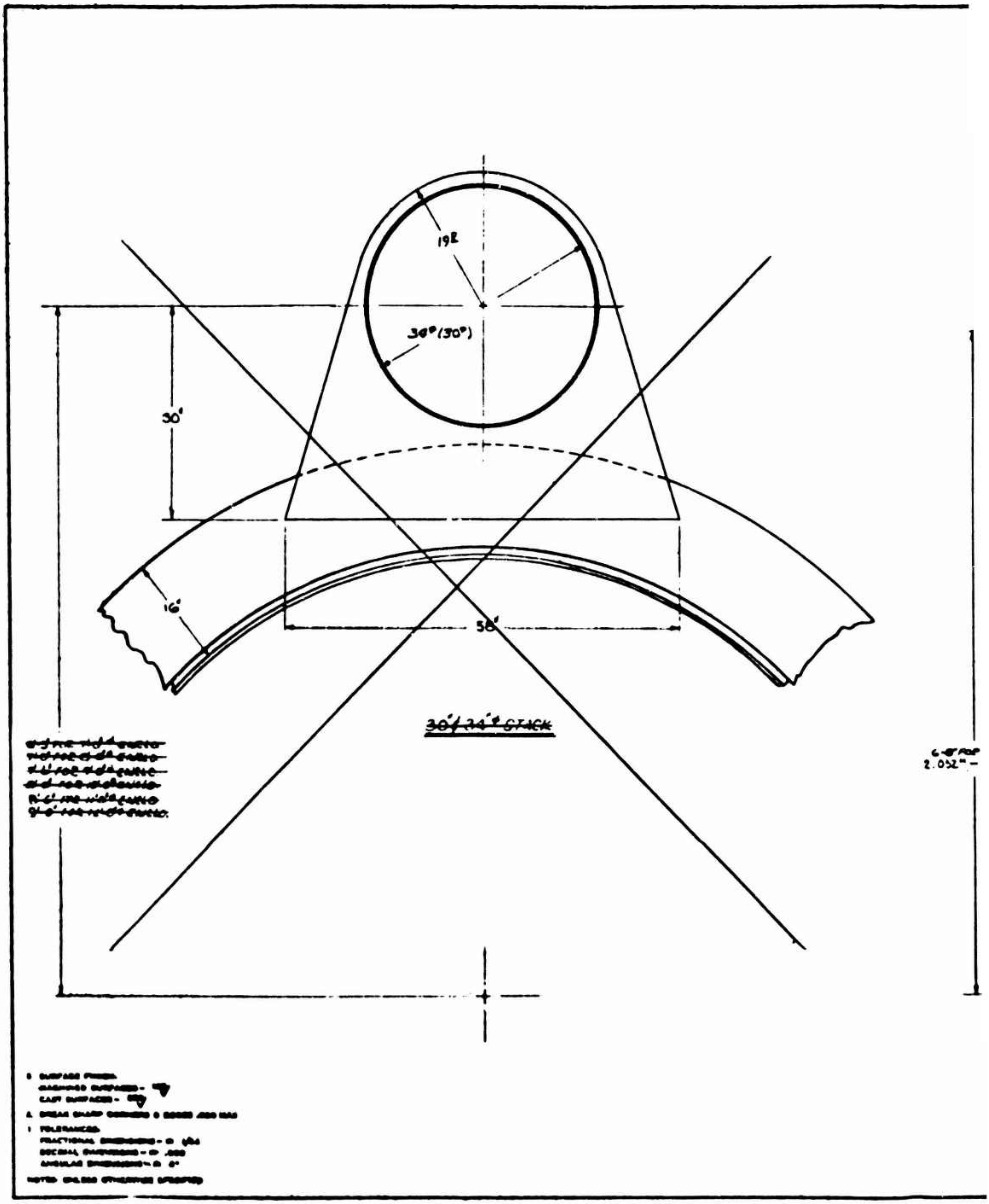
FIGURE 6-6

RANSBURG CORPORATION

Universal, Inc. Connecticut

DISC ENCLOSURE FOR 8'-0" STACK

D-24091


19R
34"(30")
30'
16'
58'
30'ø 24'ø STACK
6-8' FOR
2.052" -
SURFACE FINISH
MACHINED SURFACES -
CAST SURFACES -
BREAK SHARP CORNERS & EDGES .030 MAX
TOLERANCES
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS ± .005
ANGULAR DIMENSIONS ± 0°
NOTES UNLESS OTHERWISE SPECIFIED

1

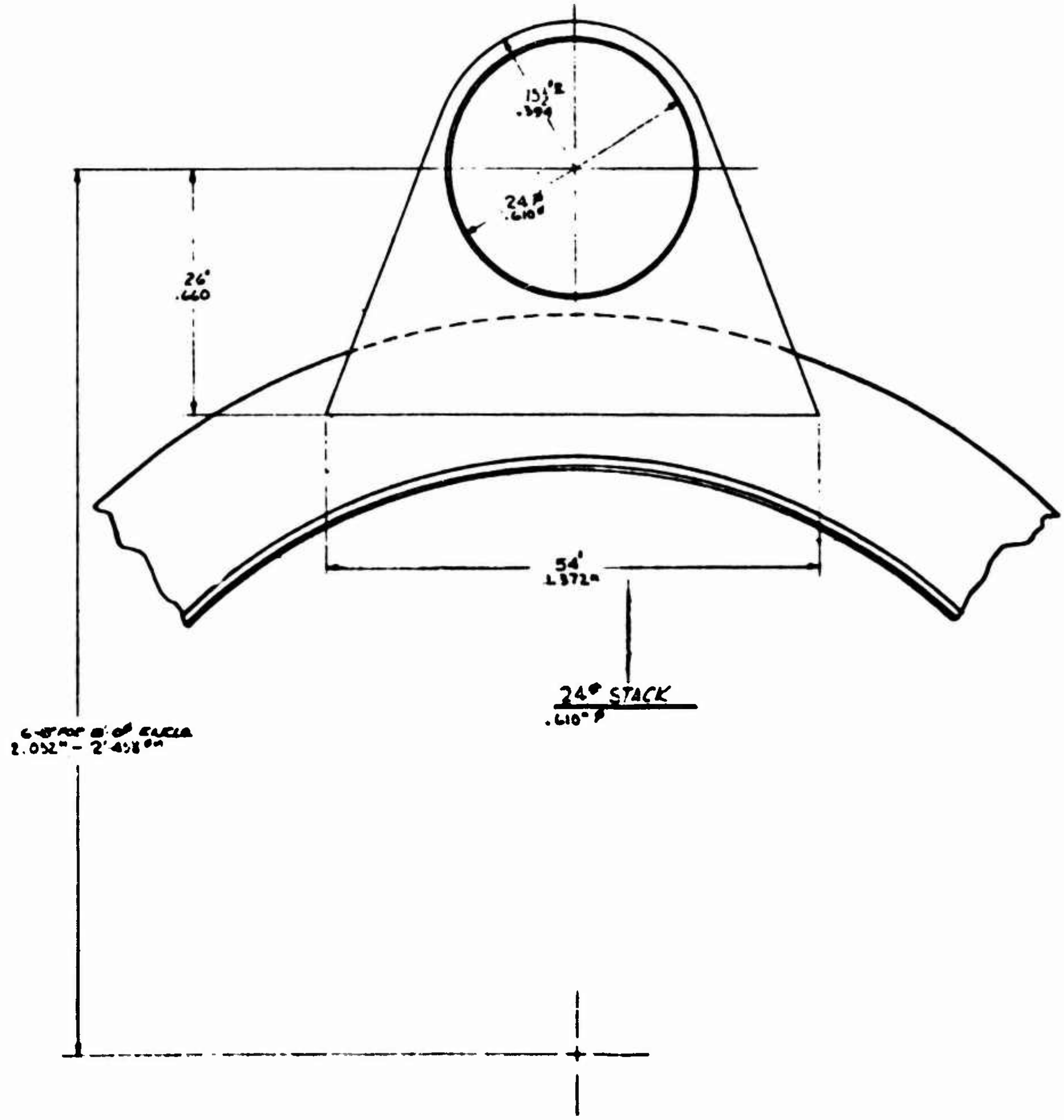
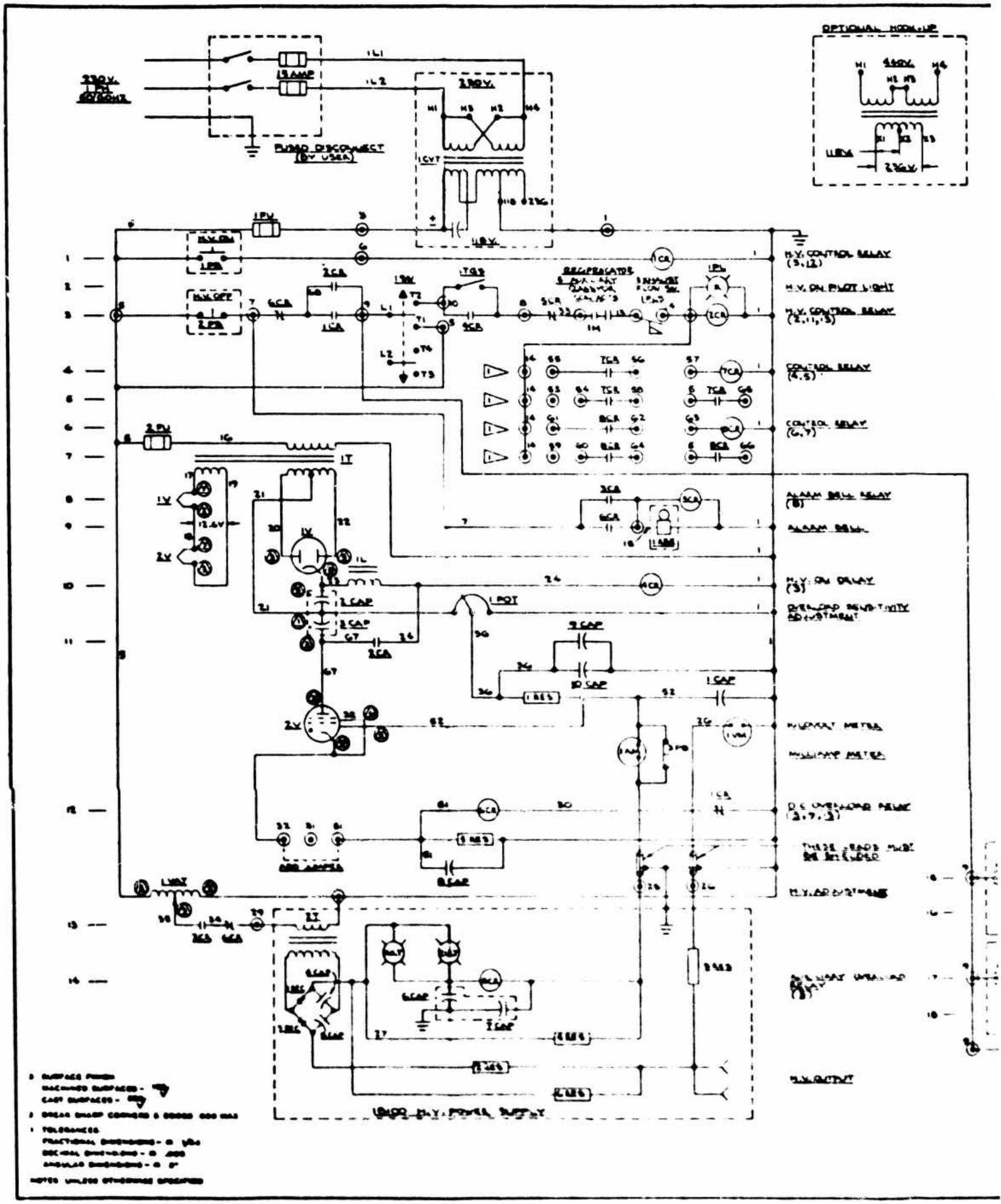


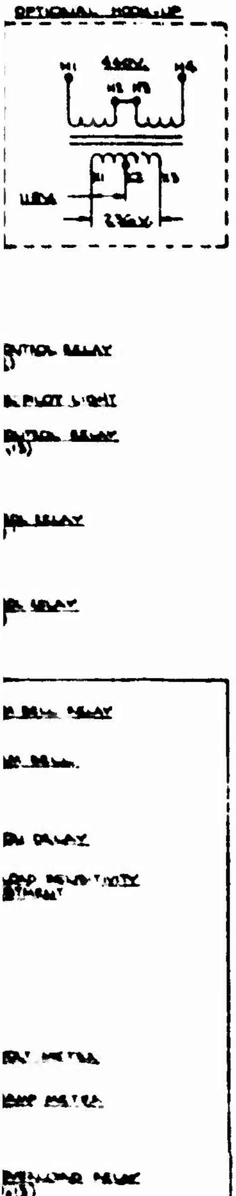
FIGURE 6-7

RANSBURG CORPORATION

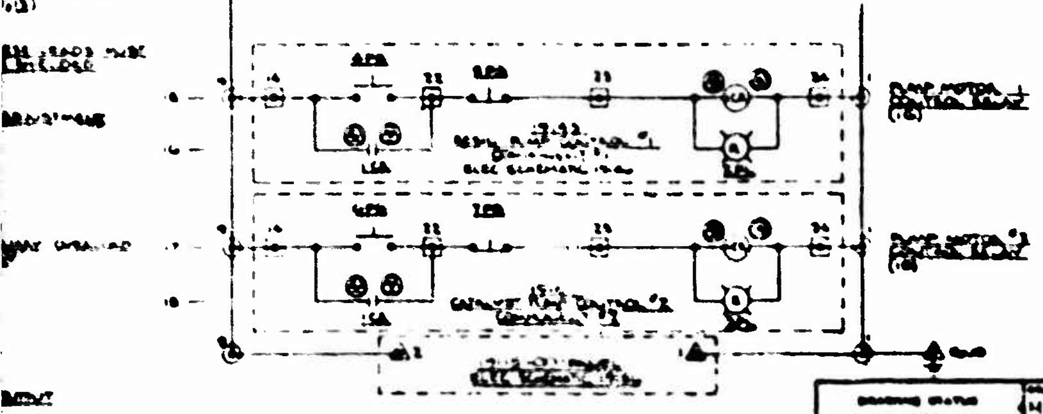
D-26091

2


OPTIONAL HOOK-UP
H1 440V. H4
H2 H3
X1 X2 X3
115V.
230V.
230V. 1PH. 60/50HZ
15AMP
1L1
1L2
FUSED DISCONNECT (BY USER)
230V.
H1 H3 H2 H4
1CVT
115V.
1FU
2FU
H.V. ON
1PB
H.V. OFF
2PB
2CR
1CR
5CR
6CR
1TGS
1SW
T1 T2 T3 T4
L1 L2
RECIPROCATOR 5 AMB. AMP. RESERVOIR SEALING
1M
1FL
1CR
2CR
7CR
8CR
3CR
6CR
1ABE
1T
12.6V
1V
2V
1L
1CAP
2CAP
3CAP
4CR
1POT
9 CAP
10 CAP
1 CAP
1RES
2V
1AM
1VM
1PB
5CR
2RES
8CAP
400 AMPERE
1VAT
1CR
H.V. CONTROL RELAY (3,12)
H.V. ON PILOT LIGHT
H.V. CONTROL RELAY (2,11,13)
CONTROL RELAY (4,5)
CONTROL RELAY (6,7)
ALARM BELL RELAY (8)
ALARM BELL
H.V. ON DELAY (3)
OVERLOAD SENSITIVITY ADJUSTMENT
KILOVOLT METER
MILLIAMP METER
D.C. OVERLOAD RELAY (3,7,3)
THESE LEADS MUST BE SHIELDED
H.V. ADJUSTMENT
KILOVOLT OVERLOAD RELAY (3)
H.V. OUTPUT
2T
3RES
4RES
5RES
6RES
6CAP
7CAP
8CAP
1REC
2REC
8CR
18KV H.V. POWER SUPPLY
3 SURFACE FINISH
MACHINED SURFACES -
CAST SURFACES -
2 BREAK SHARP CORNERS & EDGES .005 MAX
1 TOLERANCES
FRACTIONAL DIMENSIONS - ± 1/64
DECIMAL DIMENSIONS - ± .005
ANGULAR DIMENSIONS - ± 2°
NOTES UNLESS OTHERWISE SPECIFIED



SYMBOL	DESCRIPTION	RANSBURG PART NO.
1CVT	CONSTANT VOLTAGE TRANSFORMER, 60 HZ	13910-00
1VAT	VARIABLE AUTO - TRANSFORMER	3793
1T	TRANSFORMER	8181
2T	H.V. TRANSFORMER ASSY.	10030
1L	FILTER CHOKE	10701
1FU	FUSE, 4 AMP	3900-4
2FU	FUSE, 2 AMP	9079-4
2CVT	CONSTANT VOLTAGE TRANSFORMER, 50 HZ	10344-02
1SW	SWITCH - LEVER ACTION	67207-00
1CR, 3CR	CONTROL RELAY	3701
2CR, 7CR, 8CR	CONTROL RELAY	3740
4CR	CONTROL RELAY	3703
5CR	CONTROL RELAY	3606
6CR	CONTROL RELAY	3742
1TAS	SWITCH, OVERLOAD BY-PASS	3763
1PL	PILOT LIGHT	9307-0
1NLT, 2NLT	LIGHT, NEON	3003
1V	ELECTRONIC TUBE 6 X 5	3790
2V	ELECTRONIC TUBE 2050	3093
1POT	POTENTIOMETER, 5K	10211
1CAP	CAPACITOR, 1.0 MFD	5103
2CAP, 3CAP	CAPACITOR, 20 MFD	3425
4CAP, 5CAP	CAPACITOR ASSY (CONTAINS 2 4033 CAP.)	——
6CAP, 7CAP	CAPACITOR, .25 MFD	3401
8CAP, 9CAP, 10CAP	CAPACITOR, .5 MFD	10190
1REC, 2REC	RECTIFIER ASSY (CONTAINS 32 5666 RECT)	10010
1RES	RESISTOR, 51K	3730-4
2RES	RESISTOR, 5M	3077
3RES	RESISTOR, 1500M	3076
4RES	RESISTOR, 20K	10033
5RES	RESISTOR, 470K	3730-5
6RES	RESISTOR, 600M	10031
1ABE	BELL	3427
1AM	MILLIAMMETER, 0-3 MA	8004
1VM	K.V. METER, 0-150 K.V.	3207
3PB	PUSHBUTTON	8273
1PB, 2PB	PUSHBUTTON, H.V. ON-OFF PUSHBUTTON, [illegible] CAP [illegible] OR	3150 8604
4PB, 5PB, 2PL 6PB, 7PB, 3PL	PUSHBUTTON SWITCH W/PILOT LIGHT	3110-01



6. ▲ TERMINALS IN 19415 CONTROL PANEL
5. ⊡ TERMINALS IN 10103 PUMP CONTROLLER
4. △ INDICATES PIN NUMBER ON PLUG-IN COMPONENTS.
3. ◎ INDICATES TERMINALS & WIRE NUMBER ON 17309 CONTROL PANEL.
2. LAST WIRE NUMBER USED -60
▷ DELAYS IN PANEL - NOT USED.

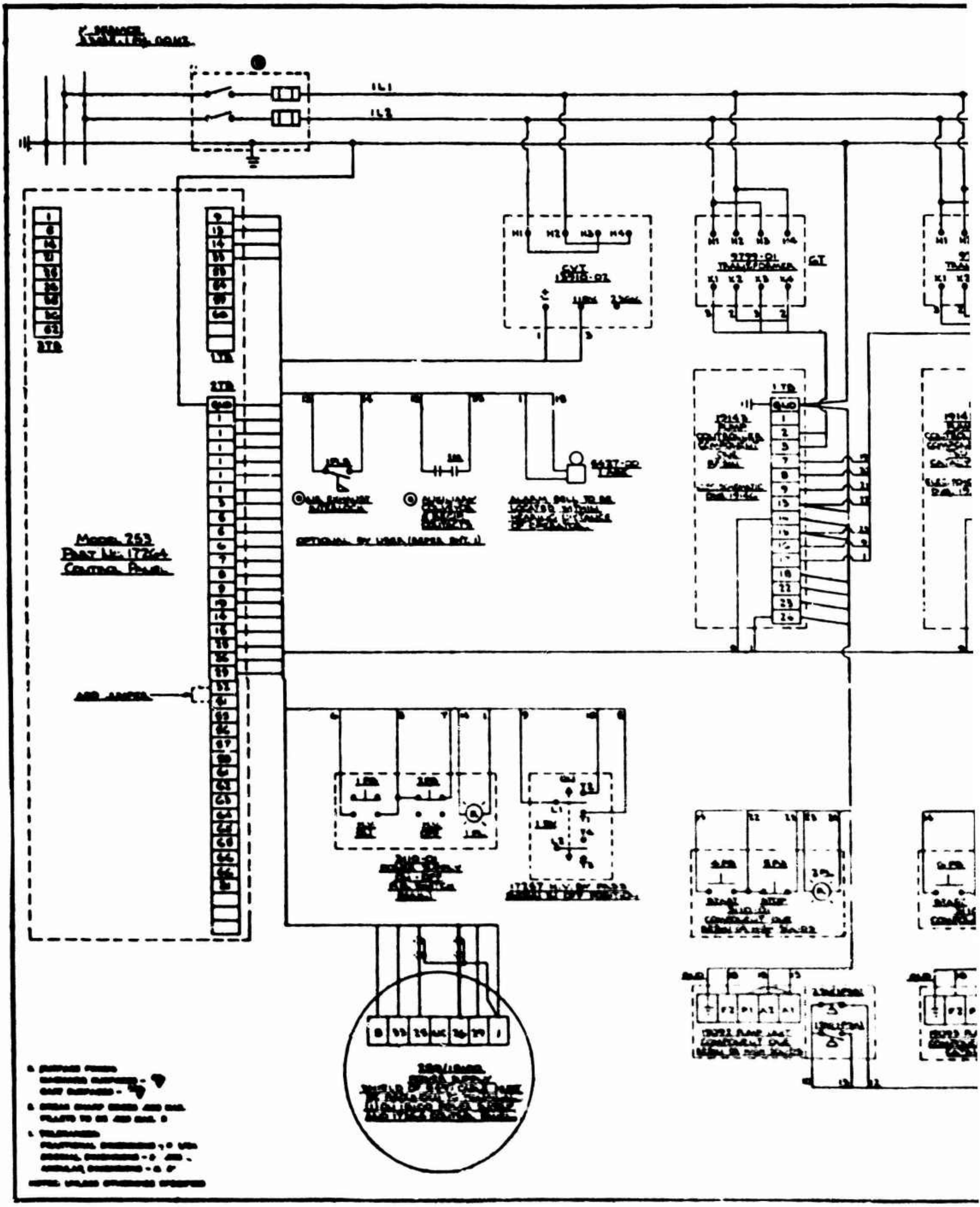
FIGURE G-8

DRAWING STATUS

RANSBURG CORPORATION
INDIANAPOLIS, IND.

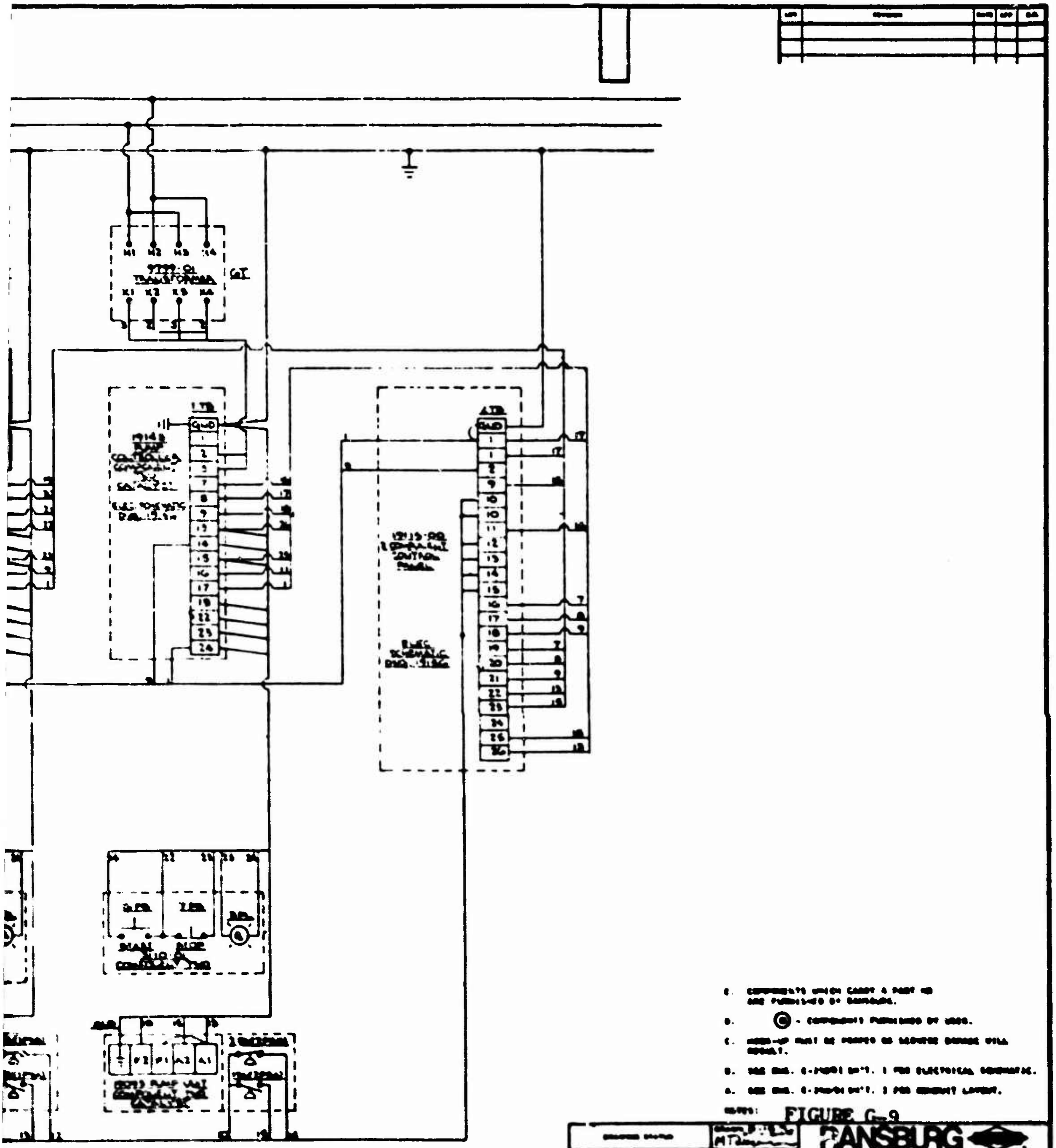
Uniroyal, Inc.

E-24091



1L1
1L2
H1 H2 H3 H4
CVT
X1 X2 X3 X4
TRANSFORMER
CT
3TB
1TB
2TB
GND
MODEL 253
PART NO. 17764
CONTROL PANEL

1



E. COMPONENTS WHICH CARRY A PART NO ARE FURNISHED BY RANSBURG.

D. ◎ - COMPONENTS FURNISHED BY USER.

C. [illegible]

B. SEE DWG. [illegible] SH'T. 1 FOR ELECTRICAL SCHEMATIC.

A. SEE DWG. [illegible] SH'T. 3 FOR CONDUIT LAYOUT.

NOTES:

FIGURE G-9

IMPORTANT

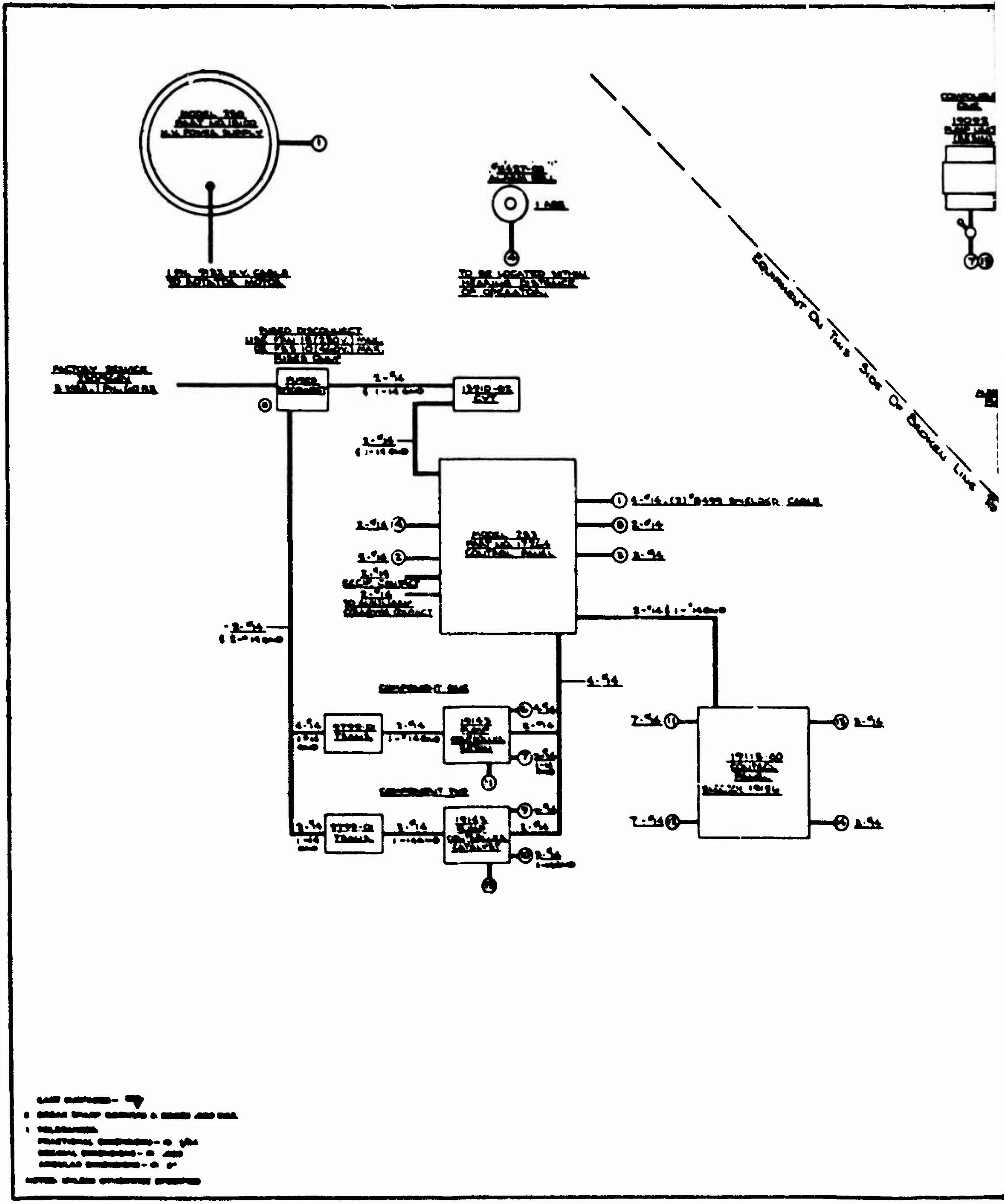
SEE [illegible] DRAWING NO. F 7200 FOR REFERENCE TO OSHA STANDARDS.

RANSBURG CORPORATION

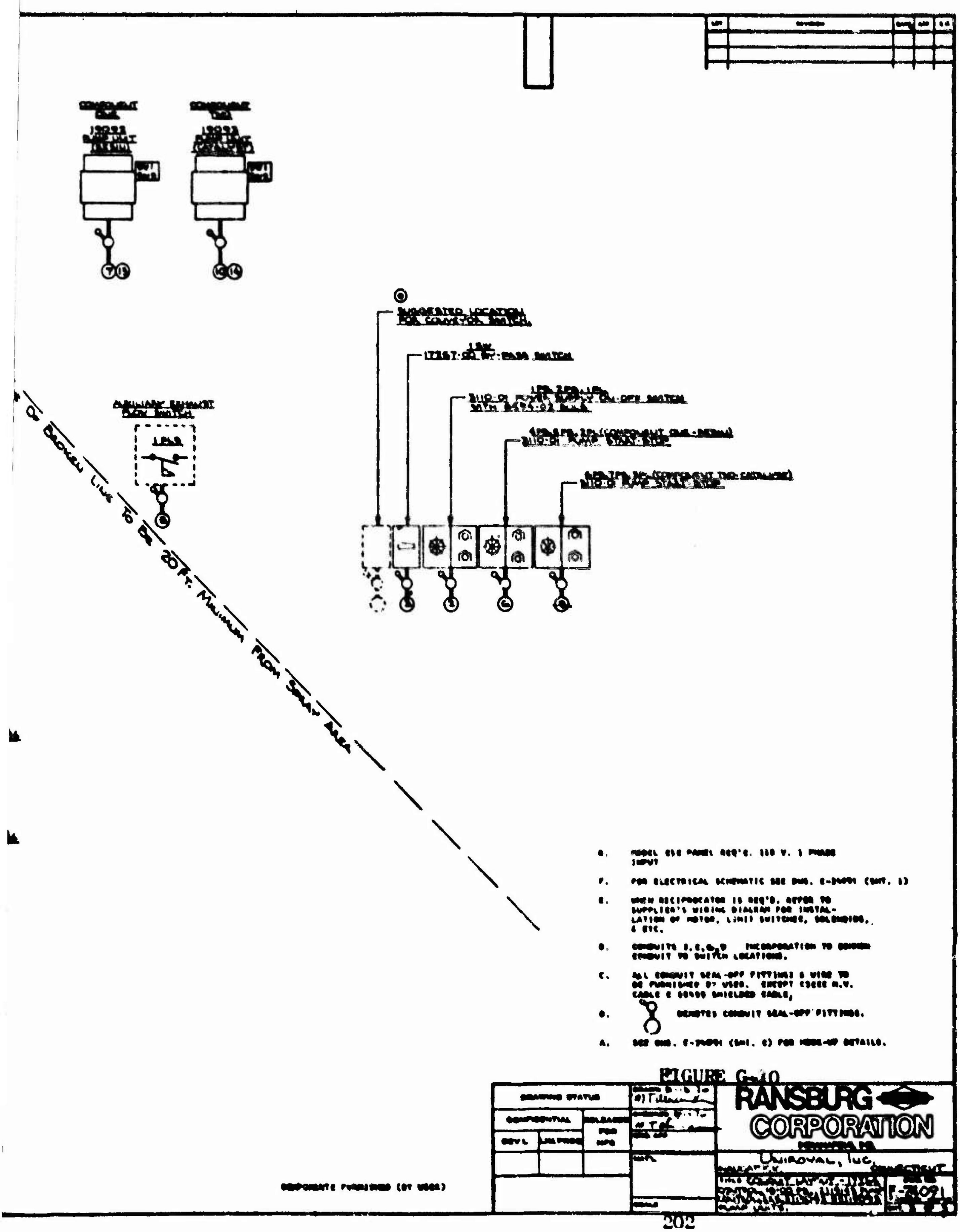
INDIANAPOLIS, IND.

UNIROYAL, INC.

E-24,071


EQUIPMENT ON THIS SIDE OF BACKWALL LINE
2-#14
13910-02
19115-00
19143
19143
19093
2-#14
4-#14
7-#14
7-#14
2-#14
2-#14

1



G. MODEL [illegible] PANEL REQ'S. 110 V. 1 PHASE INPUT

F. FOR ELECTRICAL SCHEMATIC SEE DWG. E-[illegible] (SHT. 1)

E. WHEN RECIPROCATOR IS REQ'D. REFER TO SUPPLIER'S WIRING DIAGRAM FOR INSTALLATION OF MOTOR, LIMIT SWITCHES, SOLENOIDS, & ETC.

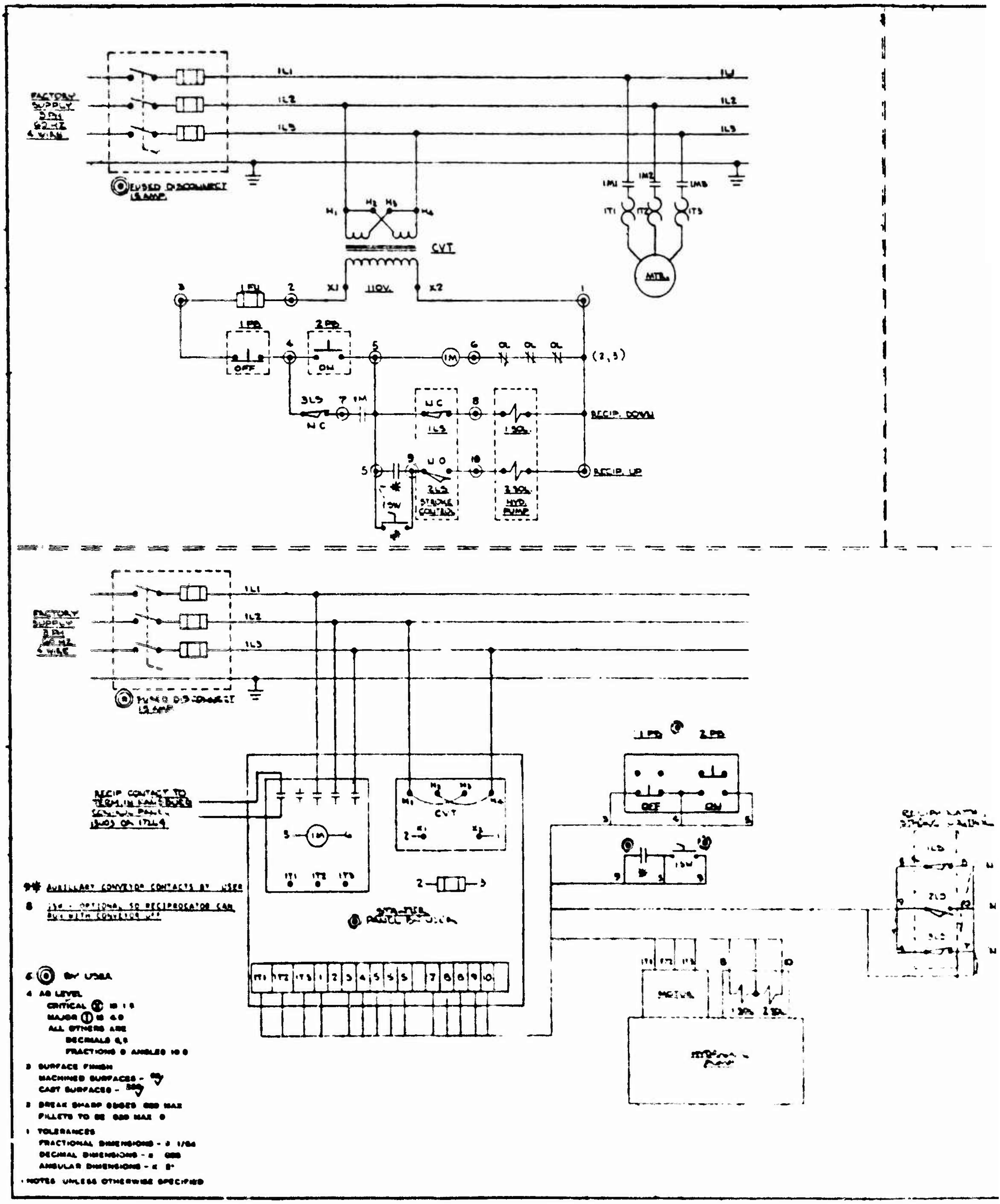
D. CONDUITS [illegible] INCORPORATION TO CONNECT CONDUIT TO SWITCH LOCATIONS.

C. ALL CONDUIT SEAL-OFF FITTINGS & WIRE TO BE FURNISHED BY USER. EXCEPT [illegible] H.V. CABLE & [illegible] SHIELDED CABLE,

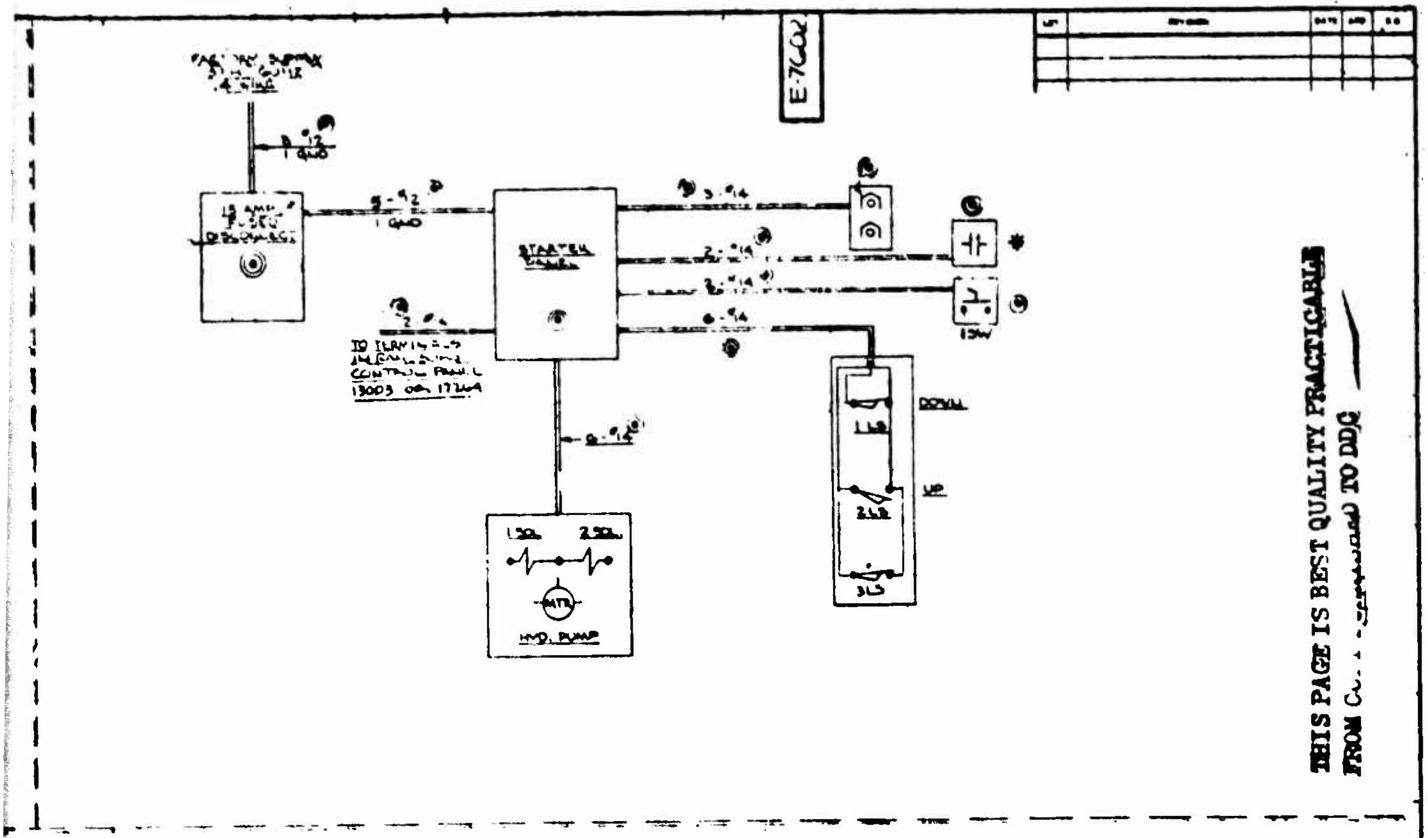
B. DENOTES CONDUIT SEAL-OFF FITTINGS.

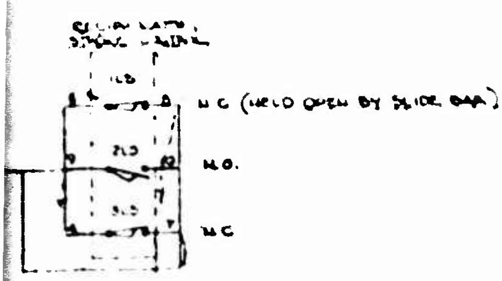
A. SEE DWG. E-[illegible] (SHT. 2) FOR HOOK-UP DETAILS.

FIGURE G-10


FACTORY SUPPLY 3 PH 60 HZ 4 WIRE
FUSED DISCONNECT 15 AMP
1L1
1L2
1L3
1M1
1M2
1M3
1T1
1T2
1T3
MTR.
H1
H2
H3
H4
CVT
X1
110V.
X2
1FU
1PB
OFF
2PB
ON
1M
OL
(2,3)
3LS
NC
1LS
1SOL
RECIP. DOWN
NO
2LS
STROKE CONTROL
2SOL
HYD. PUMP
RECIP. UP
1SW
RECIP CONTACT TO TERMINALS ON CONTROL PANEL
STA-TRIE PANEL
MOTOR
HYDRAULIC PUMP
9 ✱ AUXILLARY CONVEYOR CONTACTS BY USER
8 1SW - OPTIONAL, SO RECIPROCATOR CAN RUN WITH CONVEYOR OFF
6 ◎ BY USER
4 AQ LEVEL
CRITICAL IS 1.5
MAJOR IS 4.0
ALL OTHERS ARE
DECIMALS 6.5
FRACTIONS & ANGLES 10.0
3 SURFACE FINISH
MACHINED SURFACES -
CAST SURFACES -
2 BREAK SHARP EDGES .020 MAX
FILLETS TO BE .020 MAX
1 TOLERANCES
FRACTIONAL DIMENSIONS - ± 1/64
DECIMAL DIMENSIONS - ± .005
ANGULAR DIMENSIONS - ± 2°
NOTES UNLESS OTHERWISE SPECIFIED

1





NOTES

N.O. AUXILIARY STARTER CONTACT MUST BE INTERLOCKED WITH HIGH VOLTAGE ON-OFF. DE-ENERGIZING MOTOR STARTER TURNS OFF HIGH VOLTAGE TO DISK.

USED TO FURNISH (1PB) AND (1M) WITH (1) AUXILIARY N.O. CONTACT & CONTROL CIRCUIT TRANSFORMER WITH 100 WATT EXTRA CAPACITY AND FUSED SECONDARY. SELECT HEATERS DEPENDING ON PLANT VOLTAGE AND RECIPROCATOR HORSEPOWER AND CURRENT RATING. USE THE FOLLOWING ALLEN BRADLEY COMBINATION STARTERS OR EQUAL

208	VOLTS	712-BOH24	SPECIFY W/CONTROL TRANSFORMER
240	VOLTS	712-BOA24	SPECIFY W/CONTROL TRANSFORMER
480	VOLTS	712-BOB24	SPECIFY W/CONTROL TRANSFORMER
550	VOLTS	712-BOC24	SPECIFY W/CONTROL TRANSFORMER

TYPE RECIPROCATOR CONTROLS	OVERHEAD MOUNTED		PIT MOUNTED	
	SCHEMATIC SYMBOL	VICKERS MARKING	SCHEMATIC SYMBOL	VICKERS MARKING
EXPLOSION PROOF SOLENOIDS TO OPERATE VICKERS 4 WAY VALVE	1 SOL 2 SOL	A SOL B SOL	1 SOL 2 SOL	B SOL A SOL
VICKERS DOUBLE SOLENOID VALVE	1 SOL 2 SOL	B SOL A SOL	1 SOL 2 SOL	A SOL B SOL

MOTOR HORSE POWER	VOLTAGE	F. L. CURRENT
2	220	7.1 AMPS
2	440	3.5 AMPS
2	550	2.9 AMPS
3	220	10.5 AMPS
3	440	5.3 AMPS
3	550	4.0 AMPS
5	220	15.5 AMPS
5	440	7.75 AMPS

RANSBURG CORPORATION
INDIANAPOLIS, IND

FIGURE G-11

E-7602

203

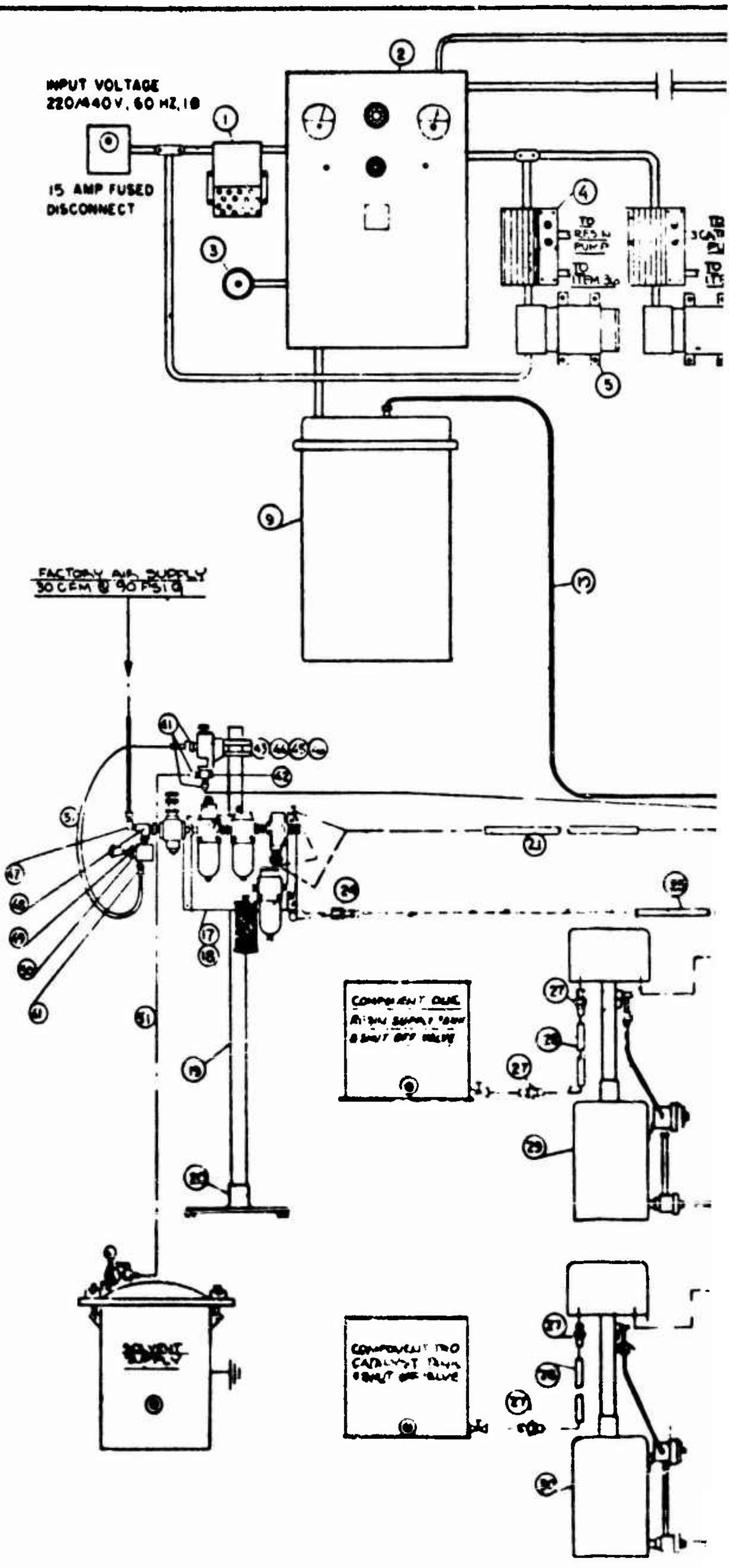
2

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	13910-02	CVT TRANSFORMER 220/440V to 118V. 500VA	1
2	17264	CONTROL PANEL	1
3	5427	ALARM BELL	1
4	19143	PUMP SPEED CONTROL	2
5	9799-01	STEP DOWN TRANSFORMER 220/440V to 120V, 500VA	2
6	19102-	MIXER MTG ASS'Y.	1
7	310-01	PUSH BUTTON STATION & PILOT LIGHT	3
8	17257	HIGH VOLTAGE BYPASS SWITCH	1
9	18100	POWER SUPPLY	1
10	9132	HIGH VOLTAGE CABLE	[illegible]
11	8115-6	1/4 NPT X 3/8 NPT	1
12	15855	AIR MOTOR	1
13	1547	FRONT COVER	1
14	7783-32C	MACH. SCR - HEX HD.	
15	16775	DISH DNFD ALUM DEEP WELL	1
16	17424-02	FEED TUBE ASS'Y	1
17	17423	AIR CONTROL PANEL	1
18	17348	MOUNTING BRACKET	2
19	17315-	POLE (-01, 48")(-02, 72")(-03, 108")	1
20	17346	BASE ASSY	1
21	9704-07	TUBING, 1/2 OD x 3/8 ID	[illegible]
22	7893-03	TUBE FITTING, 3/8 NPT x 1/2 TUBE	1
24	9495-05	SWIVEL HOSE FITTING	1
25	8477-10	EXHAUST HOSE	[illegible]
26	17276	BARB FITTING OR SEE ⊕ 25 A	1
27	10581-01	SWIVEL FITTING, 1/4 NPS x 1/2 TUBE	8
28	9704-06	TUBING, 1/2 O D X 17[illegible] I D	[illegible]
29	19092	PUMP - COMPONENT ONE (RESIN)	1
30	19093	PUMP - COMPONENT TWO (CATALYST)	1
31	8156-24F	5/16-24 UNF CAP SCREW	3
32	1613-03	SUPPORT INSULATOR	1
33	17274	CABLE CONNECTOR SINGLE	1
34	17439	CABLE CONNECTOR (DOUBLE) OPTIONAL	
35	1553-00	NIPPLE 1/4NPS x 1/8NPT	2
36	19-15-00	2 COMPONENT ELECTRICAL CONTROL PANEL	1
37			
38			
39			
40	9218-02	VALVE, FLUID, 1/8NPT	1
41	7892-03	FITTING 1/8NPT x 1/4HOSE	6
42	1625-11	PLUG 1/8NPT	1
43	9575-01	HANGER	2
44	8347-16C	SCREW 1/4-20 UNC	2
45	7734-06	FLAT WASHER 1/4"	2
46	7733-12	HEX NUT 1/4-20 UNC	2
47	4342-04	STREET "EL" 1/8NPT	1
48	6782-03	STREET "T" 1/8NPT	1
49	8115 05	REDUCING NIPPLE 1/4NPT x 1/8NPT	1
50	6769-01	VALVE, 3 WAY, MANUAL 1/8 NPT NC AIR PILOTED	1
51	9704-03	P.E. TUBING 1/4OD x .041 WALL	[illegible]

ELECTRICAL SCHEMATIC- C-24091; 19156, 19160

⊙ ITEMS SUPPLIED BY USER.

ITEMS 1-5 & 9 MUST BE LOCATED
20' MINIMUM FROM "SPRAYING AREA".



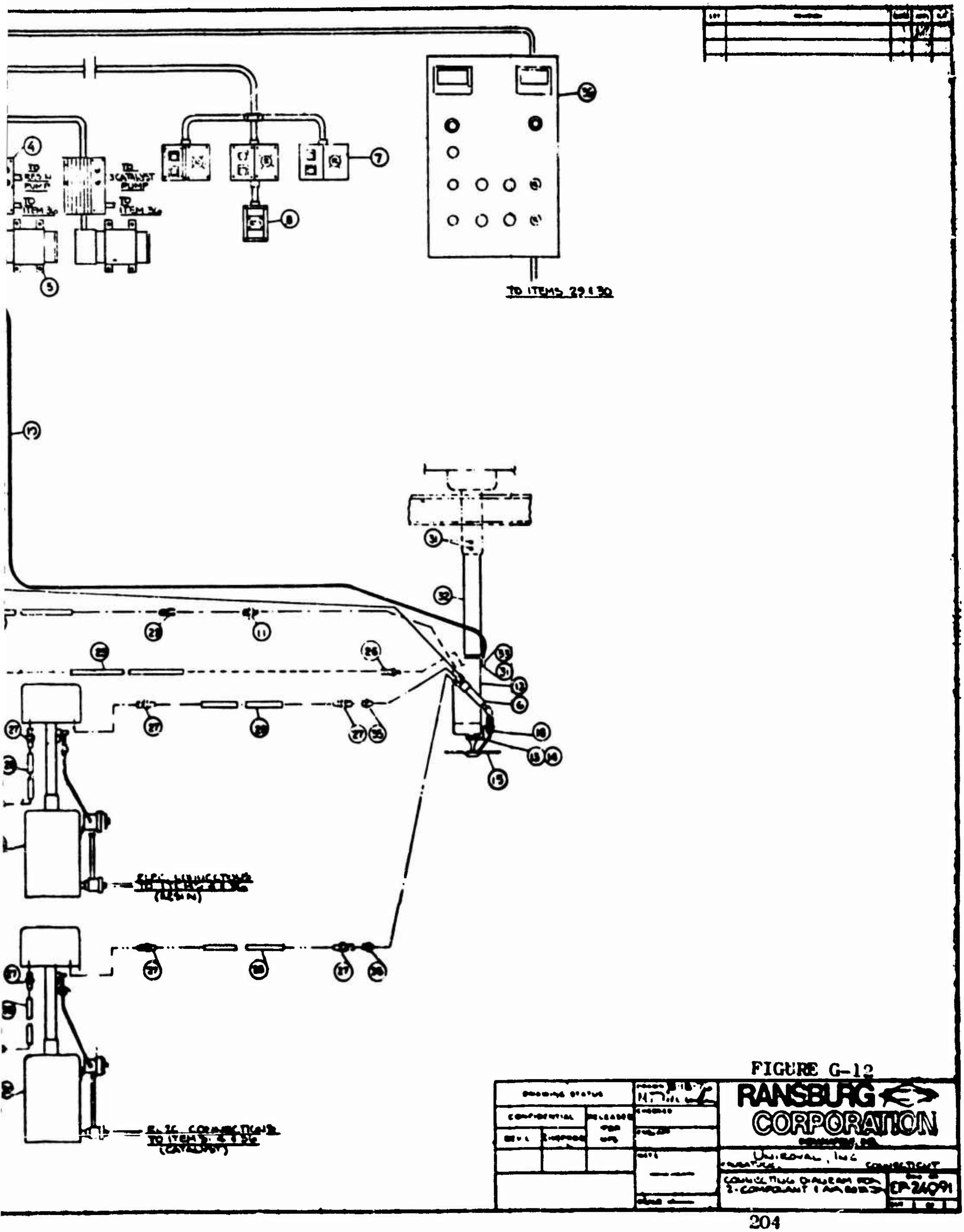
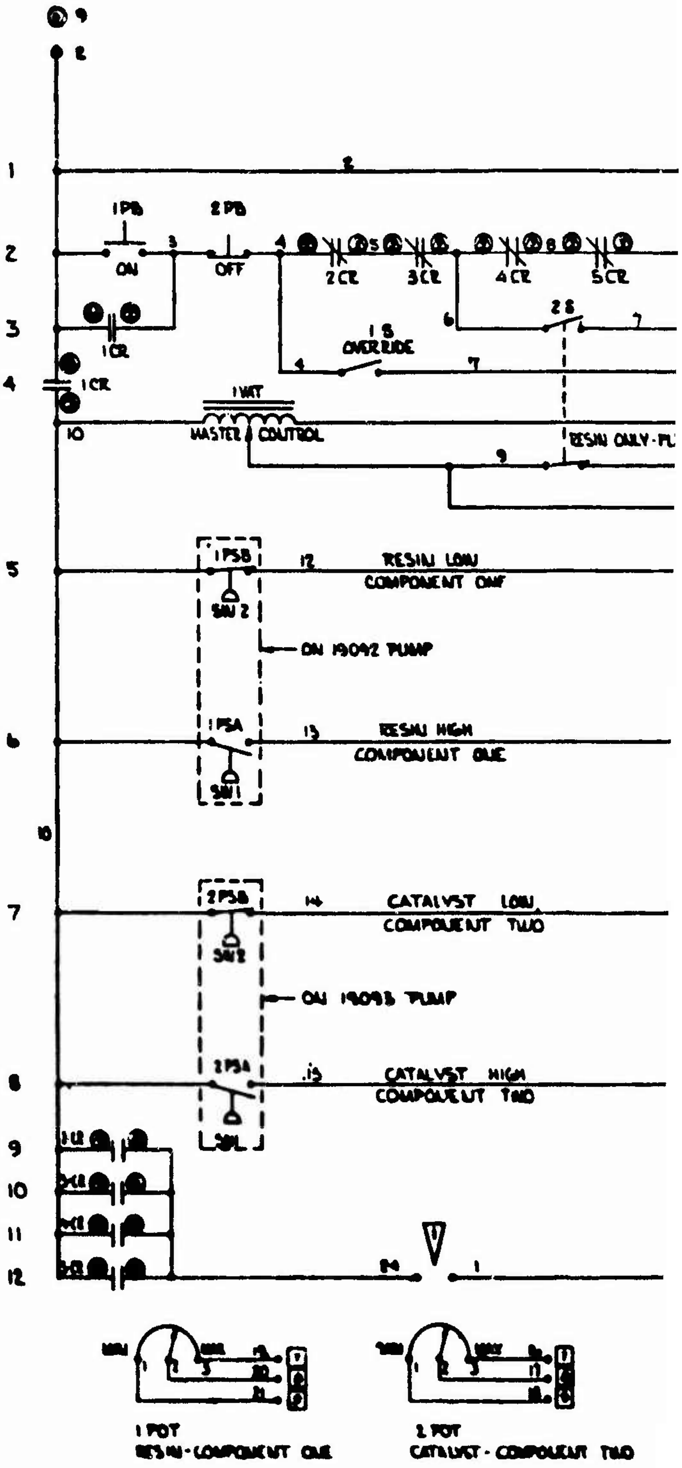

4
TO RESIN PUMP
TO ITEM 36
TO CATALYST PUMP
TO ITEM 36
5
7
8
36
TO ITEMS 29 & 30
17
31
32
27
11
33
26
31
12
6
27
28
27
35
18
13
14
15
27
38
ELEC. CONNECTIONS TO ITEMS 5 & 36 (RESIN)
27
28
27
36
ELEC. CONNECTIONS TO ITEMS 5 & 36 (CATALYST)
RANSBURG CORPORATION
UNIROYAL, INC
CONNECTING DIAGRAM FOR 2-COMPONENT
EP 24091

FIGURE G-12



◉	TERMINALS ON ITEM 4 CONTROL PANEL
○	PIN NO. ON PLUG-IN COMPONENTS
▣	TERMINALS ON [illegible] PUMP CONTROLLERS
▷	EXTERNAL LAMP OR BELL 75 VA MAX (BY USER)

4. [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
3. [illegible]
[illegible]
[illegible]
2. [illegible]
[illegible]
1. [illegible]
[illegible]
[illegible]
[illegible]
[illegible]

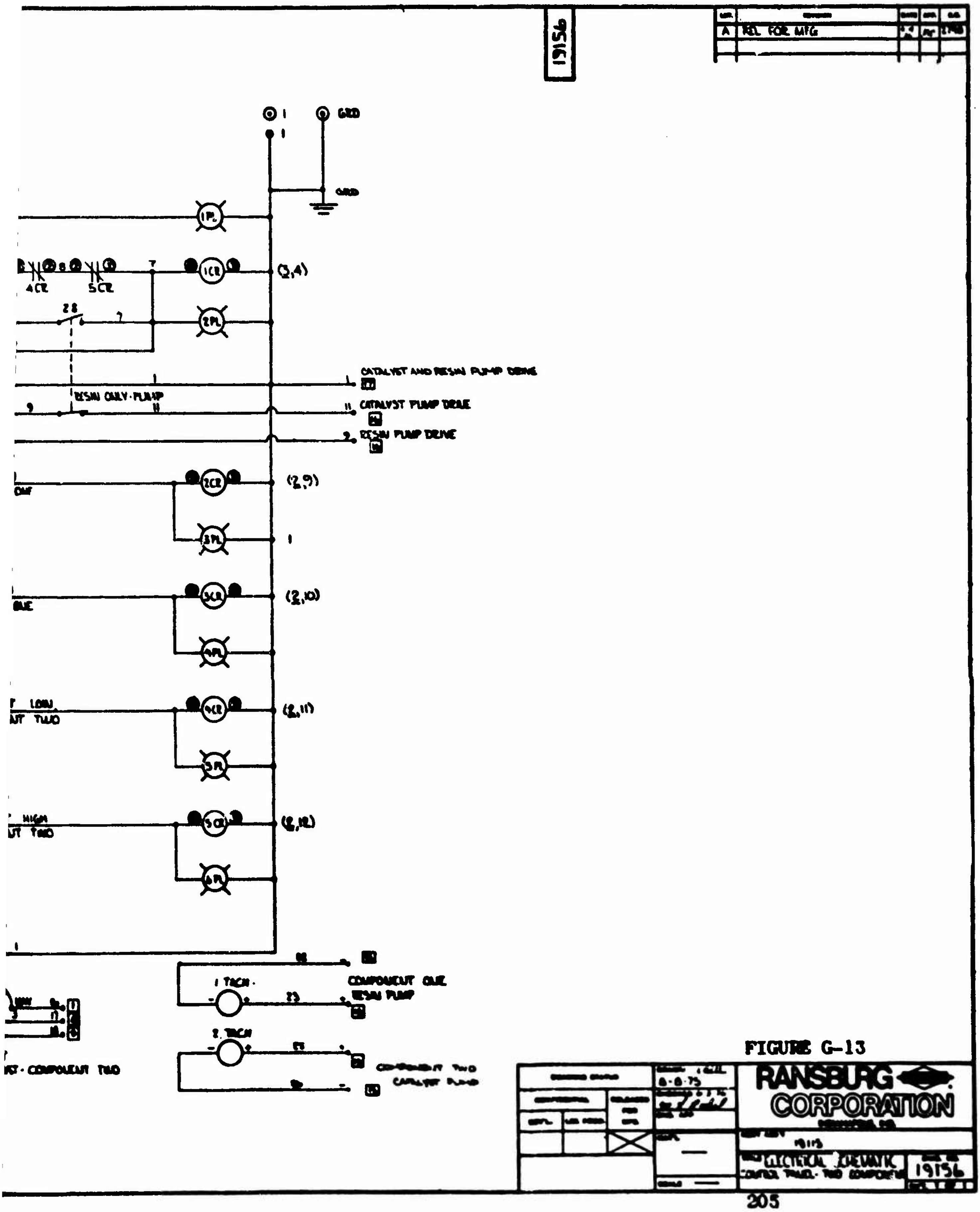
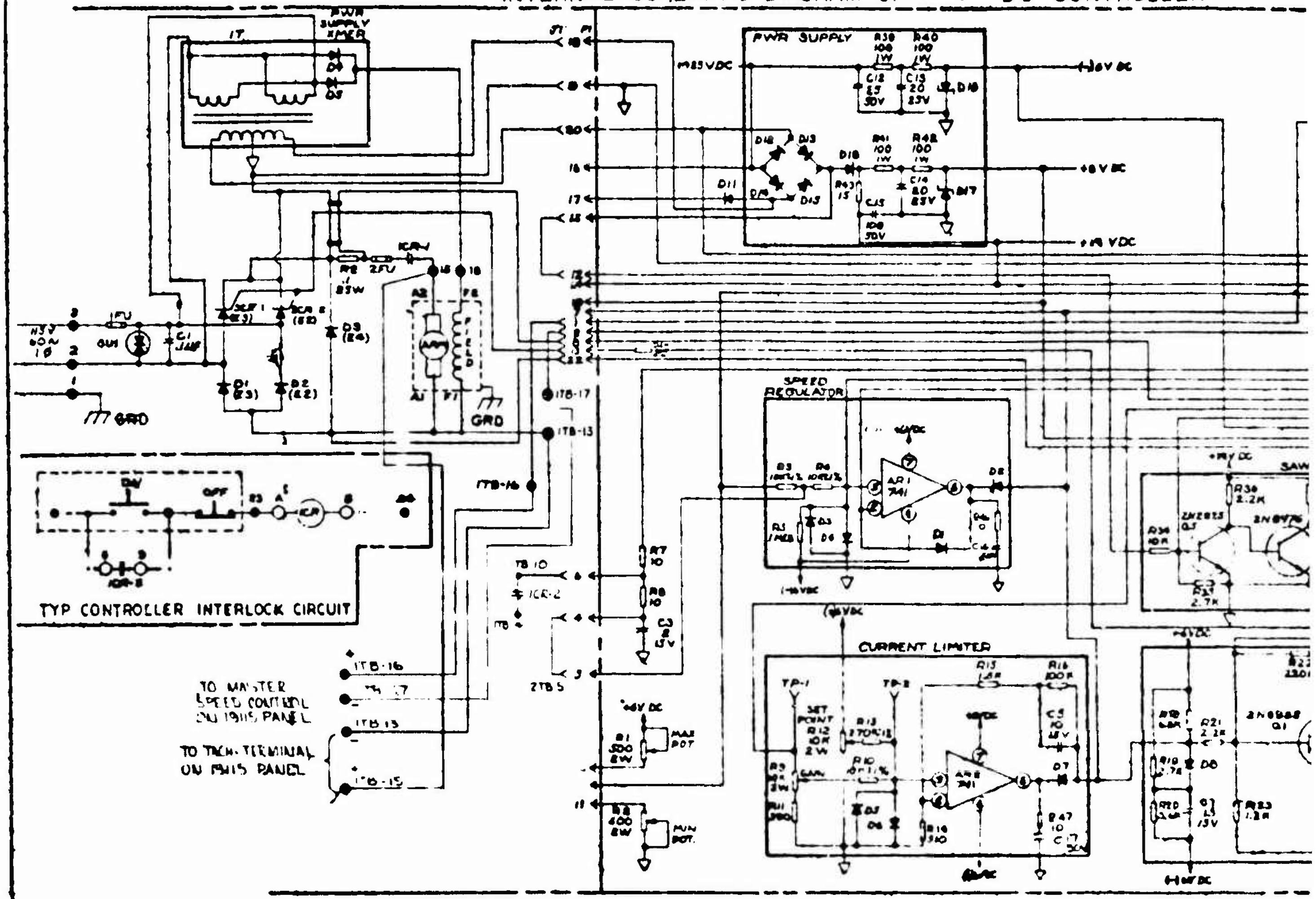
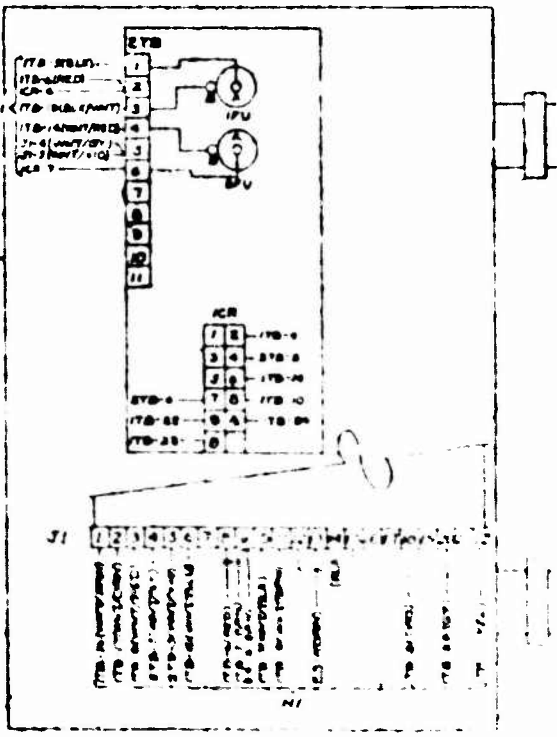

19156
A REL FOR MFG
1
GRD
1
GRD
1PL
4CR
5CR
1CR
(3,4)
28
7
2PL
CATALYST AND RESIN PUMP DRIVE
RESIN ONLY-PUMP
9
11
CATALYST PUMP DRIVE
RESIN PUMP DRIVE
2CR
(2,9)
3PL
1
3CR
(2,10)
4PL
LOW
TWO
4CR
(2,11)
5PL
HIGH
TWO
5CR
(2,12)
6PL
1 TACH
23
COMPONENT ONE
RESIN PUMP
2 TACH
COMPONENT TWO
CATALYST PUMP
COMPONENT TWO
8-8-75
RANSBURG
CORPORATION
19113
ELECTRICAL SCHEMATIC
CONTROL PANEL - TWO COMPONENT
19156

FIGURE G-13

2

INTERNAL SCHEMATIC DIAGRAM OF [illegible] DC CONTROLLER





INTERNAL WIRING DIAGRAM OF [illegible] DC CONTROLLER

▲ EQUIPMENT ENCLOSED IN DOTTED(-----) LINES IS LOCATED REMOTE FROM THE DC CONTROLLER

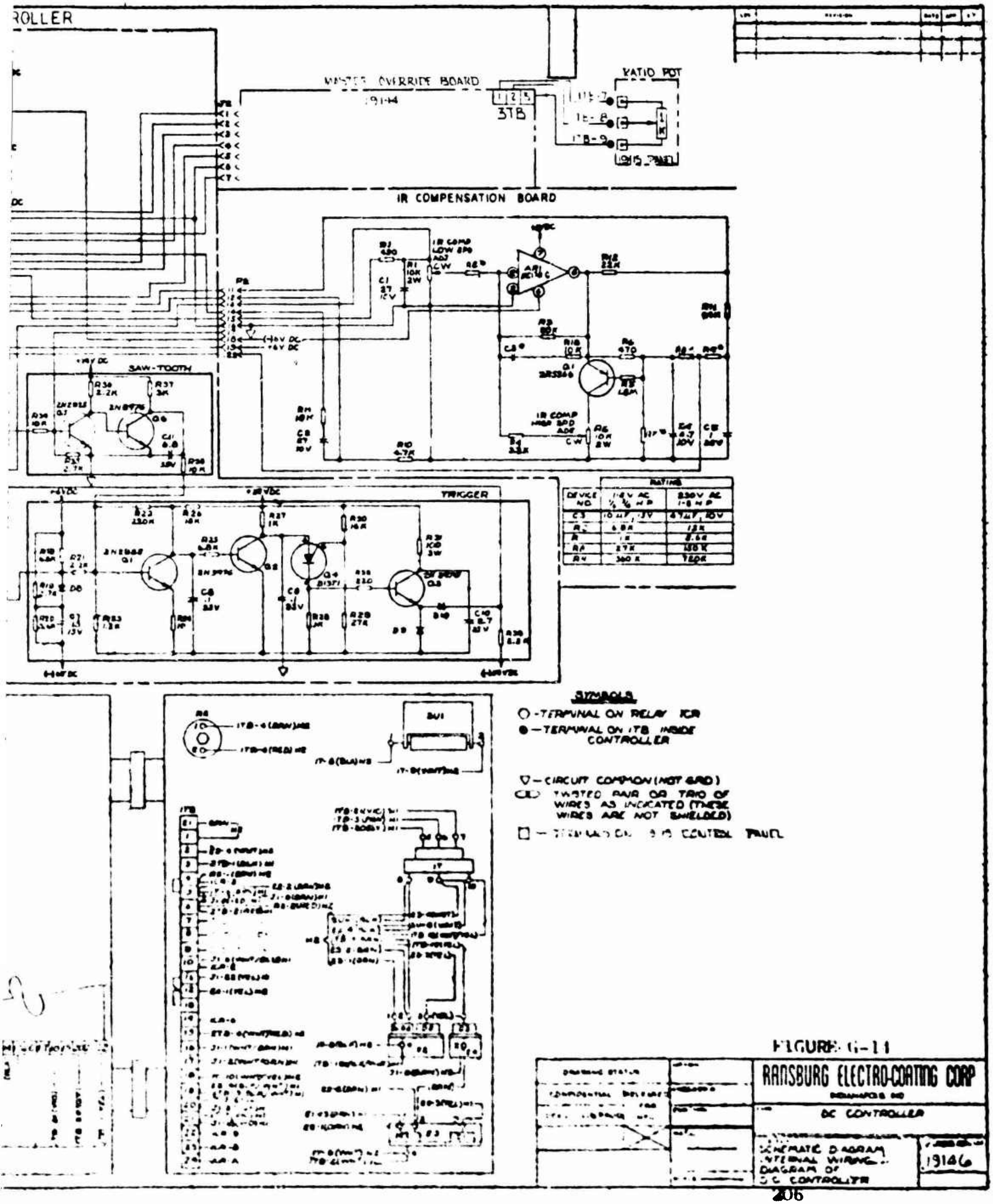
3. RATINGS FOR DEVICES INDICATED BY ● ARE SHOWN BY RATING TABLE

4. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTOR VALUES ARE IN OHMS ±5% ½W
   ALL CAPACITORS ARE IN MICROFARADS

5. SURFACE FINISH
   MACHINED SURFACES - ✓
   CAST SURFACES - ✓

6. BREAK SHARP CORNERS & EDGES [illegible]
   TOLERANCES
   FRACTIONAL DIMENSIONS - [illegible]
   DECIMAL DIMENSIONS - [illegible]
   ANGULAR DIMENSIONS - [illegible]

NOTES UNLESS OTHERWISE SPECIFIED



DEVICE NO	RATINGS 1-8V AC ⅛ ⅛ HP	230V AC 1-8 HP
C3	10 µF, 15V	47µF, 20V
R?	6.8K	12K
R	1K	5.6K
RP	27K	150K
R4	360 K	720K

SYMBOLS

○ -TERMINAL ON RELAY 1CR

● —TERMINAL ON 1TB INSIDE CONTROLLER

▽ — CIRCUIT COMMON (NOT GRD)

⊂⊃ TWISTED PAIR OR TRIO OF WIRES AS INDICATED (THESE WIRES ARE NOT SHIELDED)

☐ — TERMINALS ON 1315 CONTROL PANEL

FIGURE G-11

RANSBURG ELECTRO-COATING CORP

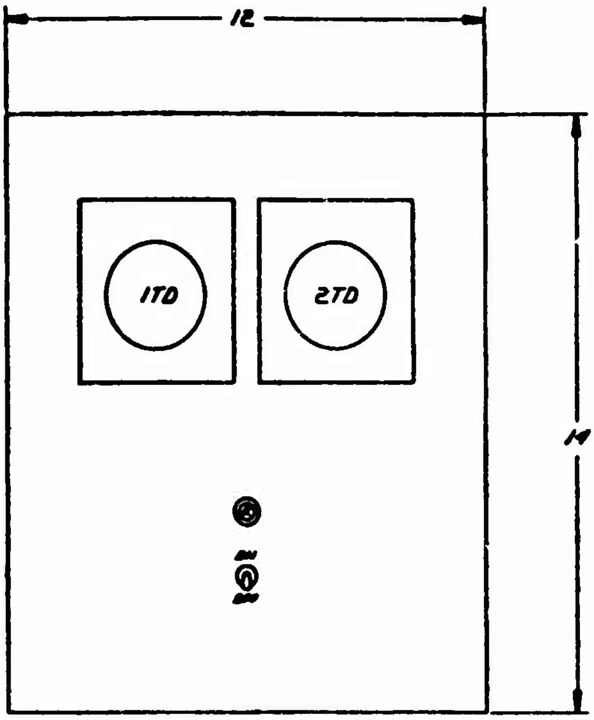
INDIANAPOLIS IND

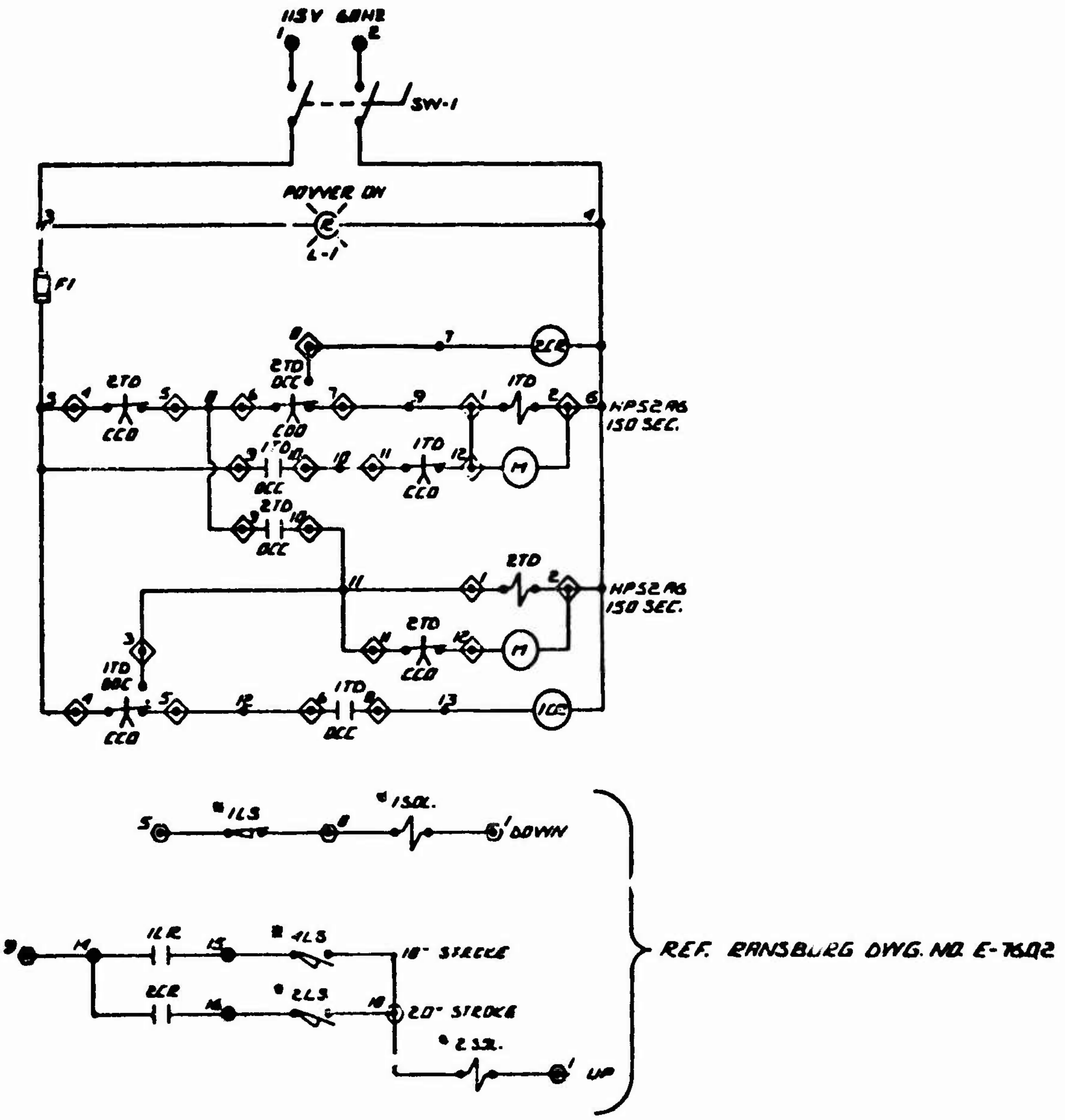
DC CONTROLLER

SCHEMATIC DIAGRAM INTERNAL WIRING DIAGRAM OF DC CONTROLLER

19146

2


12
14
1TD
2TD



● RANSBURG TERM.

● EDON TERM.

• SUPPLIED BY RANSBURG

FIGURE G-15

2	1,2TD	EAGLE TIMER HPS2R6 150 sec
2	1,2CR	LIBERTY 630 A13 115VAC
1	L-1	SBI-713A-95WRN NEON LAMP
1	F1	BAF1 1AMP FUSE
1	SW-1	C-H 7560-K5 SWITCH
AMT.	DET	PART NO. & DESCRIPTION

VARIABLE STROKE TIMER BOX
FOR EDON MODEL RBT44

RANSBURG-[illegible]
E.NY
3-14-77
RBT44
1 of 1

EDON INDUSTRIAL PRODUCTS CO.
TROY, MICHIGAN

APPENDIX "H"

CONTINUATION SHEET

REF. NO. OF DOC. BEING CONT'D.

PAGE 1 OF 2

NAME OF OFFEROR OR CONTRACTOR

ITEM NO.	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT

ATTACHMENT 2

Water Pick-up and Measurement Determinations

1. Prior to initiation of testing as specified in Tables I and II, the Contractor shall conduct the following tests on the retained prototype pairs of boots:

(a) Water pick-up - Entire boot (with collar removed) immersed for 16 hours at Room Temperature - not more than 5.0% increase in weight.

(b) Split boot into 2 parts along mold-line and obtain boot dimensions and thicknesses.

(c) Measurements for size determination:

1. Upper - After the boot is cut into two parts along the mold lines, refit the sections around the last to insure that the cut edges meet each other and the proper size dimensions have been achieved.

2. Outsole - Cut out the outsole from the boot and use the last bottom pattern as a measurement device to insure that the proper size dimensions have been achieved.

(d) Thickness Measurements - A description of the points at which the thickness measurements are to be made are as follows:

1. Upper Section:

a. Measurement points 1, 2, 3, 4, 5 and 6 are all located at the top edge of the boot. Points 1 and 2 are located on each side of the front mold parting line. Points 3 and 4 are located on each side of the rear mold parting line. Points 5 and 6 are located on each side midway between the front and rear mold parting line.

b. Measurement points 7, 8, 9, 10, 11, 12 are exactly in the same position relative to the mold parting lines as those in the paragraph above except that they are all located on a line parallel to the top edge of the boot and 6 inches down from the top edge of the boot.

c. Measurement points 13 and 14 are located on each side of the rear mold parting line approximately 8½ inches down from the top edge of the boot.

d. Measurement points 15 and 16 are located 5 inches from the bottom of the outsole measured from the front of the toe along each side of the mold parting line.

	CONTINUATION SHEET	REF. NO. OF DOC. BEING CONT'D.	PAGE	OF
		[illegible]	2	2

NAME OF OFFEROR OR CONTRACTOR

ITEM NO.	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT

ATTACHMENT 2 (continued)

e. Measurement points 17 and 18 are 2 inches above the bottom of the arch at the point where the sole lugging begins.

f. Measurement points 19 and 20 are located 3 inches from the bottom of the outsole measured from toe on each side of the front mold parting line.

g. Measurement points 21 and 22 are located 2 inches above the bottom of the outsole and 3½ inches back from each side of the front mold parting line.

2. Measurement Point Thicknesses

Point Number	Insulation Thickness Range - Inches
1, 2, 3, 4, 5, 6	.100 - .200
7, 8, 9, 10	.500 - .700
11, 12	.400 - .600
13, 14	.500 - .700
15, 16	.600 - .800
17, 18	.700 - .900
19, 20	.700 - .900
21, 22	.700 - .900

3. Outsole - Cut the outsole into two parts in the length direction along the center line of the outsole. The following measurements are to be made one inch in from each side of the center line:

Location	Insulation Thickness Range - Inches
Heel (includes cleat)	1.750 - 1.850
Ball (includes cleat)	1.000 - 1.100
Arch (does not include cleat)	0.750 - 0.850
Cleat	0.200 - 0.300

2. A pair of standard calipers shall be used to determine the actual thickness.