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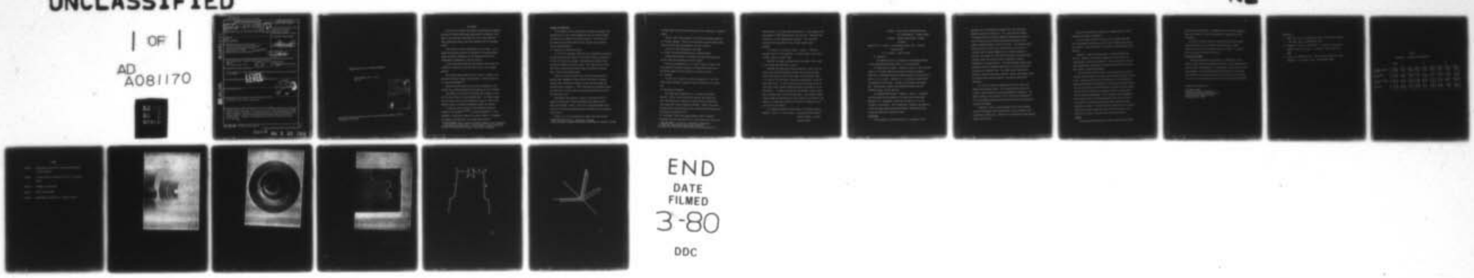

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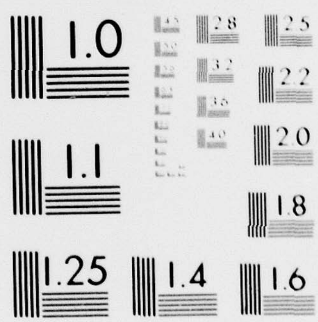

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Three commercial die spacer materials were evaluated. A die spacer material should provide even smooth coats, should be resistant to abrasion and heat, and should obliterate minor surface defects. None of the tested materials were able to fulfill all criteria well. Drawbacks of the materials and the die spacer techniques were covered.

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CHARACTERISTICS OF DIE SPACER MATERIALS

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DIE SPACER

The use of die spacer techniques to encourage more complete seating of castings has become more generally acceptable since work in the field has shown that full cast crowns made with these techniques tend to seat more completely on the specimen teeth.[1]

The reason for their effectiveness are not known. A die spacer may decrease positive discrepancies in the wax pattern caused by minute roughnesses in the preparation which are subsequently transferred to the die casting.

It may round sharp internal and external angles which are difficult to maintain in the die and to cast in an accurate pattern.

Die spacers may provide room for a layer of cement at the walls and occlusal tooth-casting boundary, a necessary factor in casting retentions.[2,3]

They may provide room for the positive roughness in the surface of a casting produced by the porosity of the investment.

The effects of the use of die spacer may encompass one or all of these effects in varying proportions. The exact reasons for the success are not truly important except as factors that should be kept in mind when evaluating various die spacers.

A study was done to compare three different brands of commercial die spacers[I,II,III] in various parameters: 1) film thickness in successive layers, 2) surface texture, 3) toughness, 4) residue in wax patterns, 4) residue after burnout.

I Die & Cement Spacer, California Dental Products, Brea, California
II Die Space Kit, Belle de St. Claire Products, Encino, California
III Tru-Fit, George Taub Products, Jersey City, New Jersey

Methods and Materials

A die (figure 1) was fabricated to simulate the contour and proportions of a full crown preparation with an occlusal groove to provide sharp angles for testing purposes. A silicone mold was made and successive multiple dies (figure 2) were poured from an improved stone.*

1) Thickness of Successive Layers

A set of five specimen stone dies were coated with thicknesses of two, three and four coats of each of the three test materials. A total of 45 dies were coated. Specimens were allowed to dry ten minutes between successive coats. Dies were placed on their base after coating preserving the same orientation to gravity that clinical dies would present.

After the final coat had dried, the dies were boxed with masking tape, imbedded in dental plaster and after a suitable setting time, sectioned to expose a cross section through the occlusal groove (figure 3). Final finishing of the ground surface was done with a scalpel blade to eliminate grinding slurry from the measuring field.

Measurements were made at 9 points (see figure 4) with a measuring microscope.$^{\Delta}$ Three measurements were made at each point and averaged. Points 1 and 9 were measured halfway up the axial wall and these measurements were combined into one category, "axial walls."

Points 2, 3, 6, 8 were made at an angle that bisected the

* Super Die, Whip Mix Co., Louisville, Kentucky
Δ Leitz Universal Toolmaker Microscope, Leitz-Wetzlar, Wetzlar, Germany

included angle (figure 5) and these points were combined as "external angles".

Points 4 and 5 were measured in the same method and combined as "internal angles." Point 7 was measured at a point midway along the top surface and was designated "occlusal surface."

A total of 1215 measurements were made.

2) Surface Texture and Obliteration of Surface Detail

Vacuum mixed portions of improved stone were poured against plastic slabs and allowed to set for 24 hours.

Areas were coated with 1, 2, 3, and 4 layers of each of the test materials and were inspected at 6X and 20X for ability to obliterate negative surface defects and surface texture.

3) Toughness

The point of a typical wax spatula weighted to 1 ounce was drawn across specimens prepared in the same manner as in section (2).

4) Resistance to Removal

Three dies were coated with 2, 3, 4 coats of each test material. After a ten minute drying period, the coated dies were lubricated with a typical wax lubricant[*] and coated with ivory inlay wax[*] using a dipping technique. After a ten minute cooling period, the wax patterns were removed and the interiors of the patterns inspected at 6X.

5) Investment[*] slabs were poured against plastic sheeting. Selected areas were coated with 2, 3, and 4 layers of each of the

* Ney Die-Lube, T. M. Ney Co., Bloomfield, Connecticut

** Ivory Wax, Sybron/Kern, Emeryville, California

*** Beauty Cast Inlay Investment, Whip Mix Corp, Louisville, KY test materials. The slabs were then placed in a cool burnout oven and brought to 1100^{o} and kept there for one hour. They were then allowed to cool and subsequently inspected. The slabs were sectioned for measurement of the residual spacer layers.

Results

1) Thickness of successive layers - Table 1 - shows the average values for the categories: external angles, axial walls, internal angles, occlusal floor.

Material III shows a greater overall thickness at all coats at all points than materials I and II.

Although the differences between materials I and II are not significant and the differences between the 3rd and 4th coats within each material could not be shown to be different, there is a trend for the thickness, after four applications, to be less than after three. It may be inferred that the wiping action of the solvent laden liquid actually decreases the thickness of the die spacers. It should be noted that the external angles always had a thickness much less than other points. The internal angles always showed an accumulation of spacer material particularly with material III where the accumulation created a thickness of more than 1/4 of a millimeter.

2) Surface texture and obliteration of underlying defects.

Material I and II - 1 and 2 layers - underlying surface defects clearly visible - surface texture smooth.

3 layers - most defects obliterated except for large defects - surface smooth.

4 layers - defects obliterated - surface irregular.

Material III - 1 layer - no underlying defects seen - surface texture rough.

2, 3, 4 layers - same as above.

3) Toughness

All materials and all thicknesses were abraded through to the underlying stone die by the 1 oz. wax instrument.

4) Resistance to removal - Material I and II. Only isolated specks of die spacer material were noted inside wax patterns. There was no difference perceived between behaviors of dies coated with 2, 3, or 4 layers. Material III - residue was noted inside all patterns from all dies. Residue was noticeable with naked eye. No difference could be distinguished between dies with different layers of test material.

5) Residue after burnout - Material I and II - investment was discolored but no thickness of residue could be measured. Material III - substantial residue was visible for 2, 3, and 4 layers of die spacer. The irregularity, fragility, and porosity of the ash layer made accurate measurements impossible but the range of thickness was from 28 to 100 μ.

Discussion

If the theory of using die spacers is acceptable to the operator then the manipulative properties of the die spacer materials become of importance. It is seen from the results in section one that the spacer materials tested vary widely in their ability to coat dies and the coating thicknesses vary greatly between different areas of the dies. The external angles which are easily worn on dies, and which are often areas of concentration for minute bubbles on the internal surface of castings, are coated to a much lesser thickness than other areas. Internal angles are places for the accumulation of great thicknesses of spacer material. This buildup might destroy some desirable internal adaptation when there are grooves placed for resistance or retention form. The trend towards decrease in thickness after multiple coats implies a solvent and wiping action by the applicator and may suggest a nonvigorous application technique.

The trend for surface irregularity with four coats also implies some solvent action. This rippling may not be of any clinical significance but may provide mechanical retention. The pebbly surface of test material III is similar microscopically to a sand blasted surface and may provide some aids to mechanical retention of cement.

Materials I and II do not complete one of the designated tasks of die spacers, obliterating minor surface defects, until the third or fourth coat. Material III obliterates surface defects after just one coat.

None of these materials seem hard or tough enough to resist abrasion from dental instruments.

If a die spacer material can be easily dislodged from the die, incorporated into the wax pattern, and influence the form of the casting, it may actually be a deterrant to good seating of the casting.

Material I and II were not prone to being dislodged from the die. Material III, however, appeared to lose some of its rough surface to the hot wax pattern. This same material left an ashy residue after burnout thus yielding the possibility of some minor amount of gold contamination.

The real action of die spacers is not known but can only be inferred from the better seat that can be gotten with cast restorations. Implied functions are the reduction of surface defects which would produce irregularities in the casting internal surface and the creation of space between walls and angles of the casting and the tooth to allow for a contiguous layer of luting cement and to avoid the disturbance in fit caused by casting roughness. When using any one of the three commercial die spacers tested, the operator and technician should be aware that none of the materials are ideal. An ideal material should cover all surfaces with an even layer, should not pull off in wax patterns, and should be resistant to abrasion from dental instruments.

Summary

The manipulative properties of three commercially produced

die spacers were evaluated. Although they are not ideal materials, they are suitable for use if the operator is cognizant of their limitations.

An ideal die spacer material should flow easily and evenly, should form even coats, obliterate surface defects, and be adherent to the die and preceding coats of material. It should also be resistant to heat and abrasion.

MILITARY DISCLAIMER

Commercial materials and equipment are identified in this report to specify the investigative procedure. Such identification does not imply recommendation or endorsement, or that the materials and equipment are necessarily the best available for the purpose. Furthermore, the opinions expressed herein are those of the author and are not to be construed as those of the Army Medical Department.

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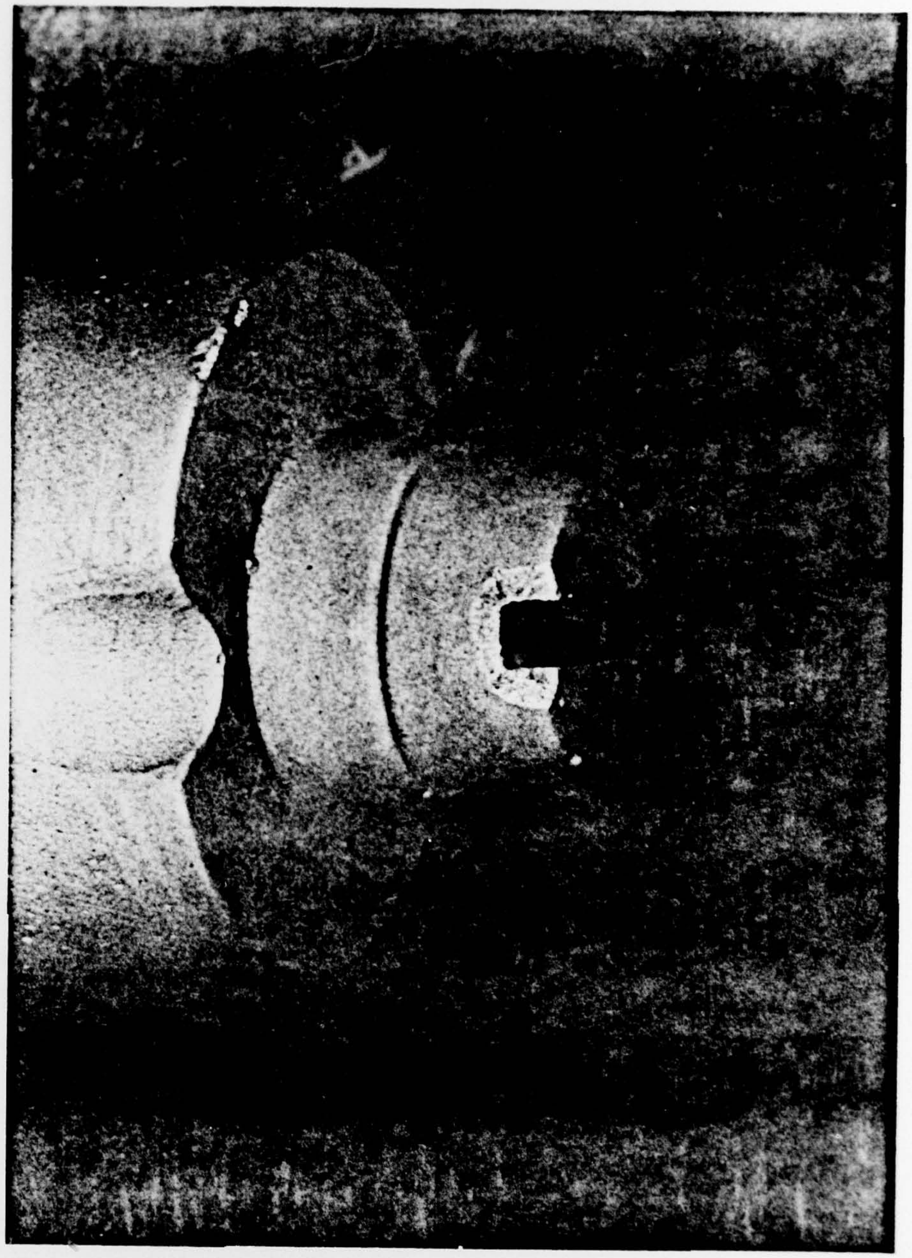
TABLE I

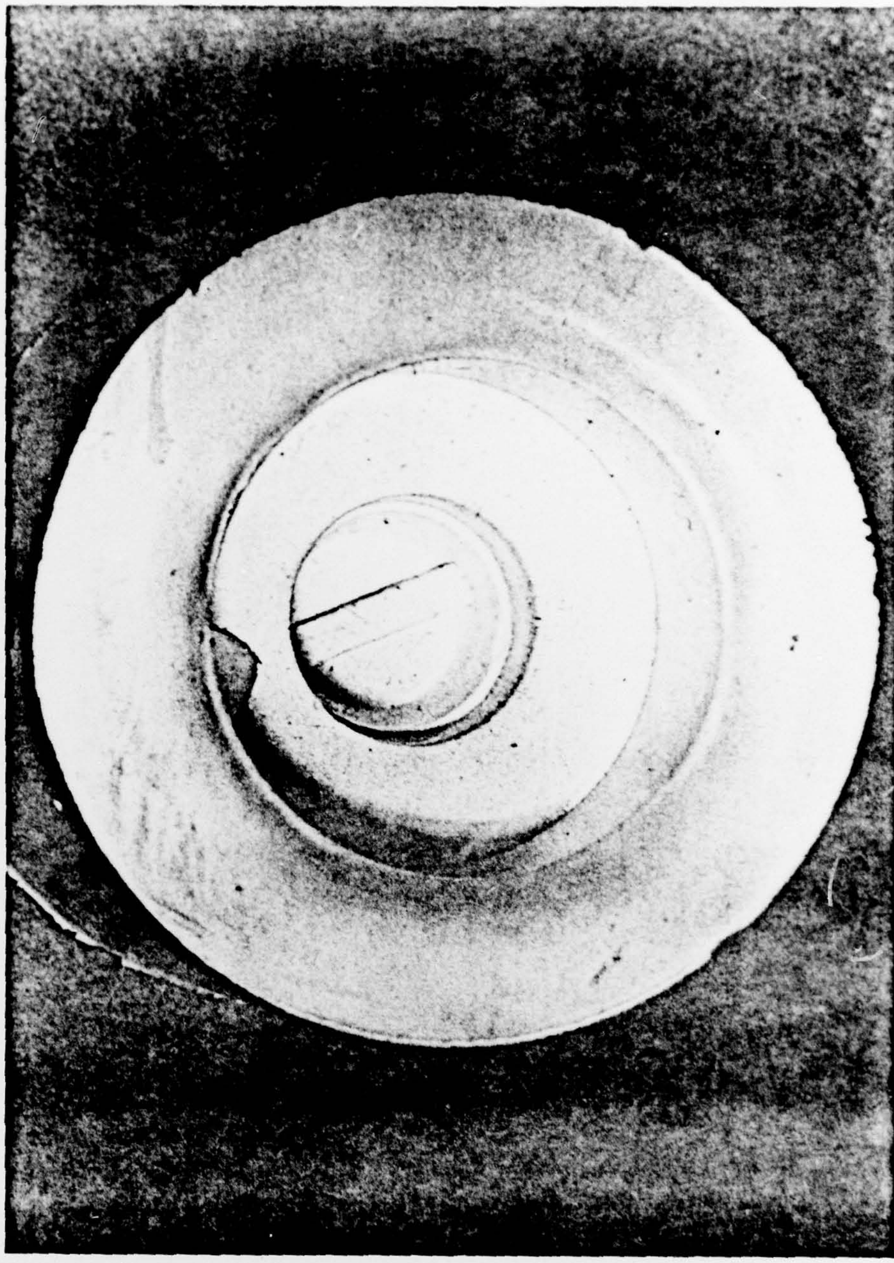
MATERIALS - THICKNESS IN MICROMETERS

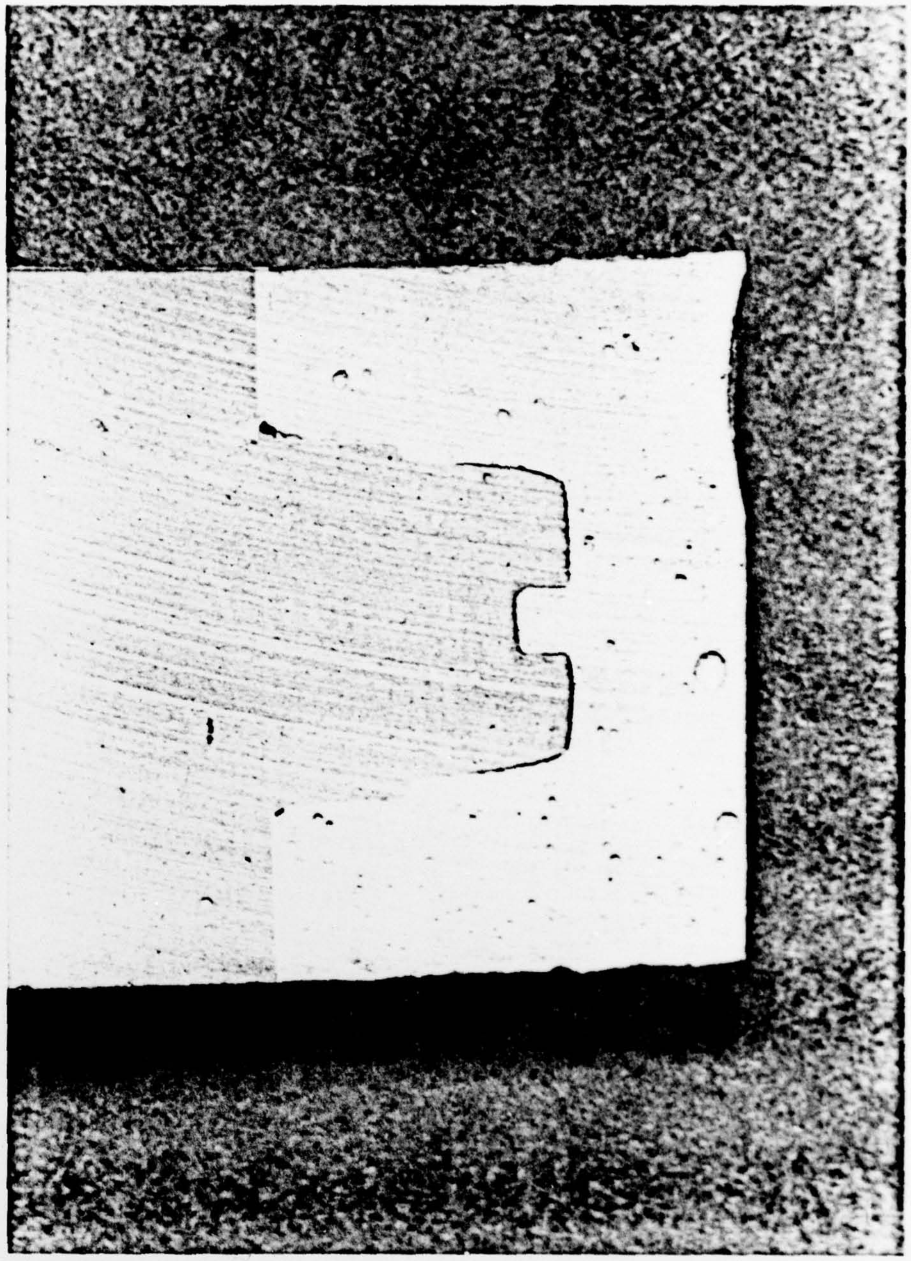
		COATS I			II			III		
		2	3	4	2	3	4	2	3	4
external angles	$\bar{x}$	4.63	9.00	15.00	10.88	19.50	16.75	23.25	42.38	40.67
2-3-6-8	s	2.67	2.98	4.14	4.91	5.29	4.43	2.63	12.53	8.57
axial walls	$\bar{x}$	12.75	35.25	28.25	20.25	37.0	31.75	35.25	41.25	75.33
1 + 9	s	2.63	7.50	5.56	3.77	8.883	6.5	7.68	6.95	6.43
internal angles	$\bar{x}$	26.75	46.00	34.00	28.25	46.50	74.75	45.00	162.50	236.50
4 + 5	s	6.55	4.97	7.59	9.81	21.79	7.59	21.74	115.9	41.16
occlusal	$\bar{x}$	25.50	31.50	28.50	28.00	58.5	36.00	49.00	39.00	92.0
7	s	.71	12.02	9.17	4.24	0.71	7.07	14.14	8.48	16.00

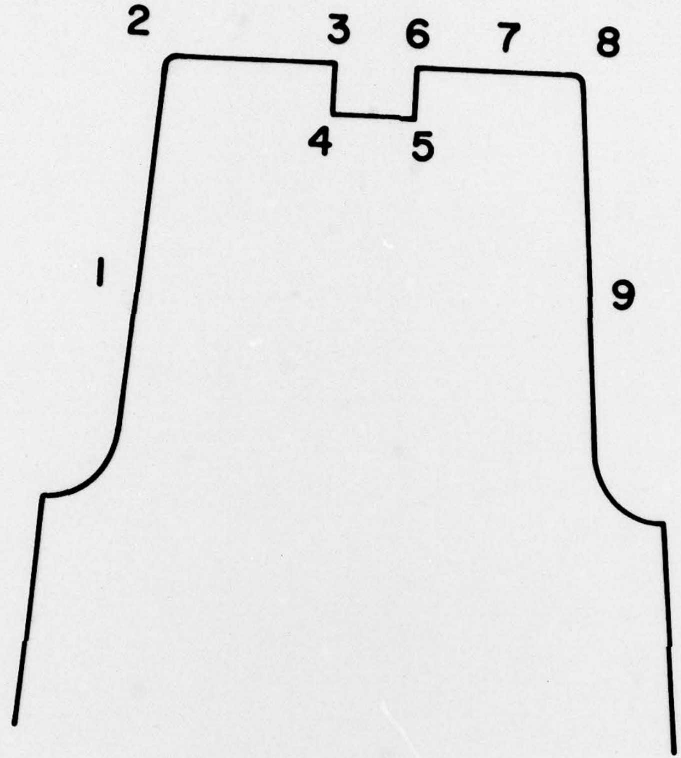
LEGEND

Figure 1	Representative die of all crown preparation with occlusal channel.
Figure 2	Silicone mold for reproductions of die in improved stone.
Figure 3	Imbedded, sectioned die.
Figure 4	Sites of measurement.
Figure 5	Measurement of thickness of coating at angles.









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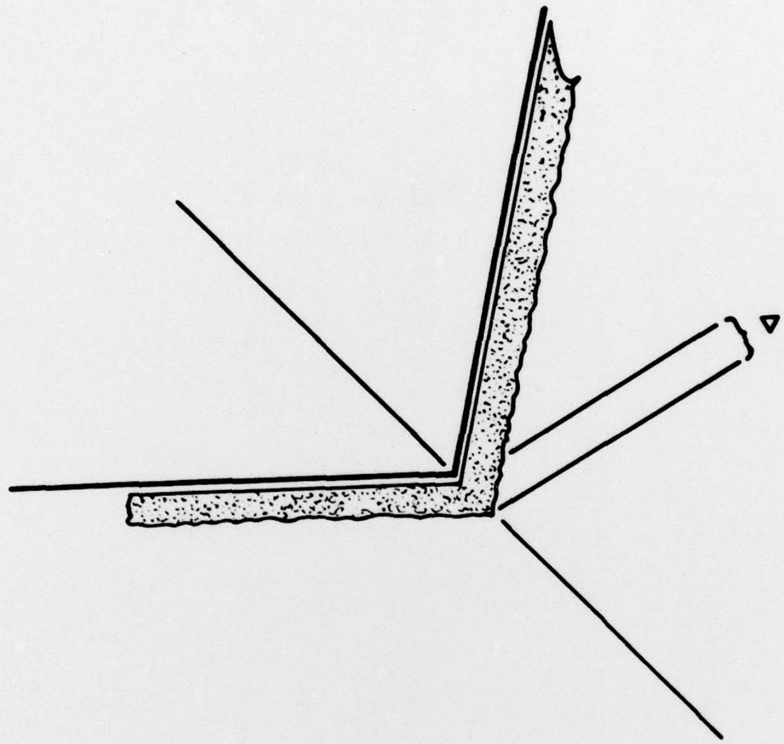
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