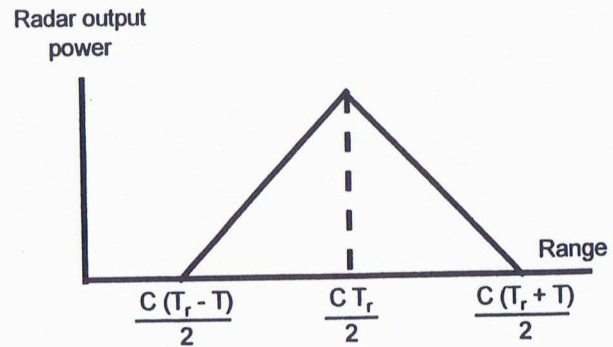
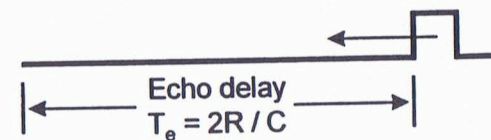
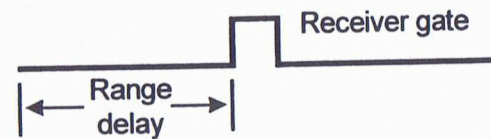
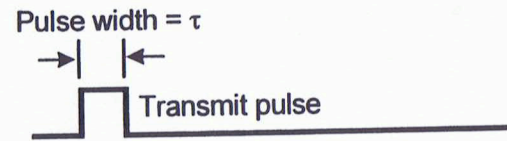
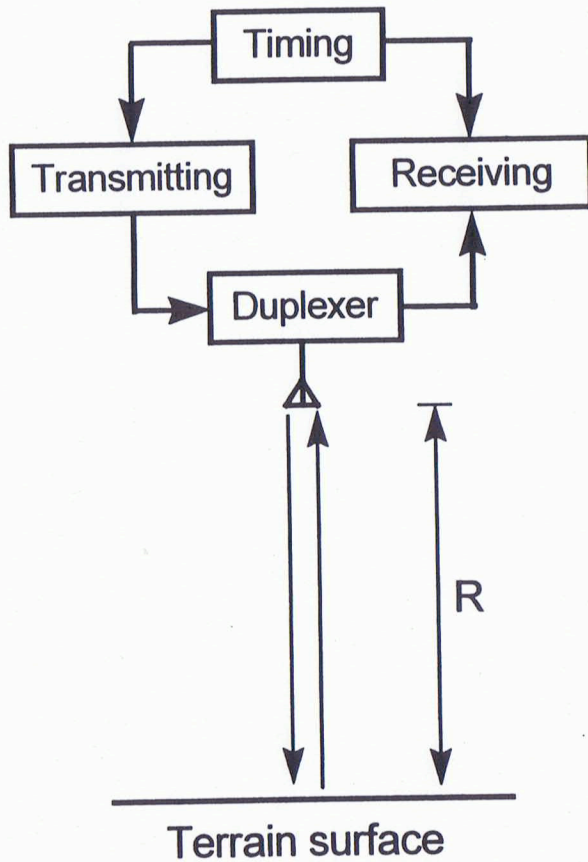


Basic Radar Operation



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Radar design considerations

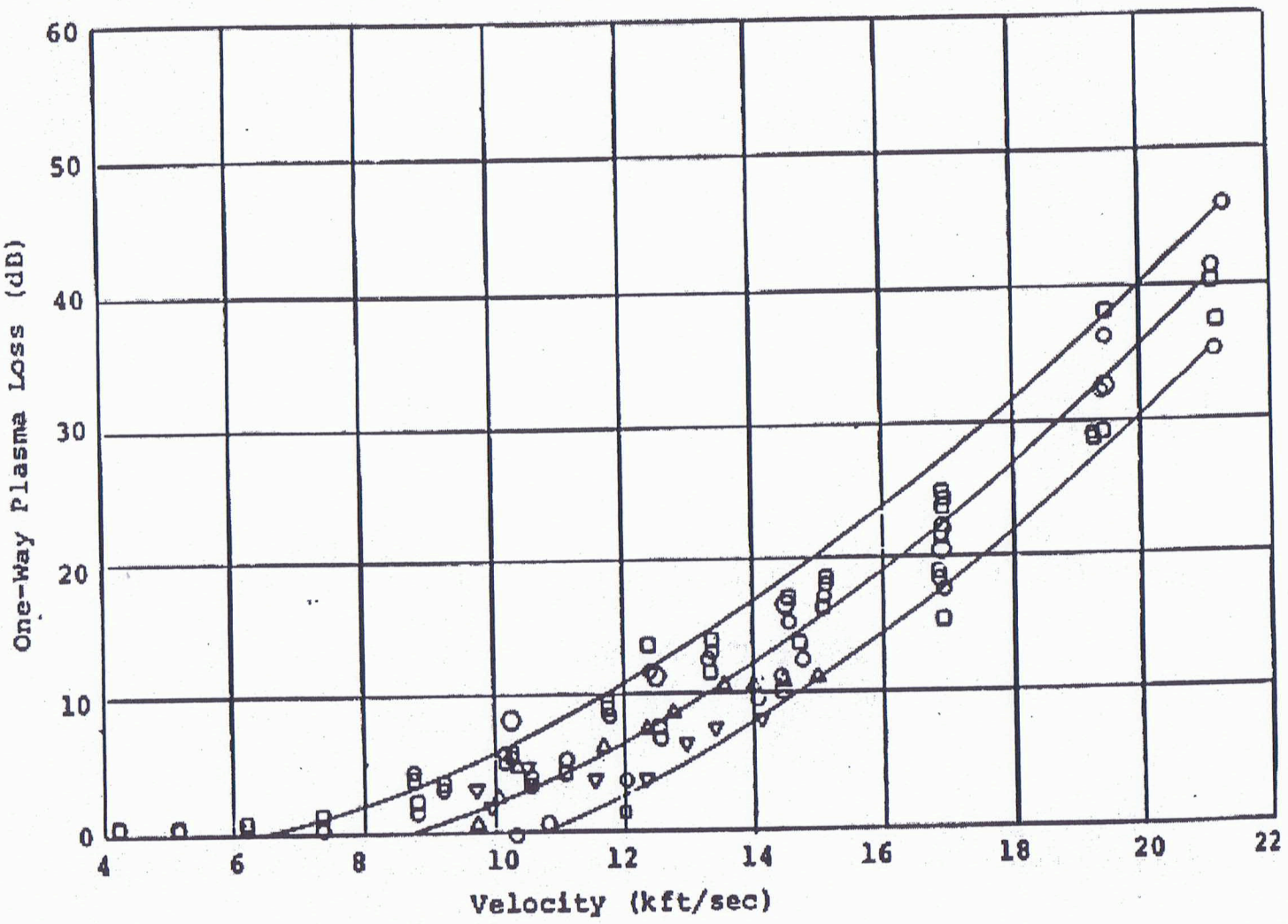
- Immunity to electronic countermeasures
 - prevent premature detection of “radar-like” signals (“spoofing”)
 - ensure detection of radar return in presence of RF energy saturation (“dudding”)
- Plasma loss (space shuttle “black-out”)
 - affects both transmit *and* receive
 - varies with: velocity
altitude
nosetip and heat shield materials

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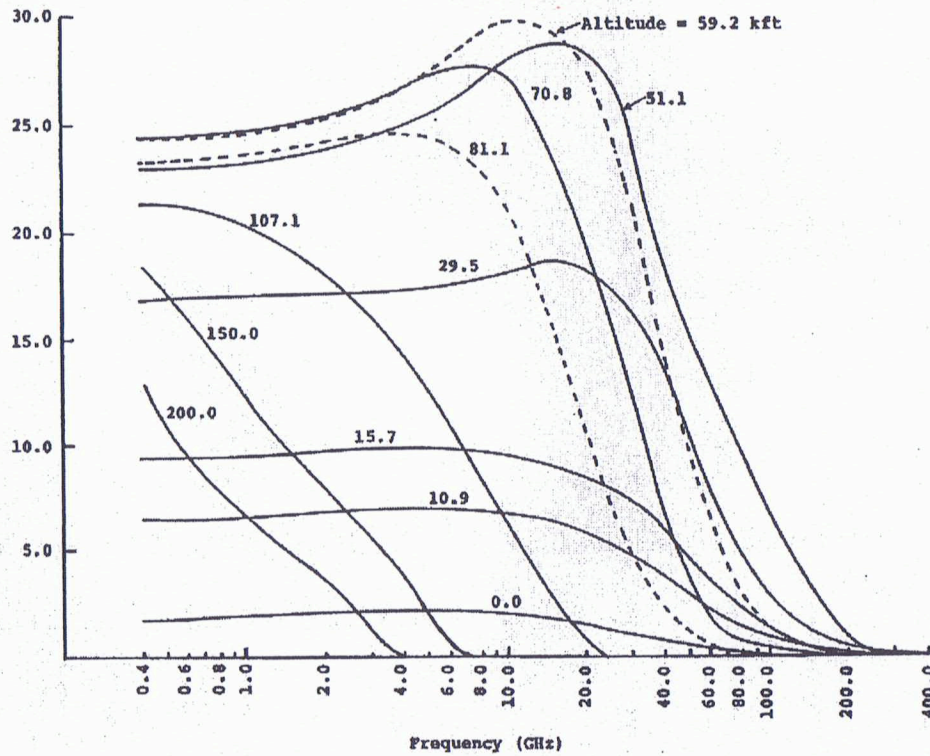


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One-way plasma loss vs. frequency for ABRV-3 trajectory



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Radar design considerations, cont'd

- Antenna gain patterns
 - affects both transmit *and* receive
 - must accommodate all flight path angles and roll orientations
- Target reflectivities
 - peak reflectivity & angular attenuation
- Frequency
 - Higher frequencies required for proximity fuze narrow pulse width
 - Higher frequencies require less "real estate" for antenna windows
 - Smaller antennas thought to have less impact on reentry body flight
 - Lower frequencies have lower "path loss" requiring less receiver loop sensitivity

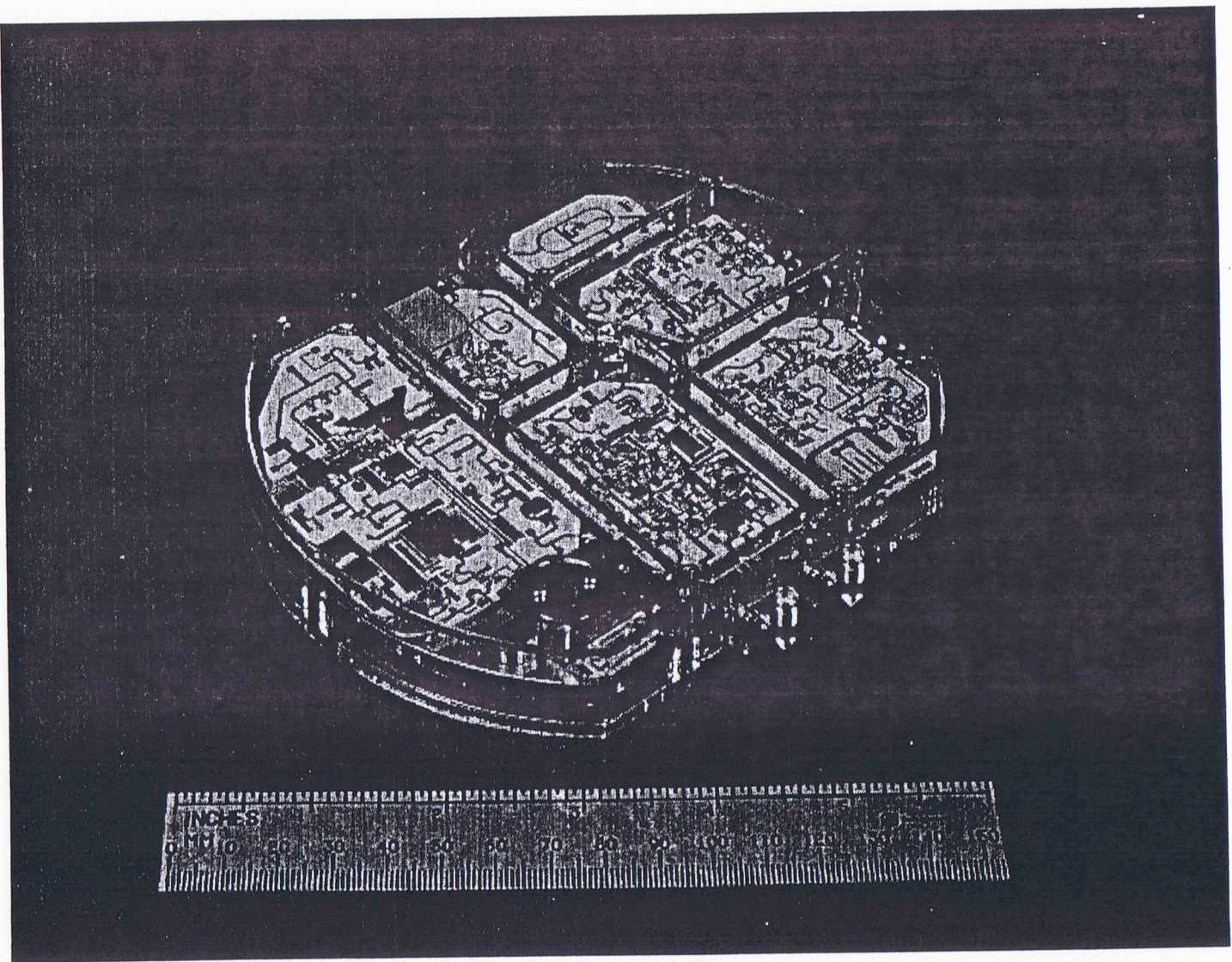
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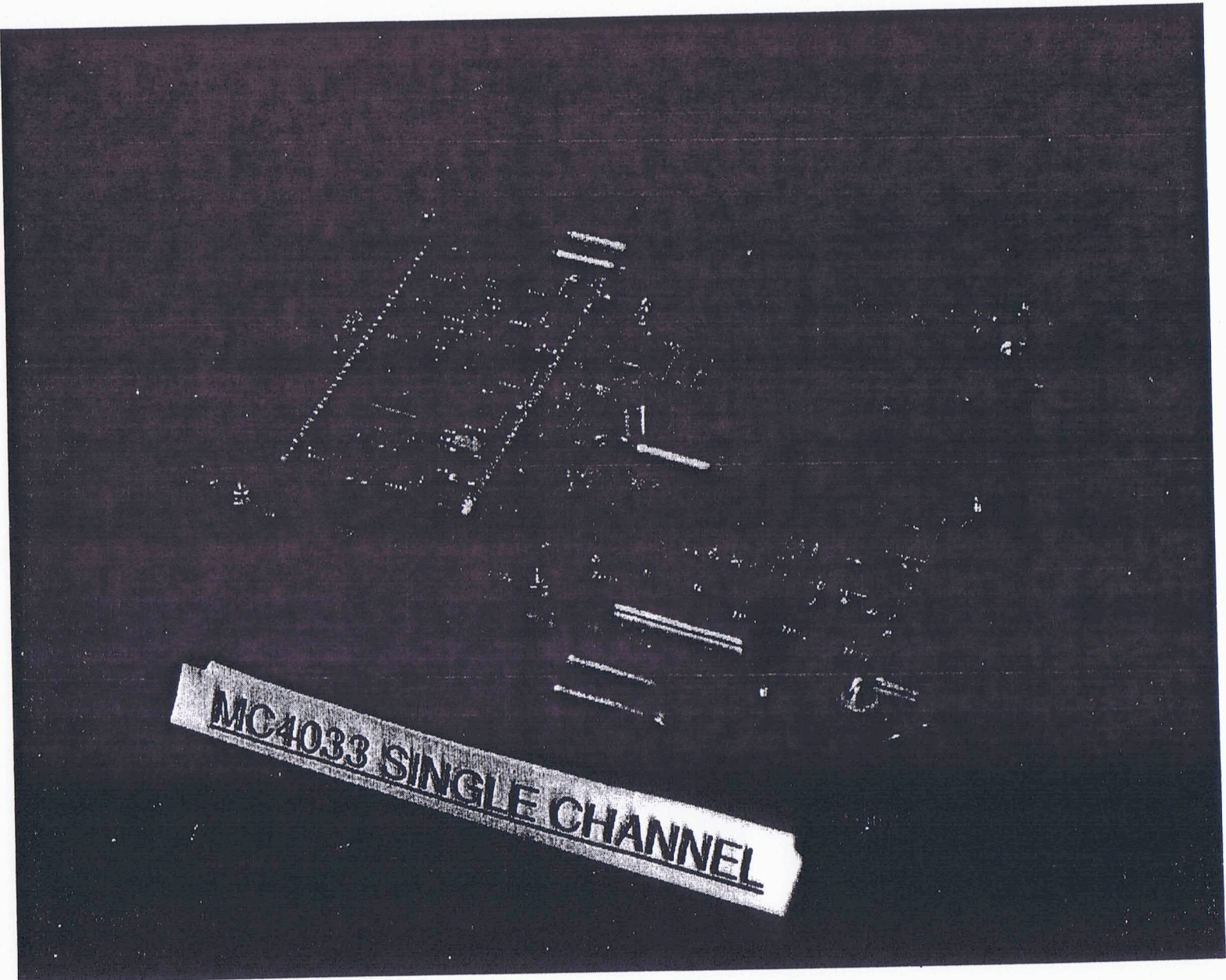
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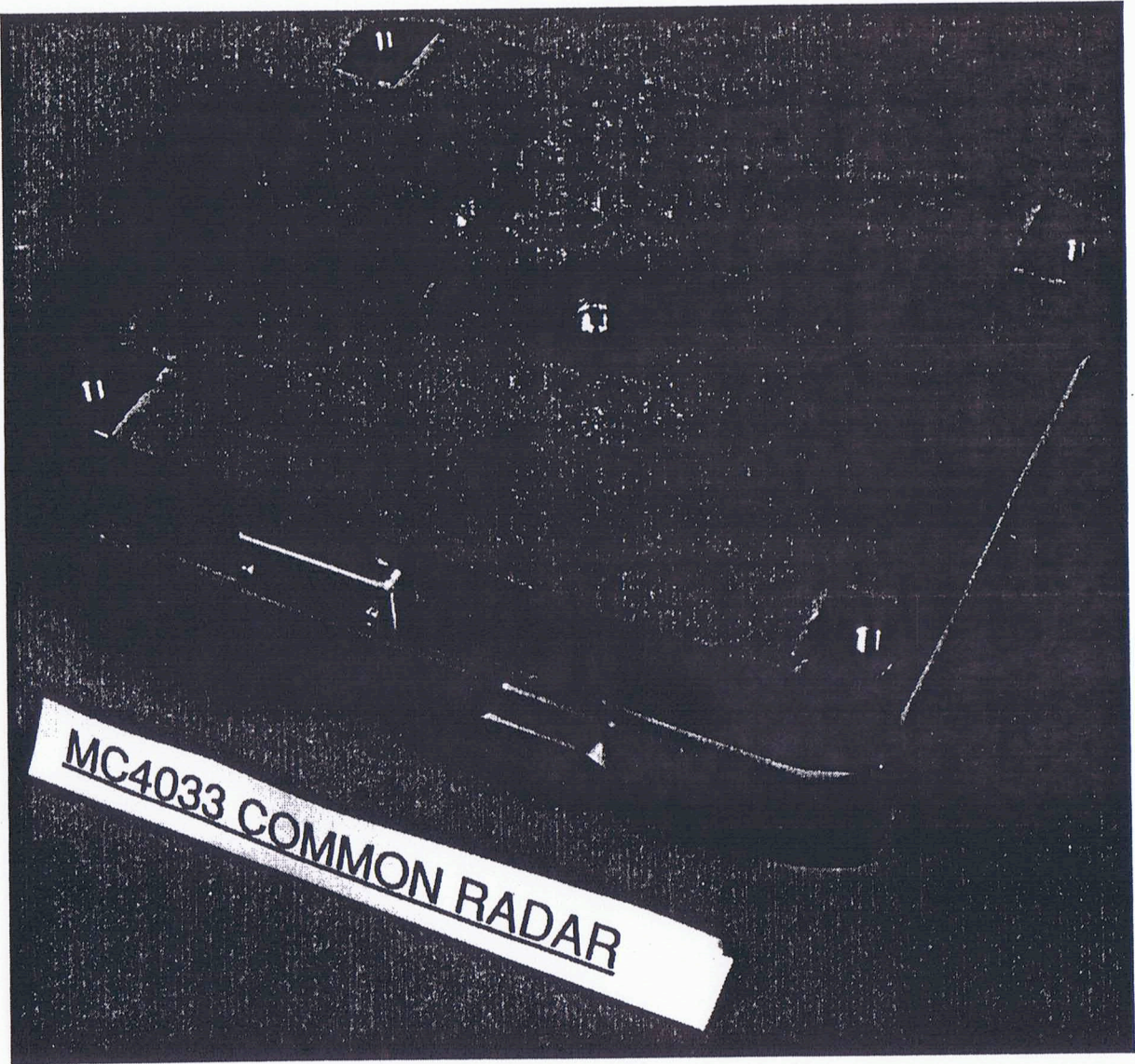
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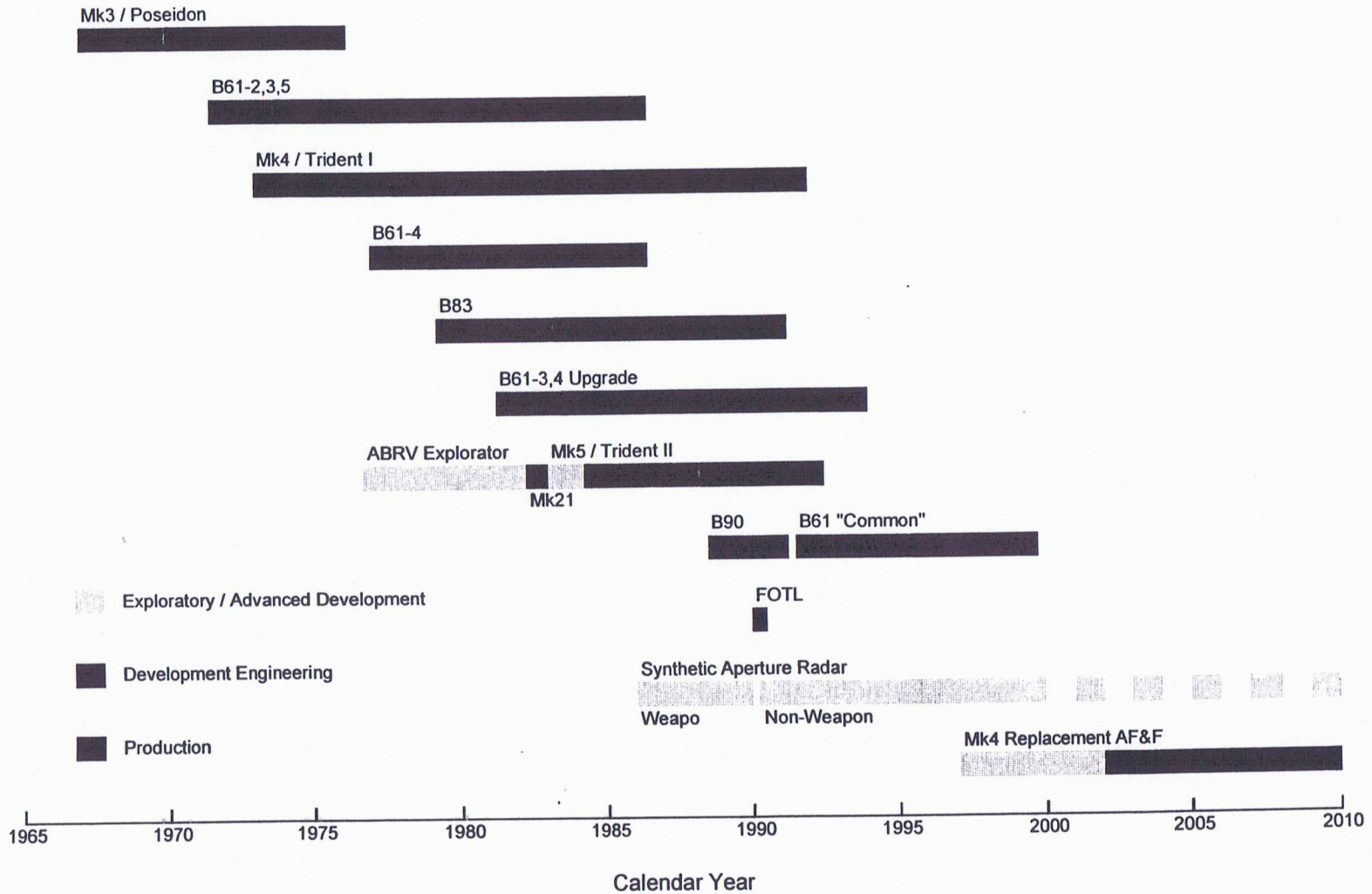
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Sandia Fuze Development & Production (1965 - 2010)



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Contact Fuzing

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Contact fuze characteristics

- Output directly triggers firing set for fast operation

OR

initiates delay mechanism for weapon designed for impact survivability

- Piezoelectric materials release charge (voltage) when shocked
 - generally not requiring external “poling” or charging
- Use pervasively throughout the stockpile for both selectable and backup fuzing

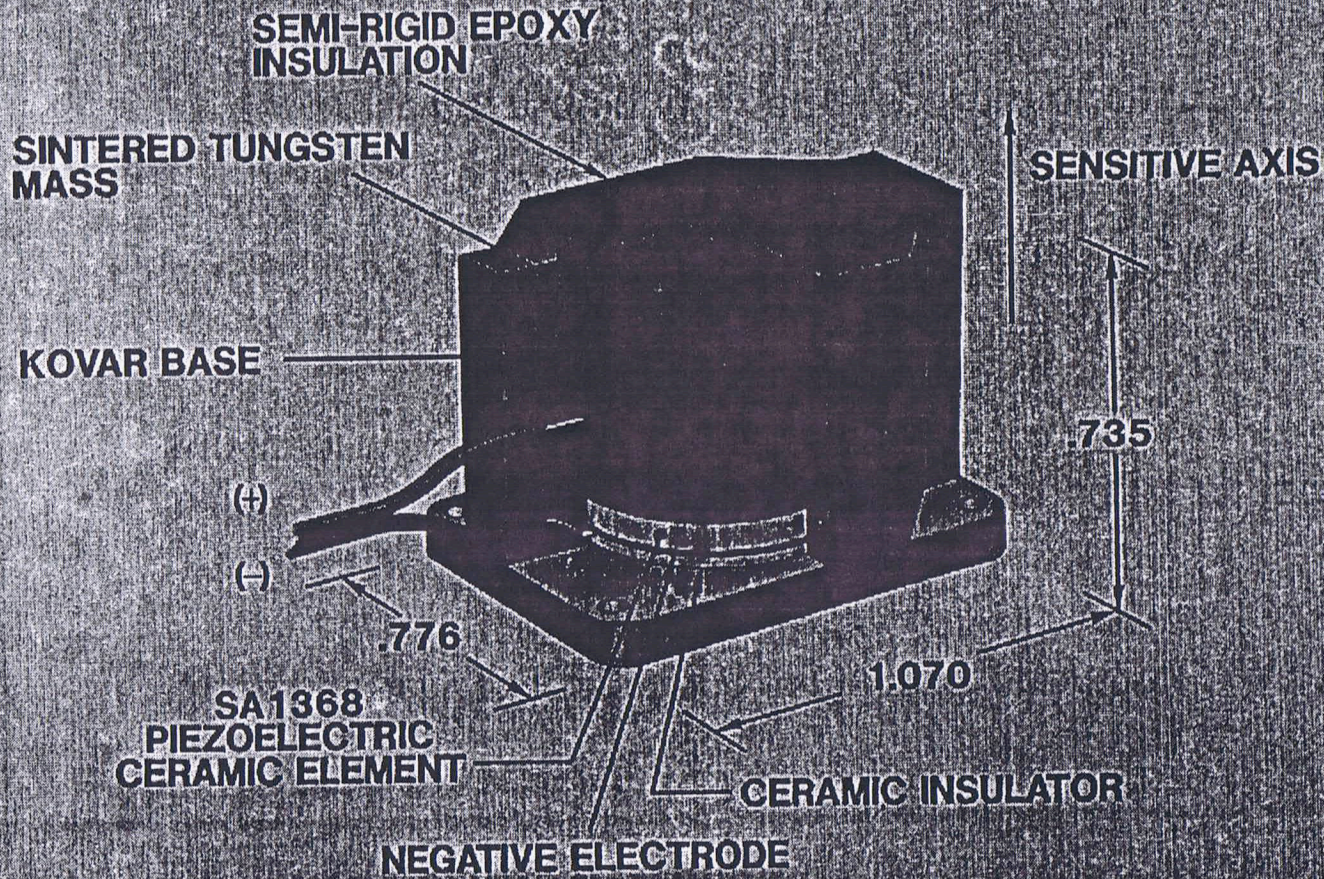
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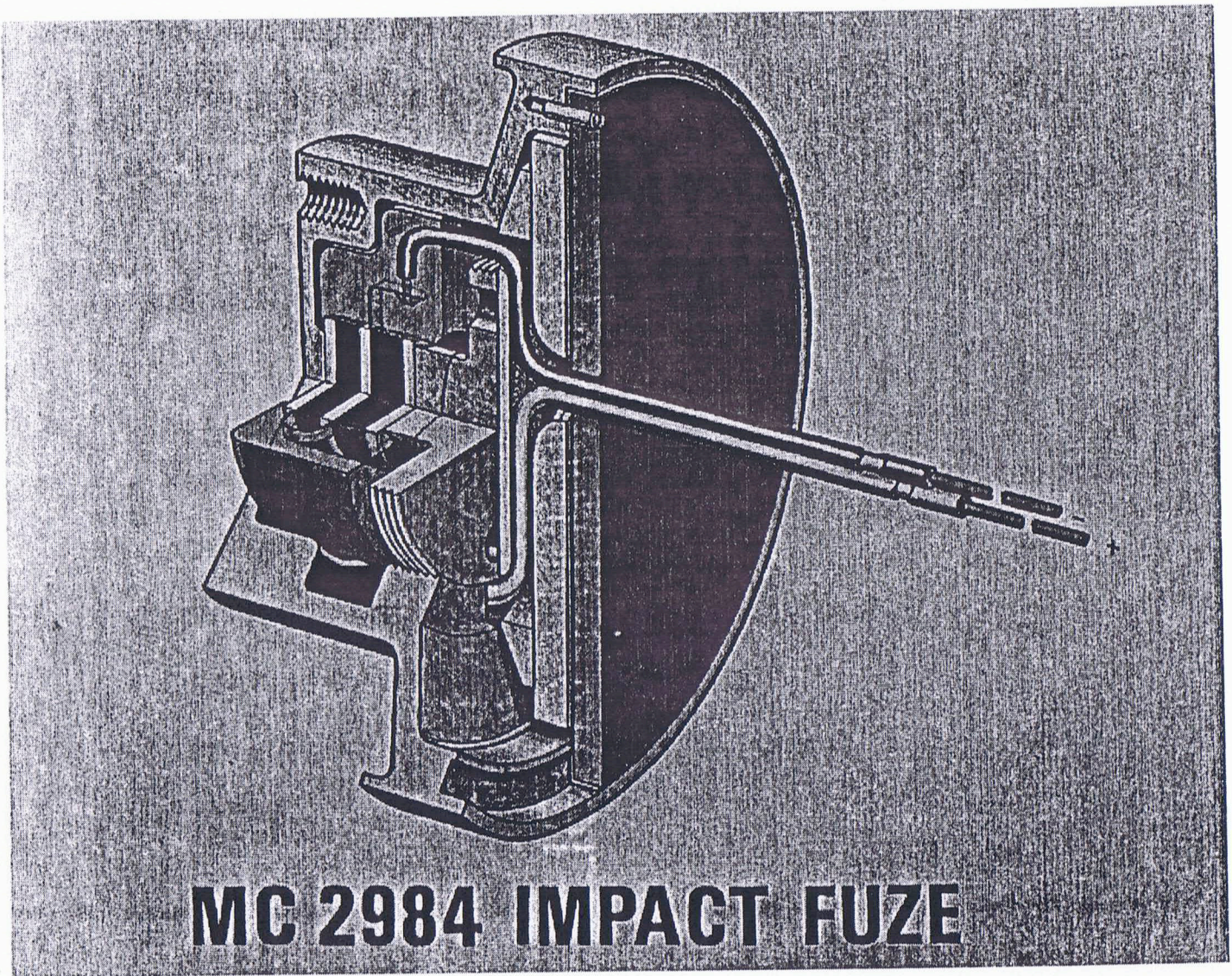
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MC3549 IMPACT SENSOR



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MC 2984 IMPACT FUZE

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Contact Fuze Characteristics

- Advantages
 - Very little penalty in weight, cost or volume
 - Desirable as backup to air burst fuzing
 - Radiation hardened and immune to jamming
 - Very reliable as a component
 - Maximizes crater volume and ground motion in comparison to other air burst options
- Disadvantages
 - Reduced "effects radius" for air burst targets
 - Range offset associated with backup role
 - Qualification / testing has been costly
 - Dependability concerns (system reliability)

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Contact fuzing degree of difficulty

	Component	System
Design	Easy	Easy
Validate	Fairly easy	Very difficult

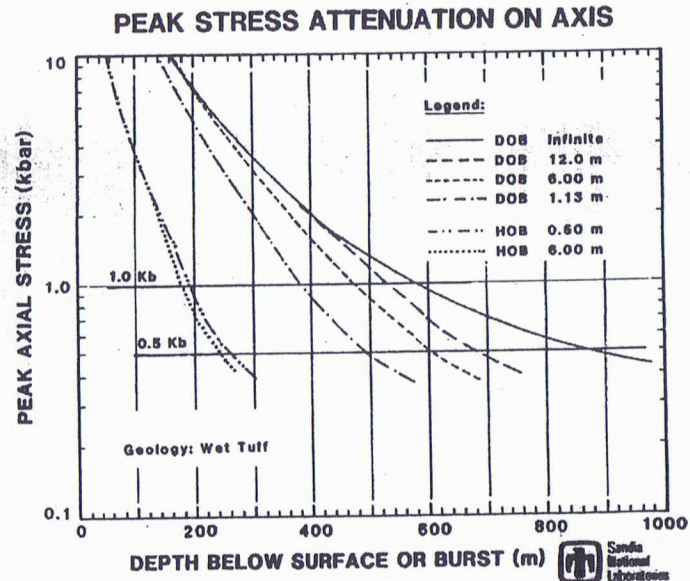
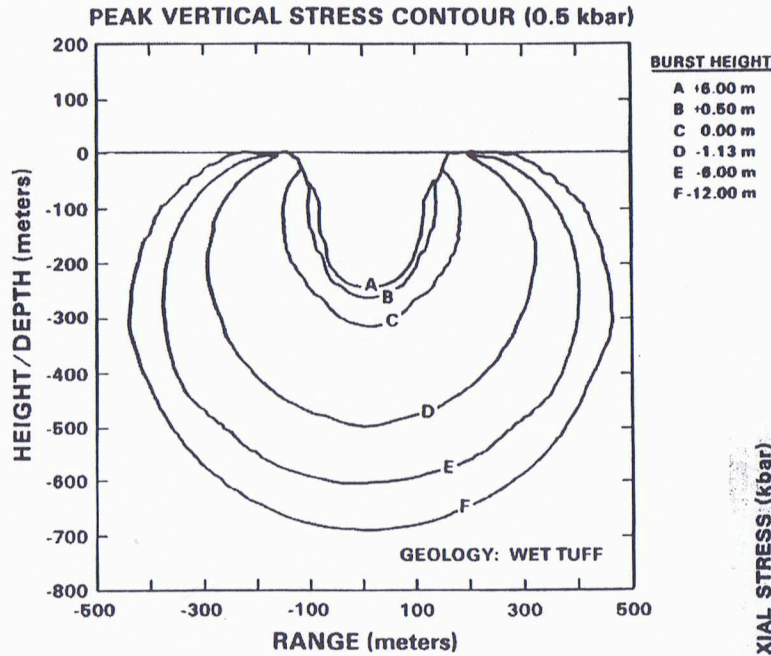
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Contact vs. Proximity - Ground shock environments



Proximity fuzing consistently results in minimal degradation in ground shock environments when compared to contact

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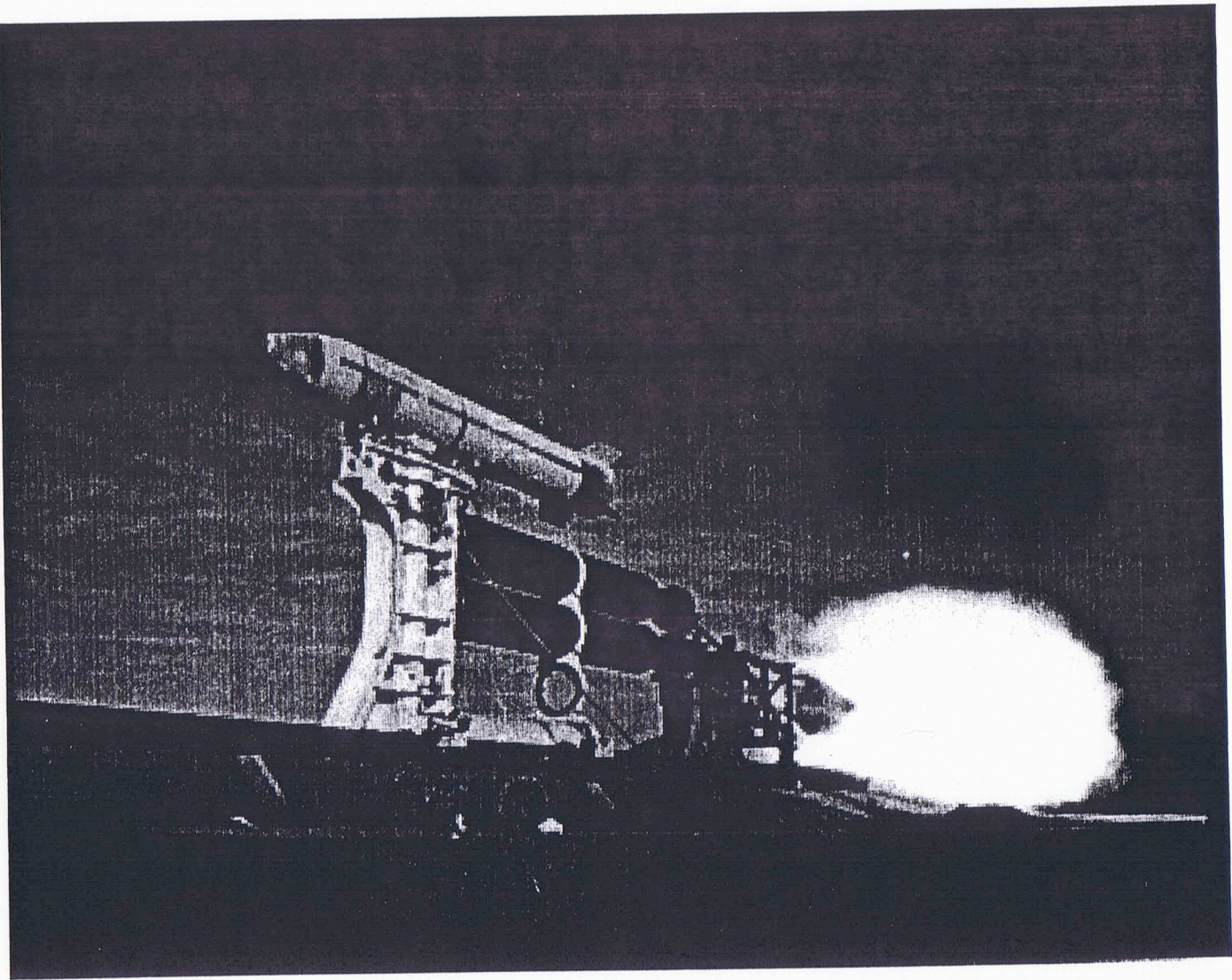
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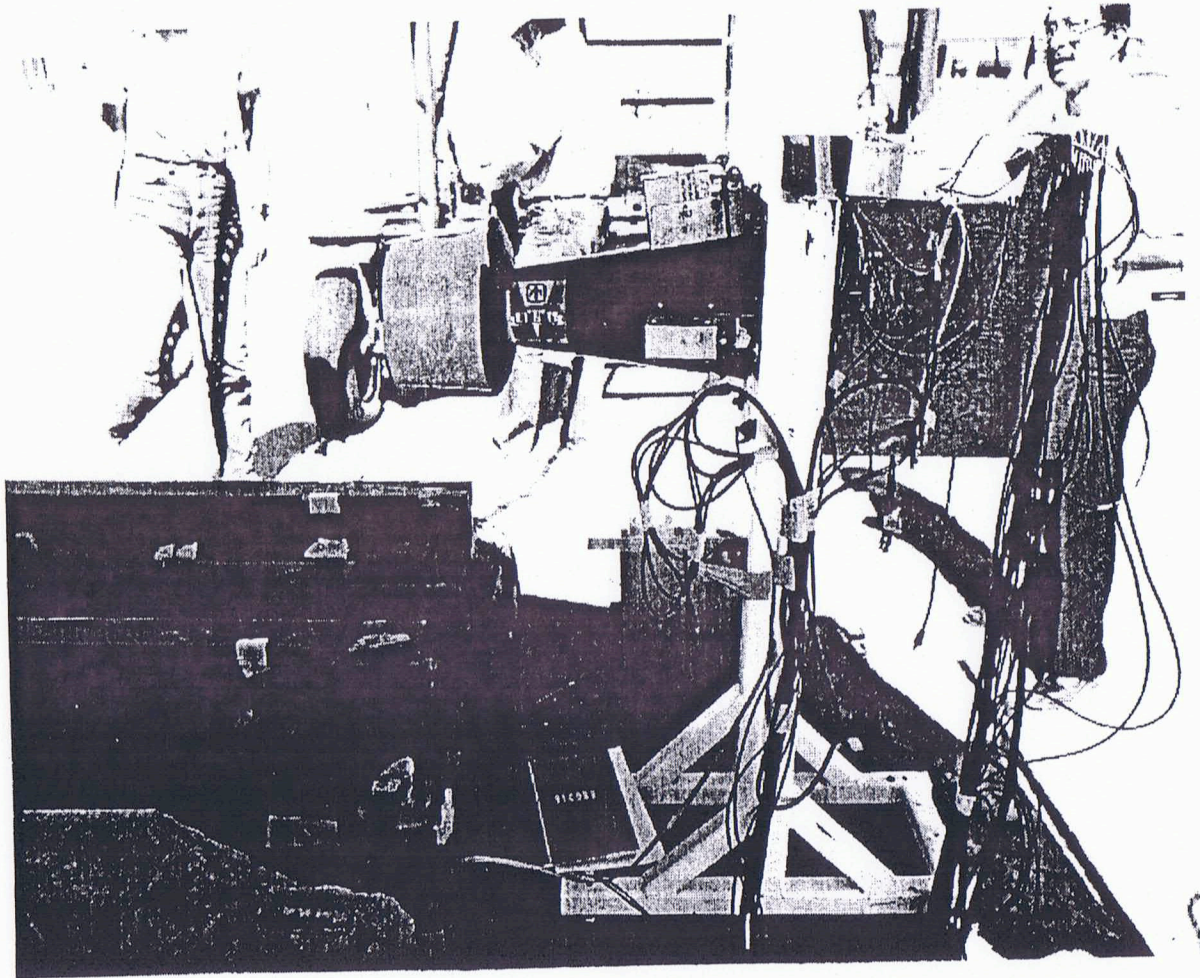
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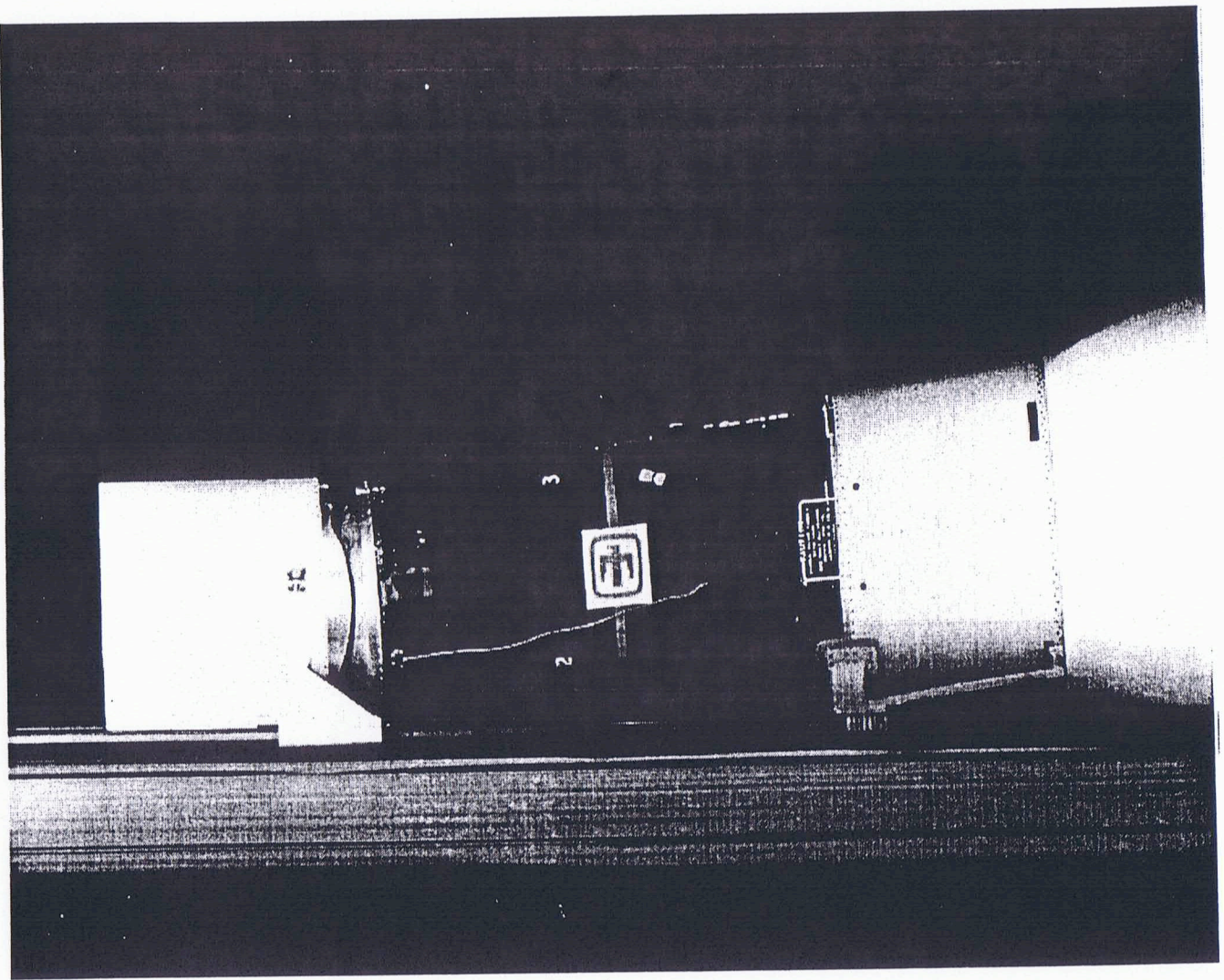
Figure 29



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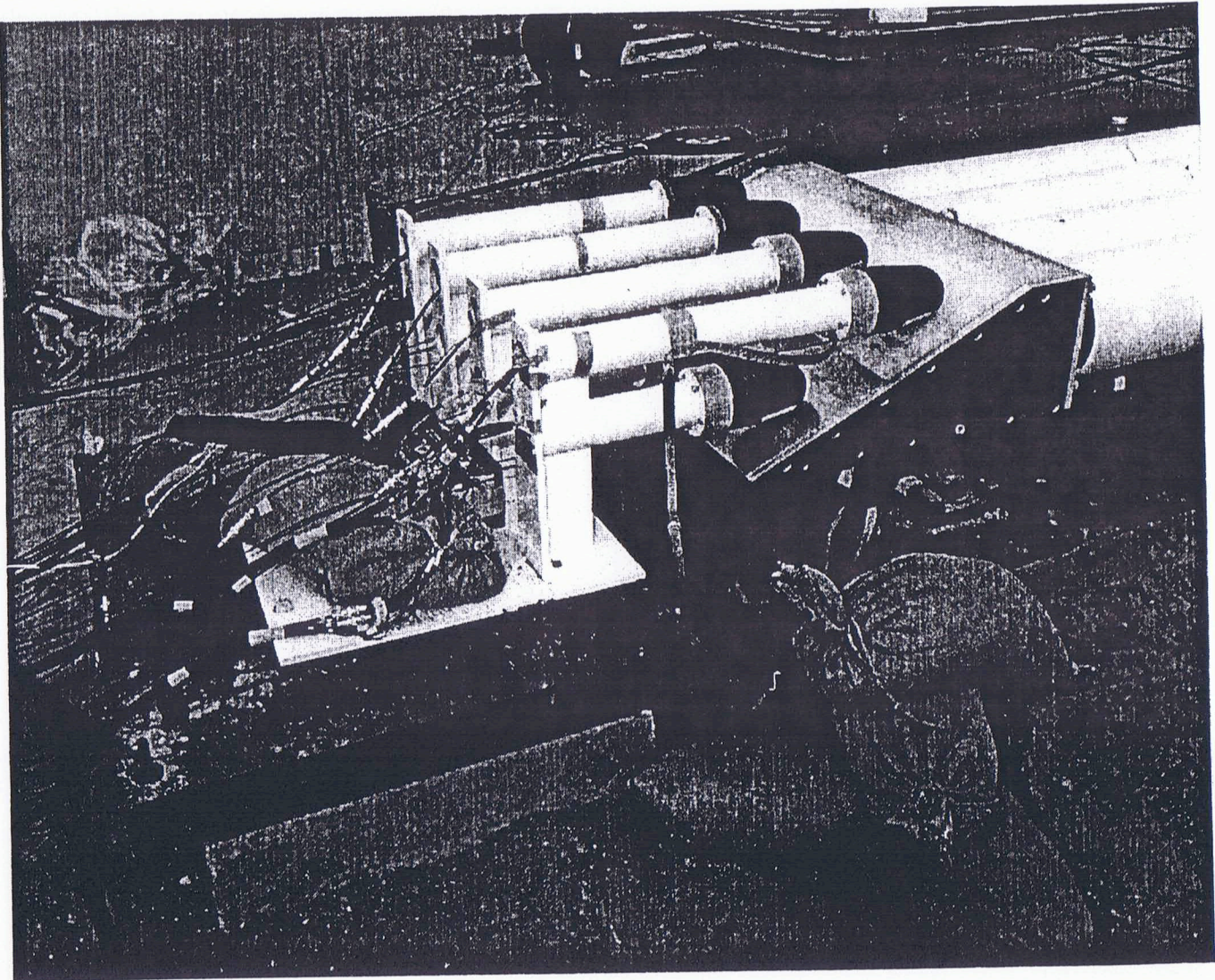
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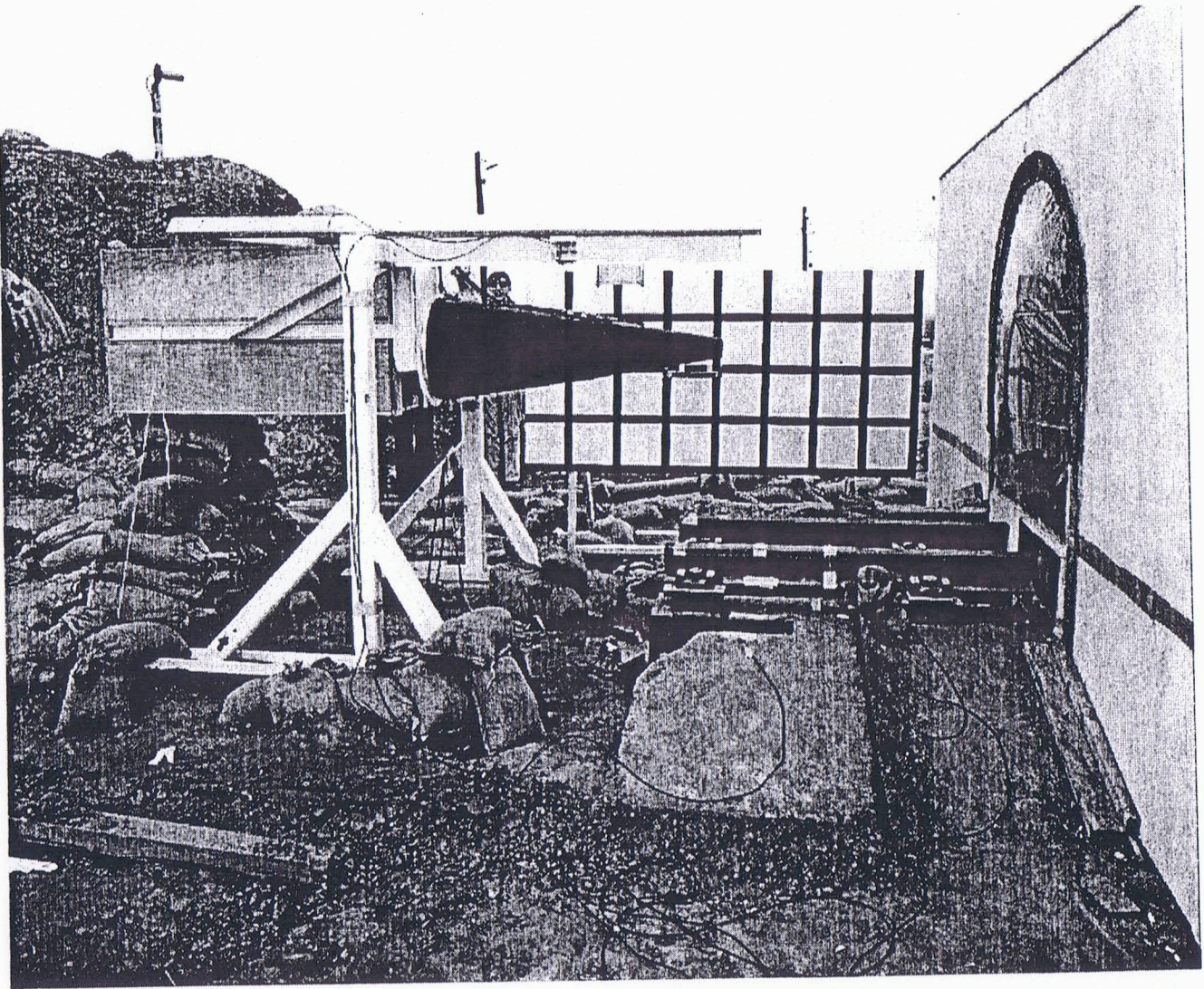
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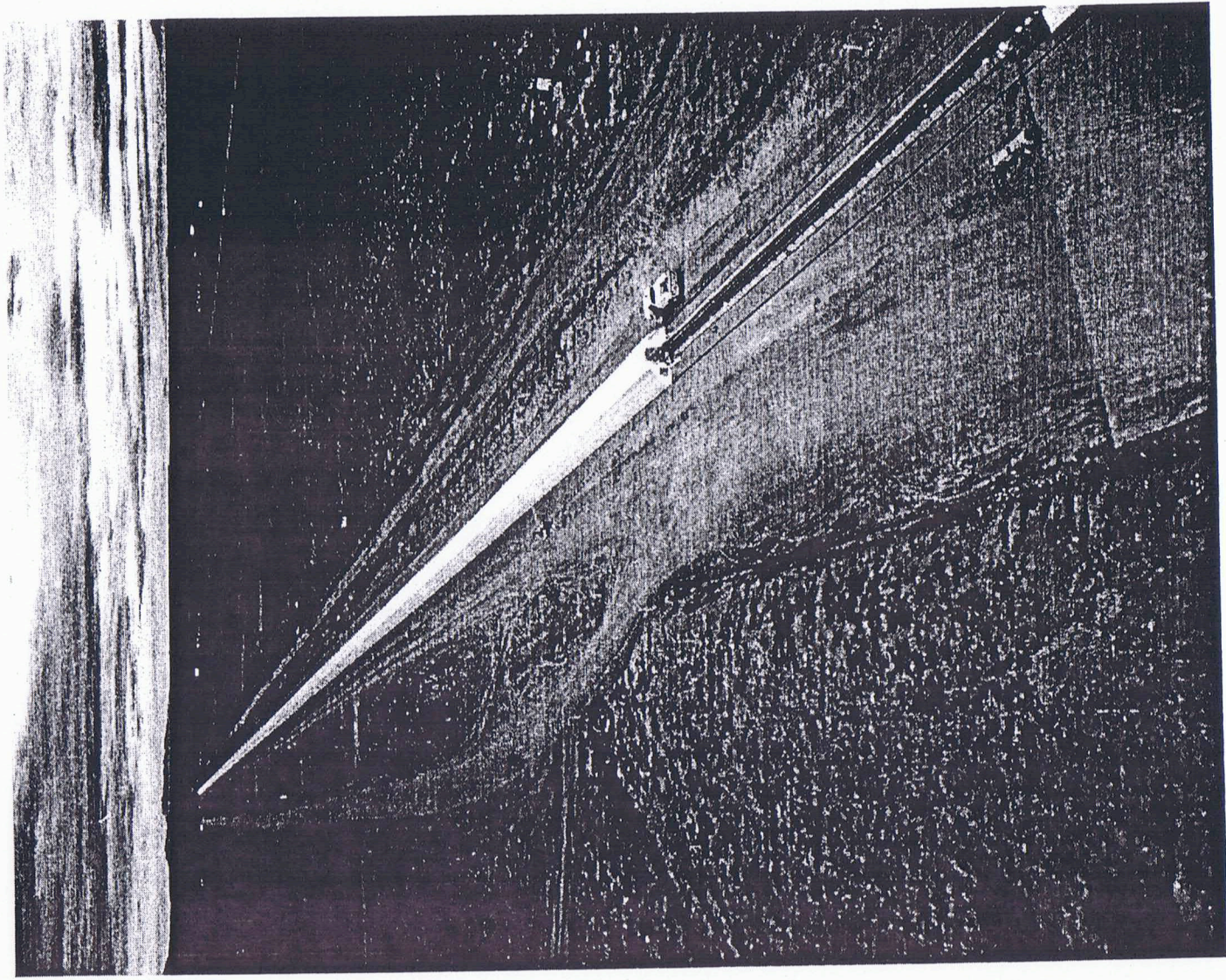


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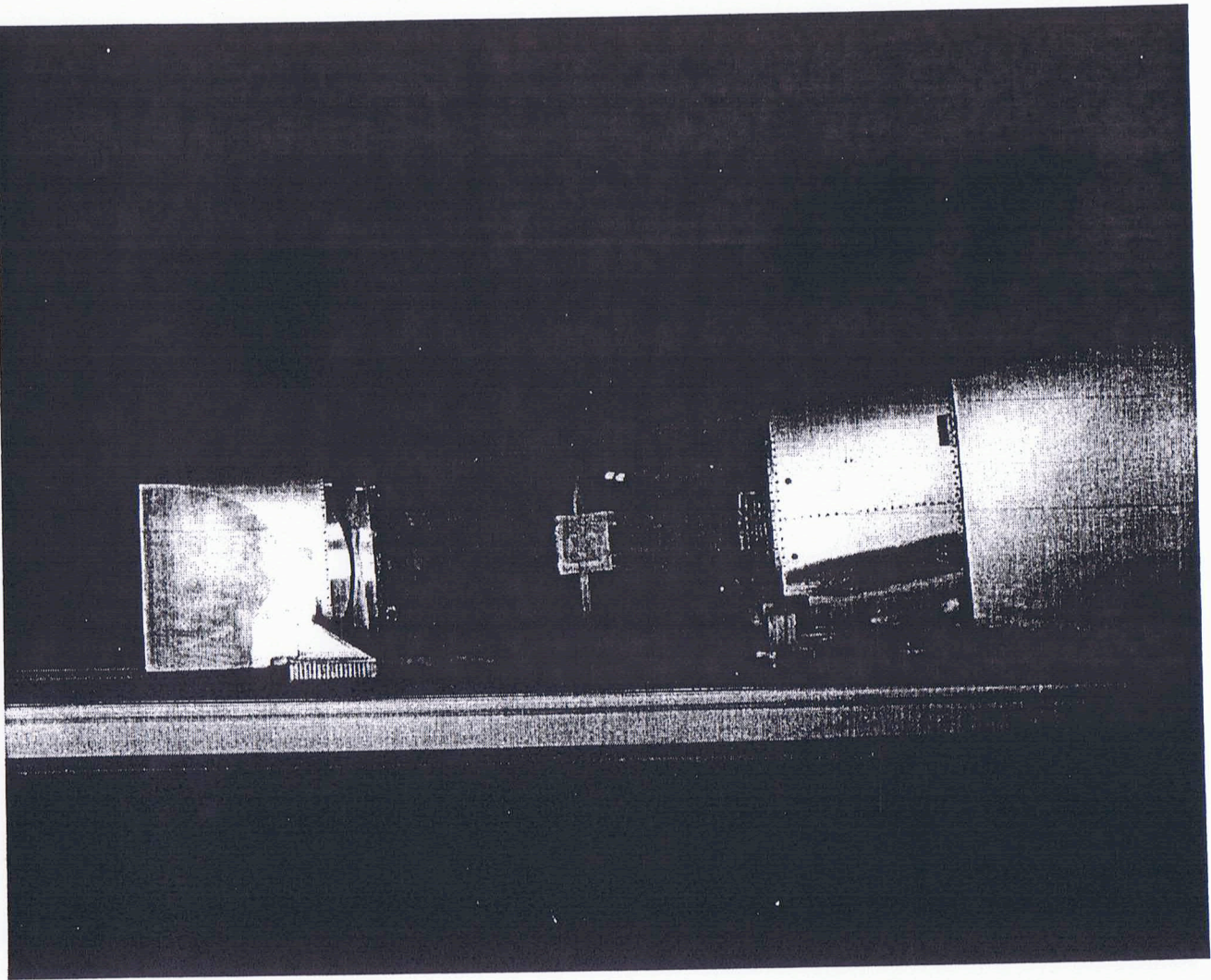
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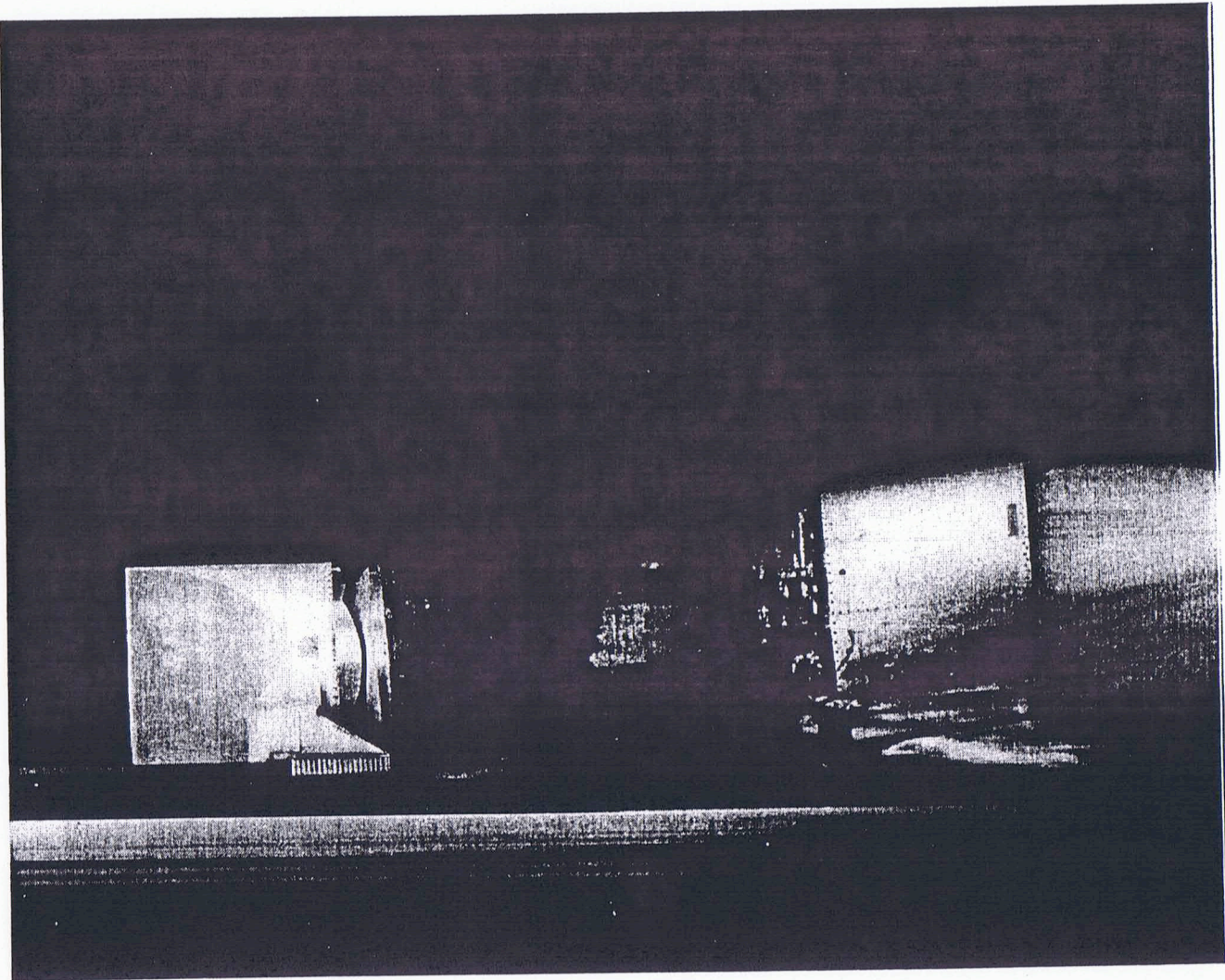
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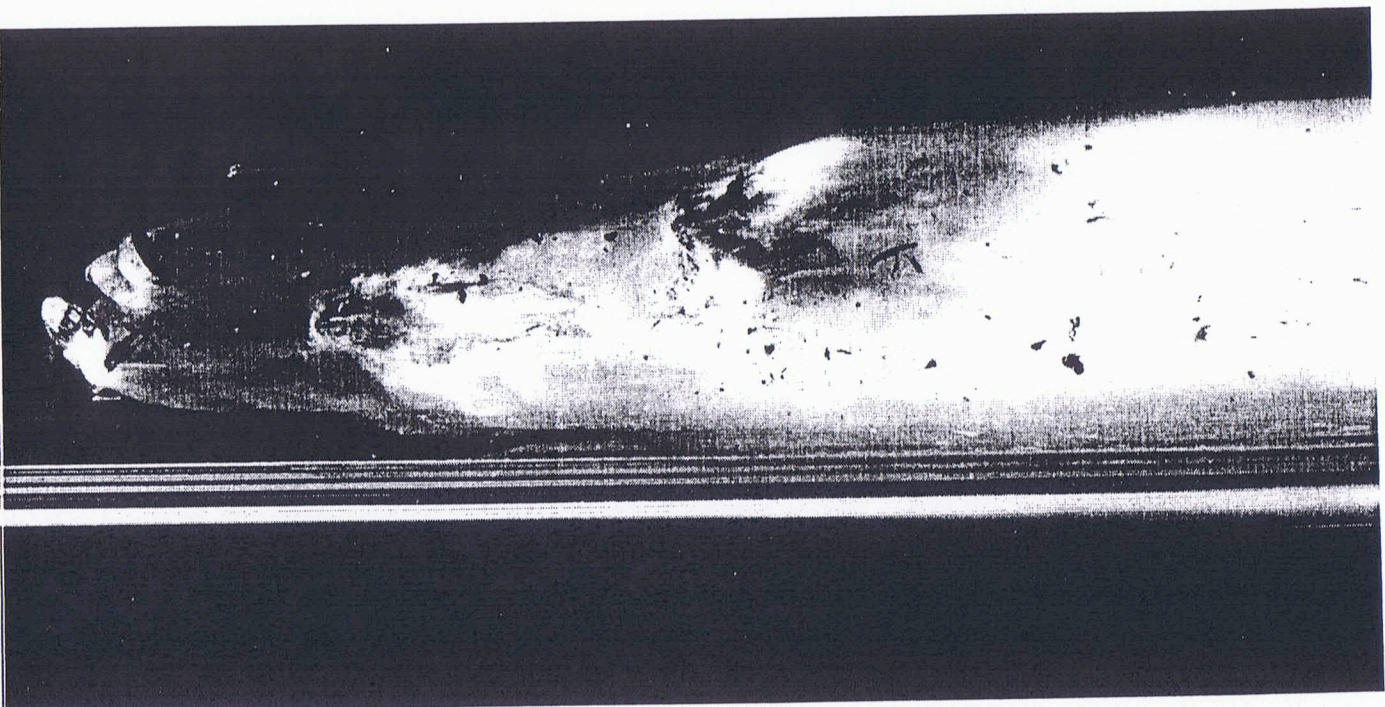
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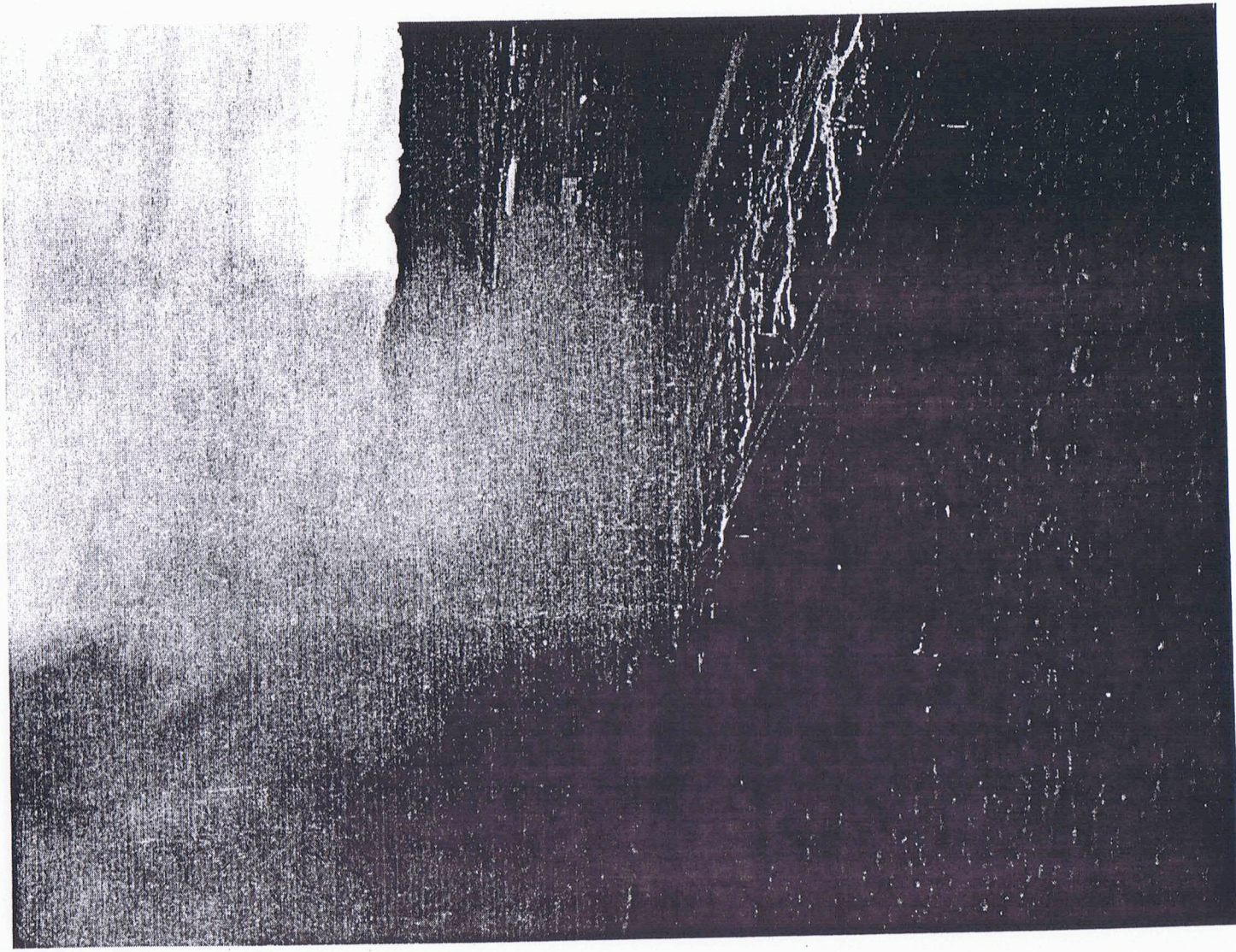
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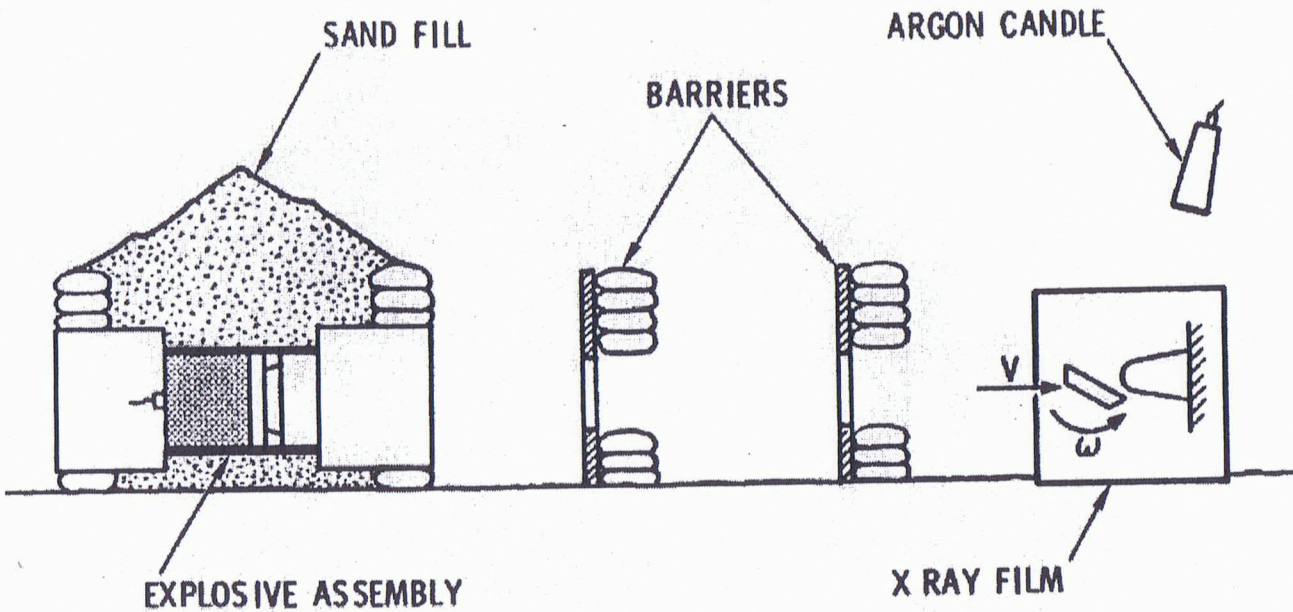
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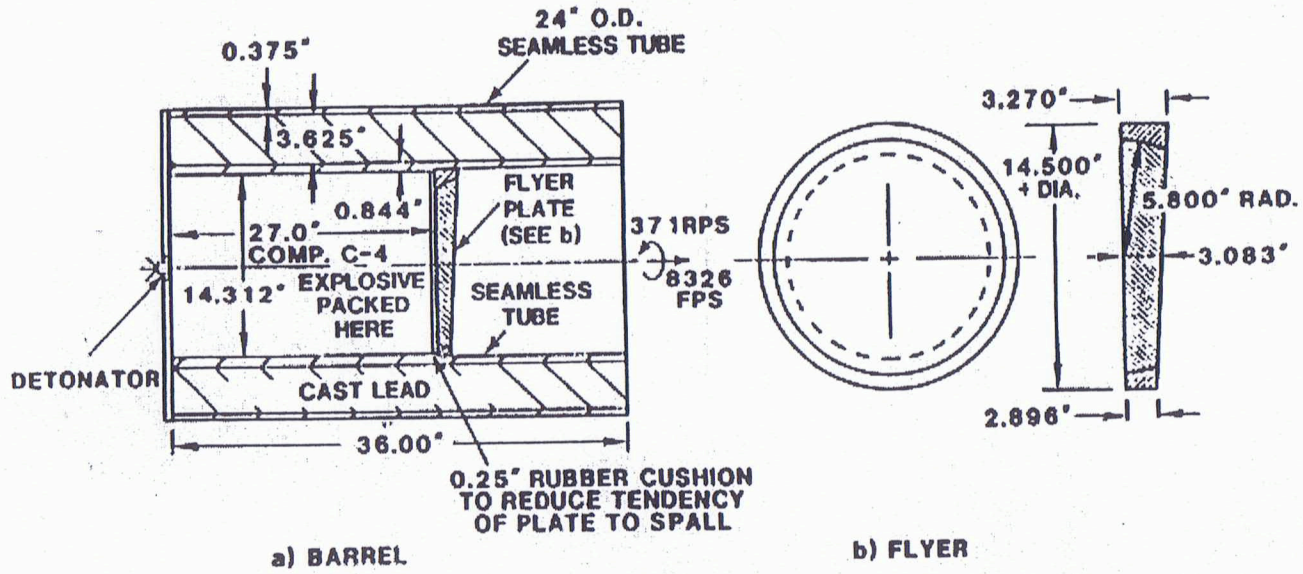
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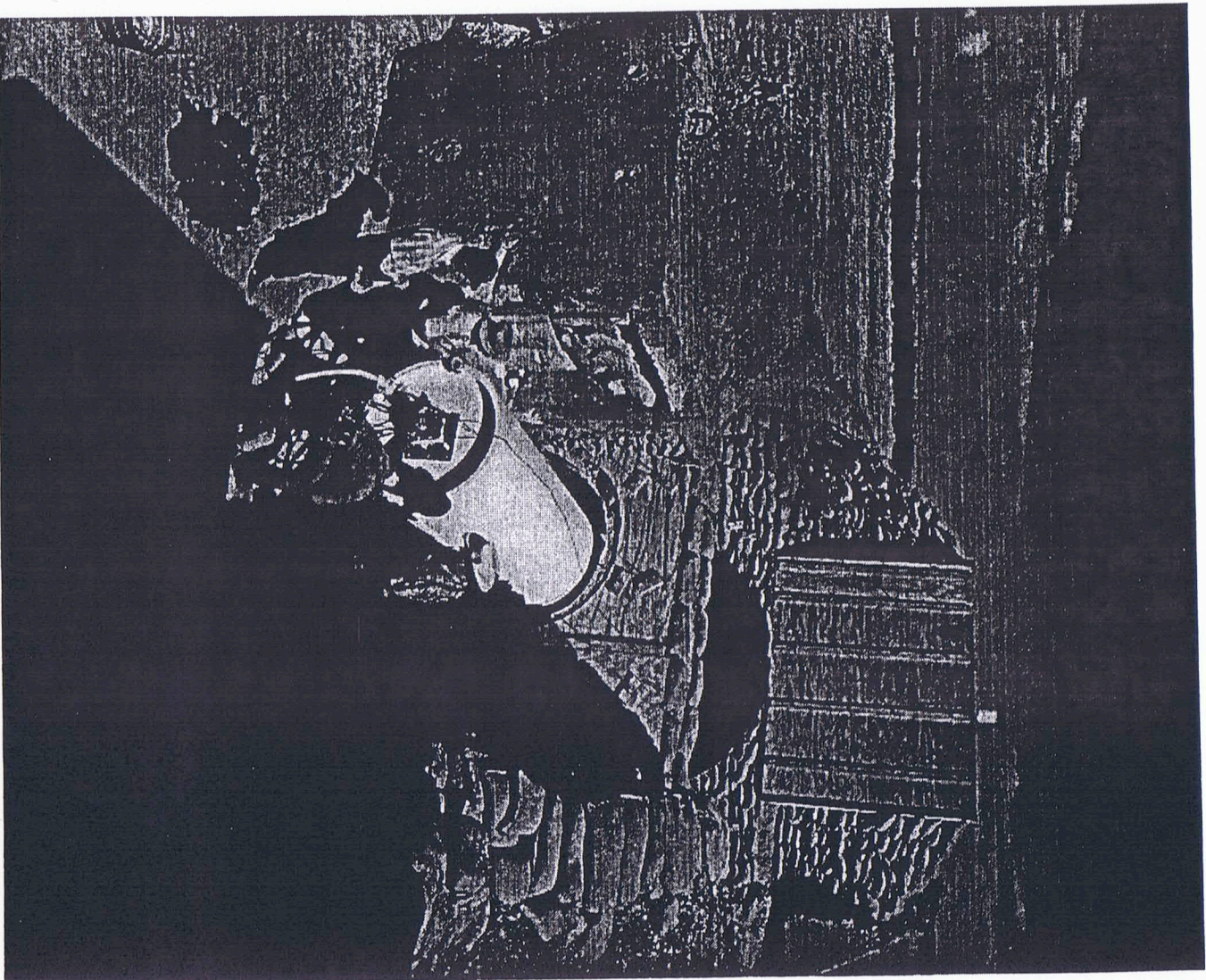
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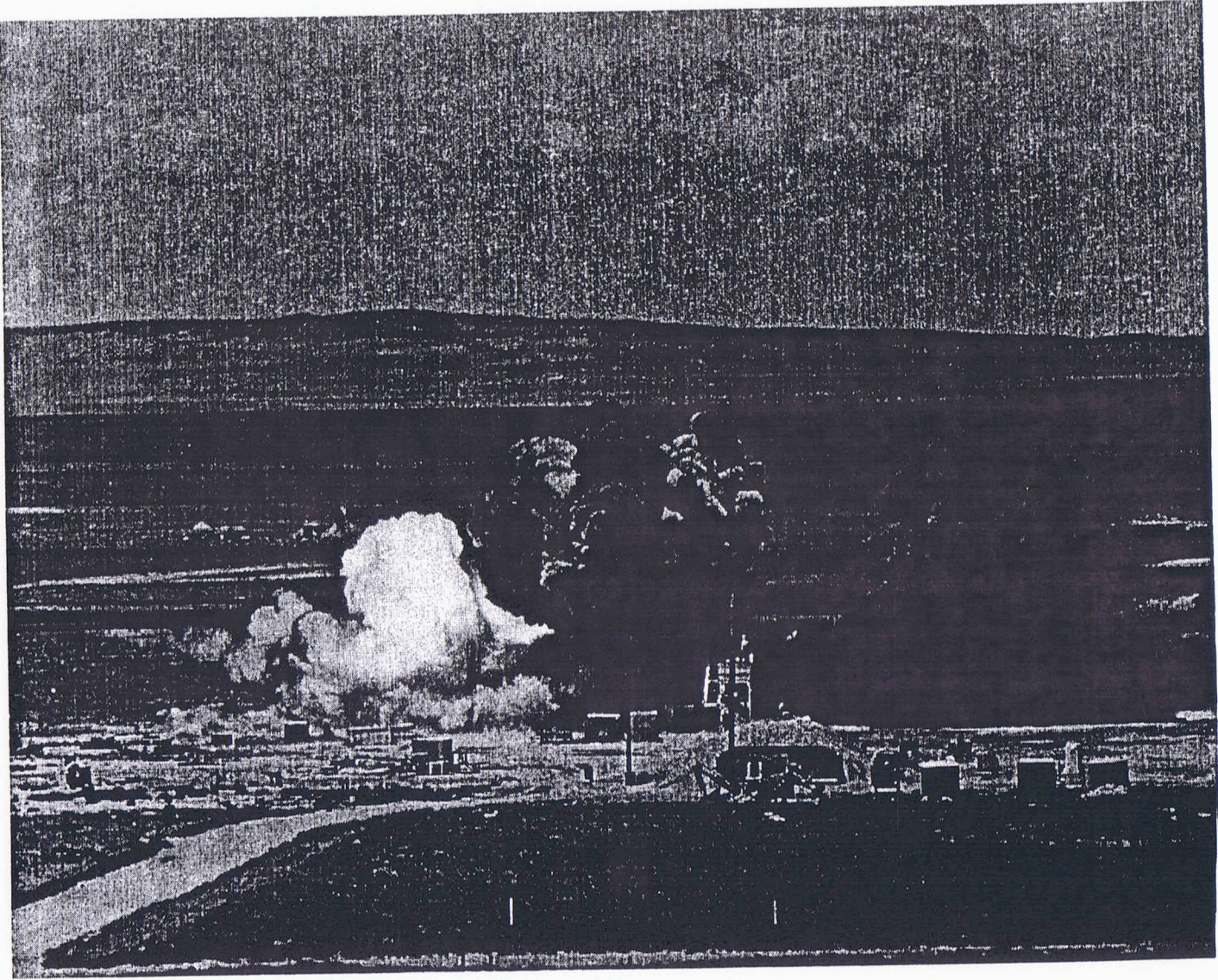
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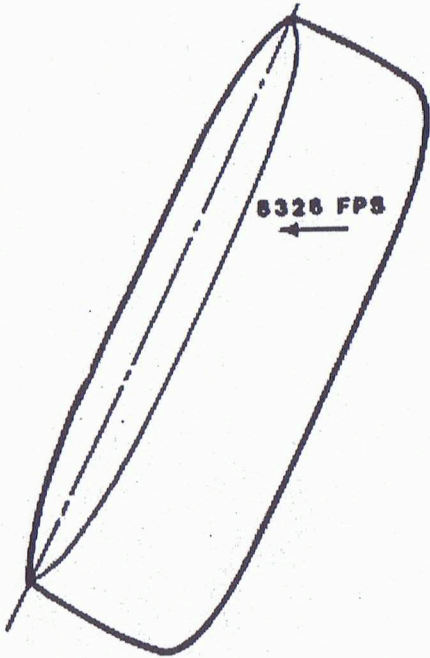
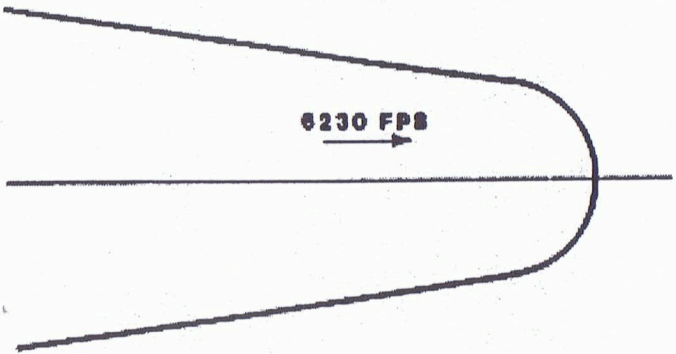
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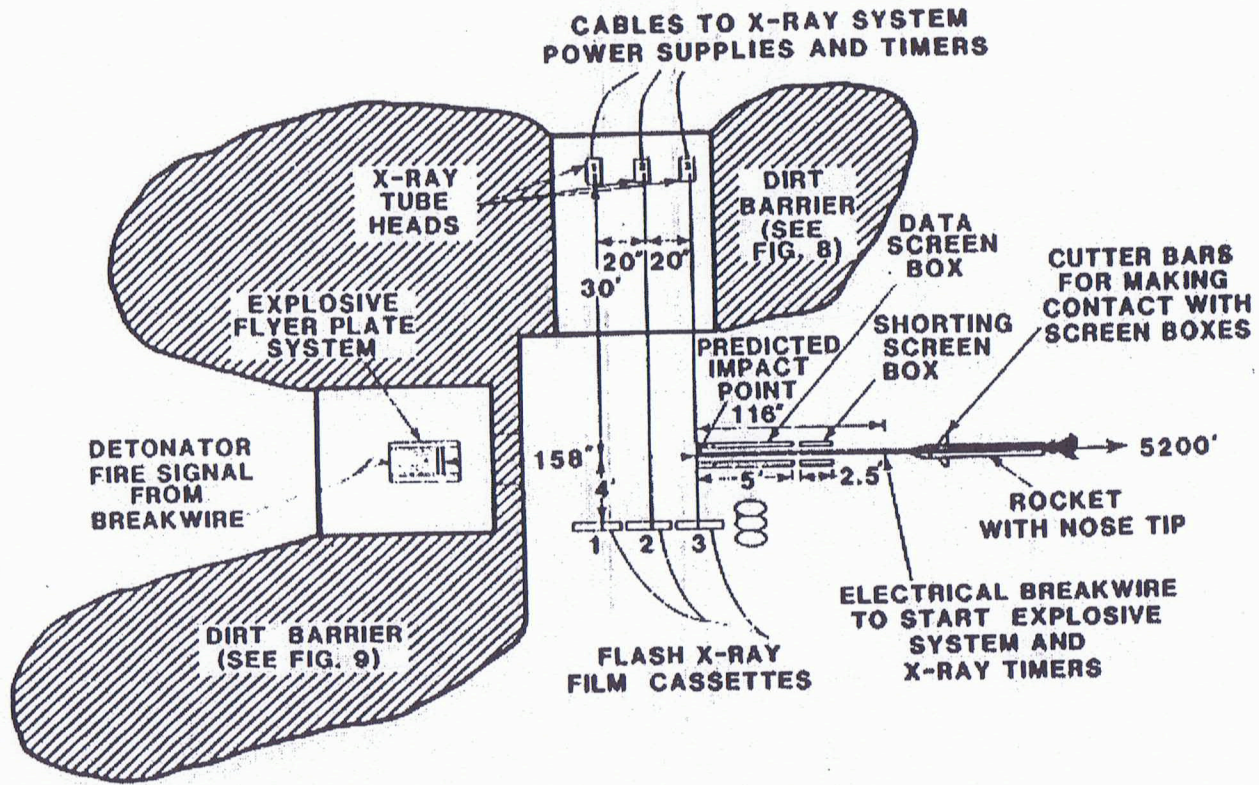
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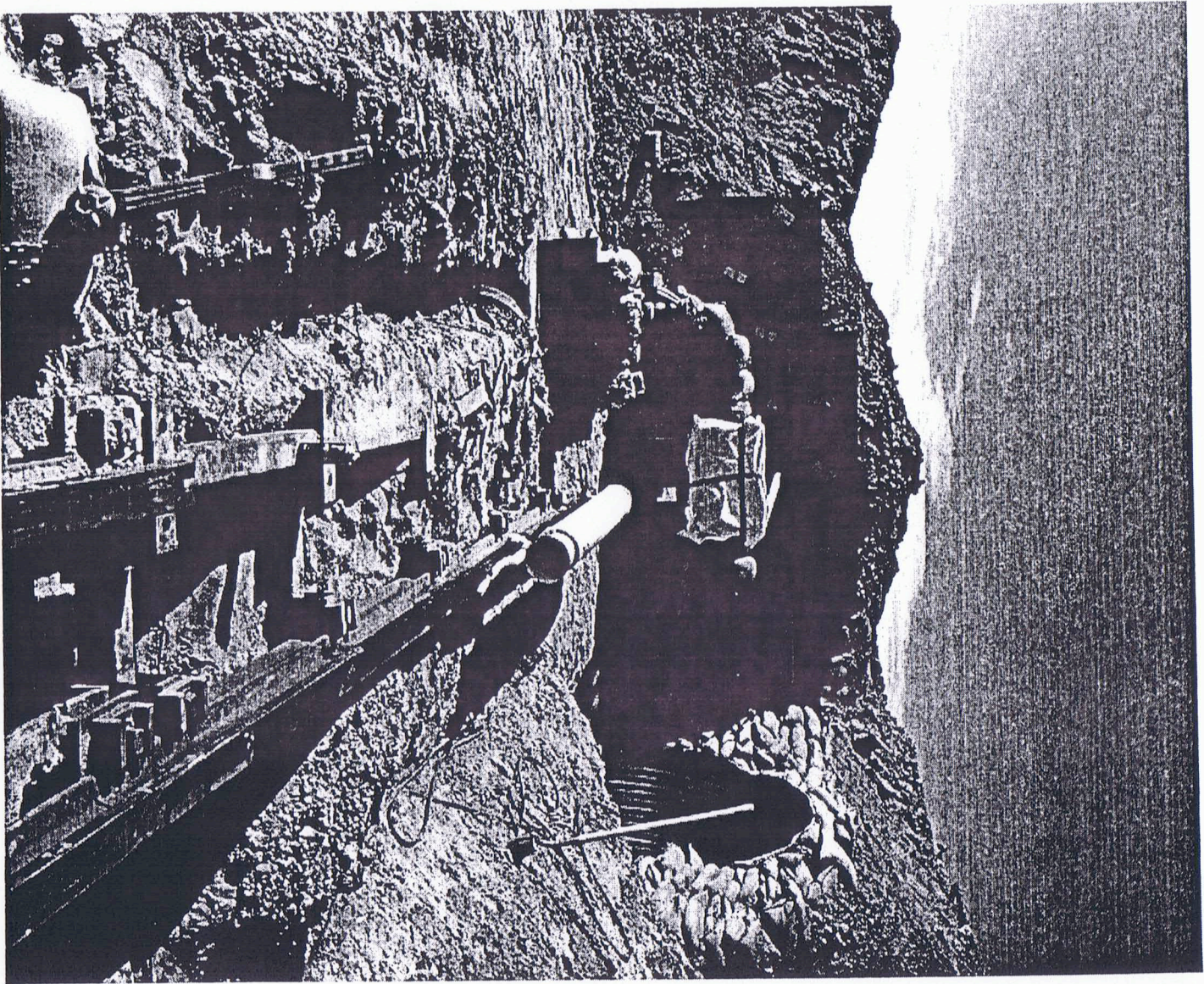
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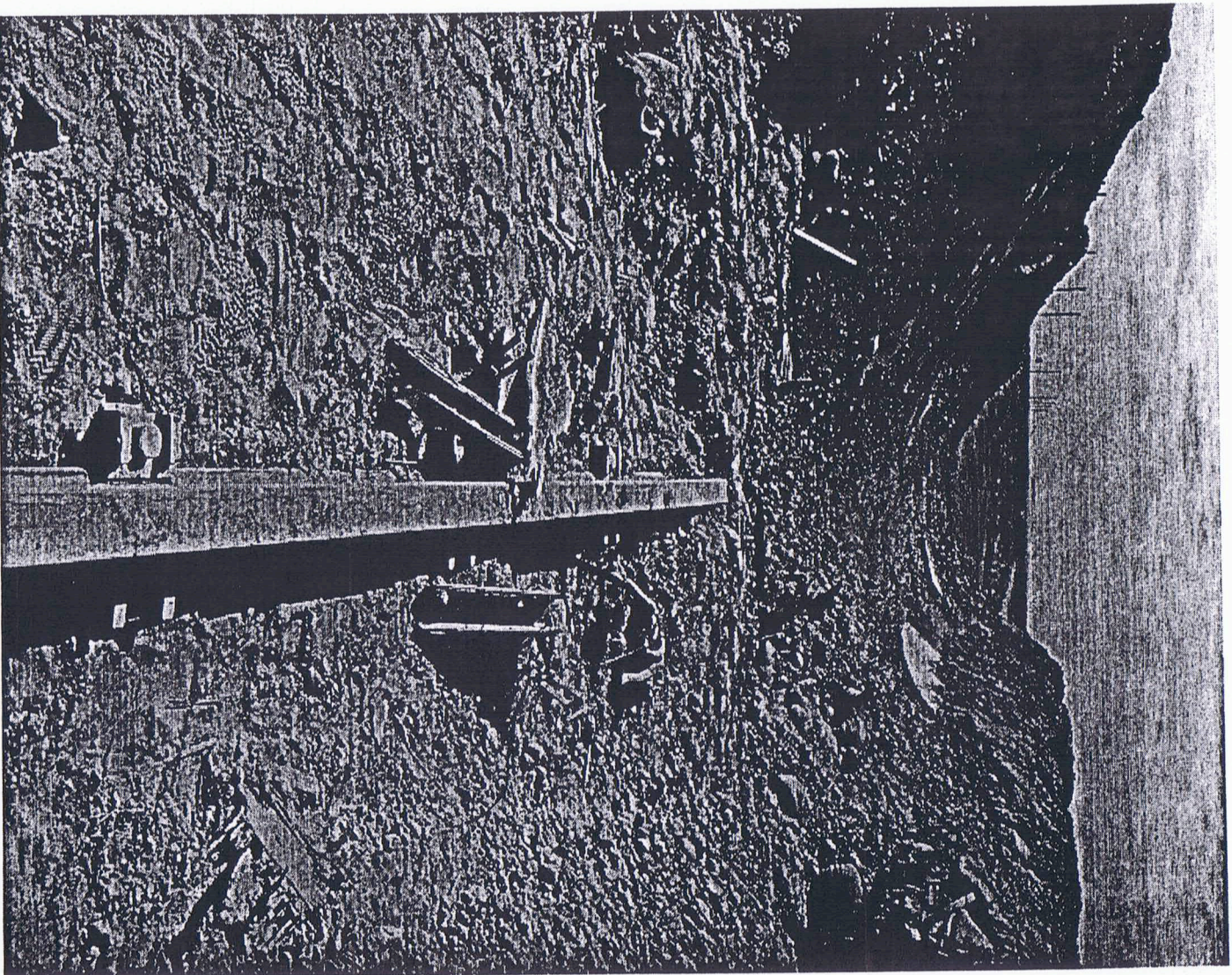
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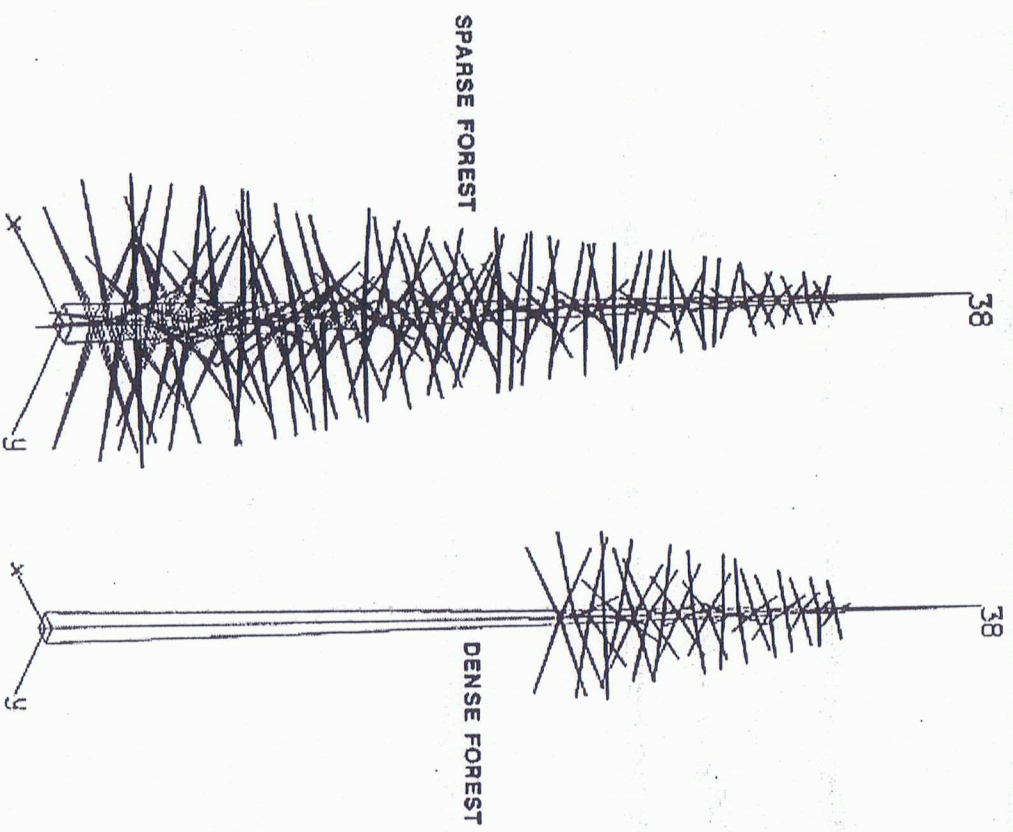
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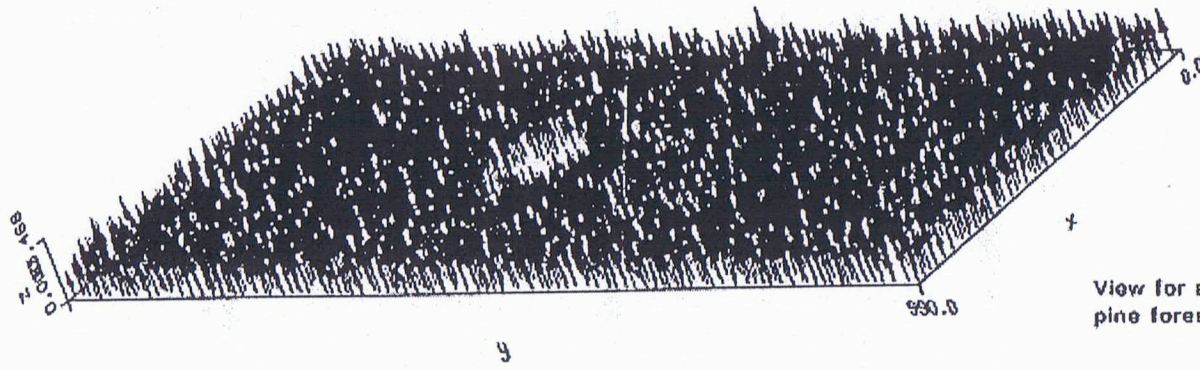
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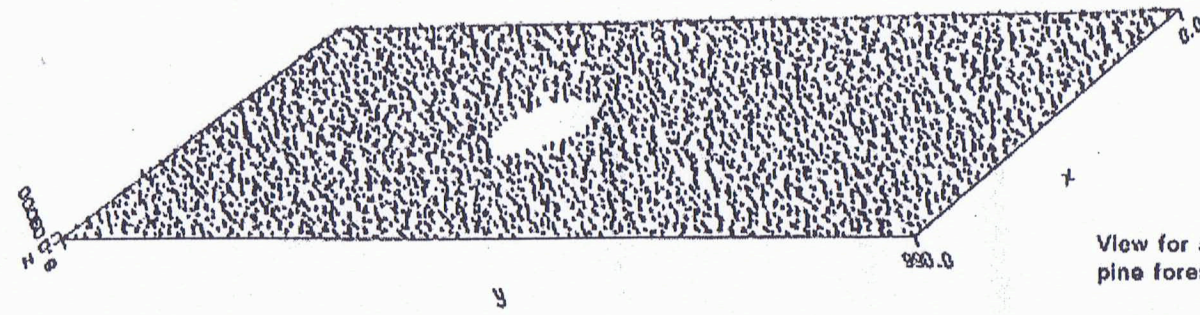
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Pine Tree Models for Sparse and Dense Forests



View for a 100 year old
pine forest, P=0.80



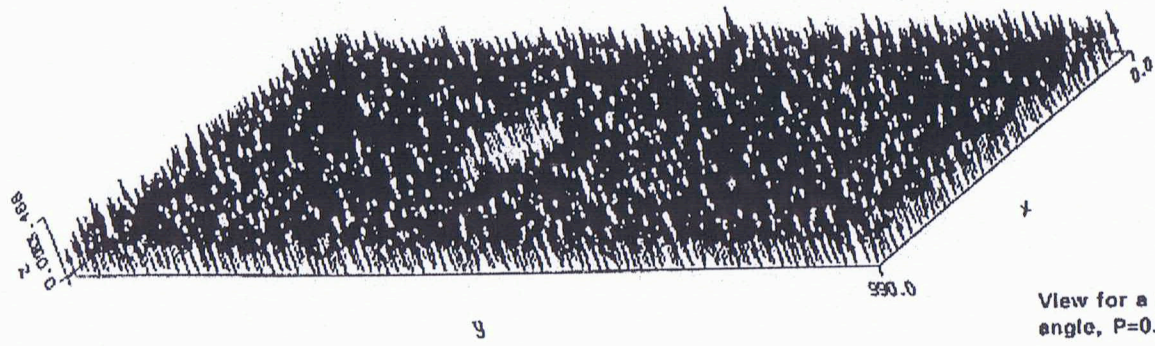
View for a 7 year old
pine forest, P=0.13

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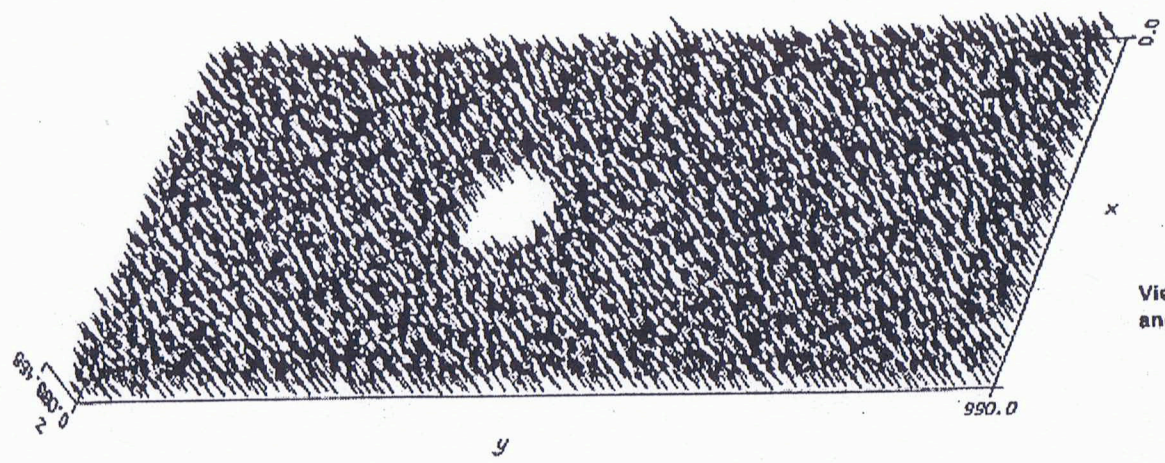
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View for a 20° Impact angle, P=0.80

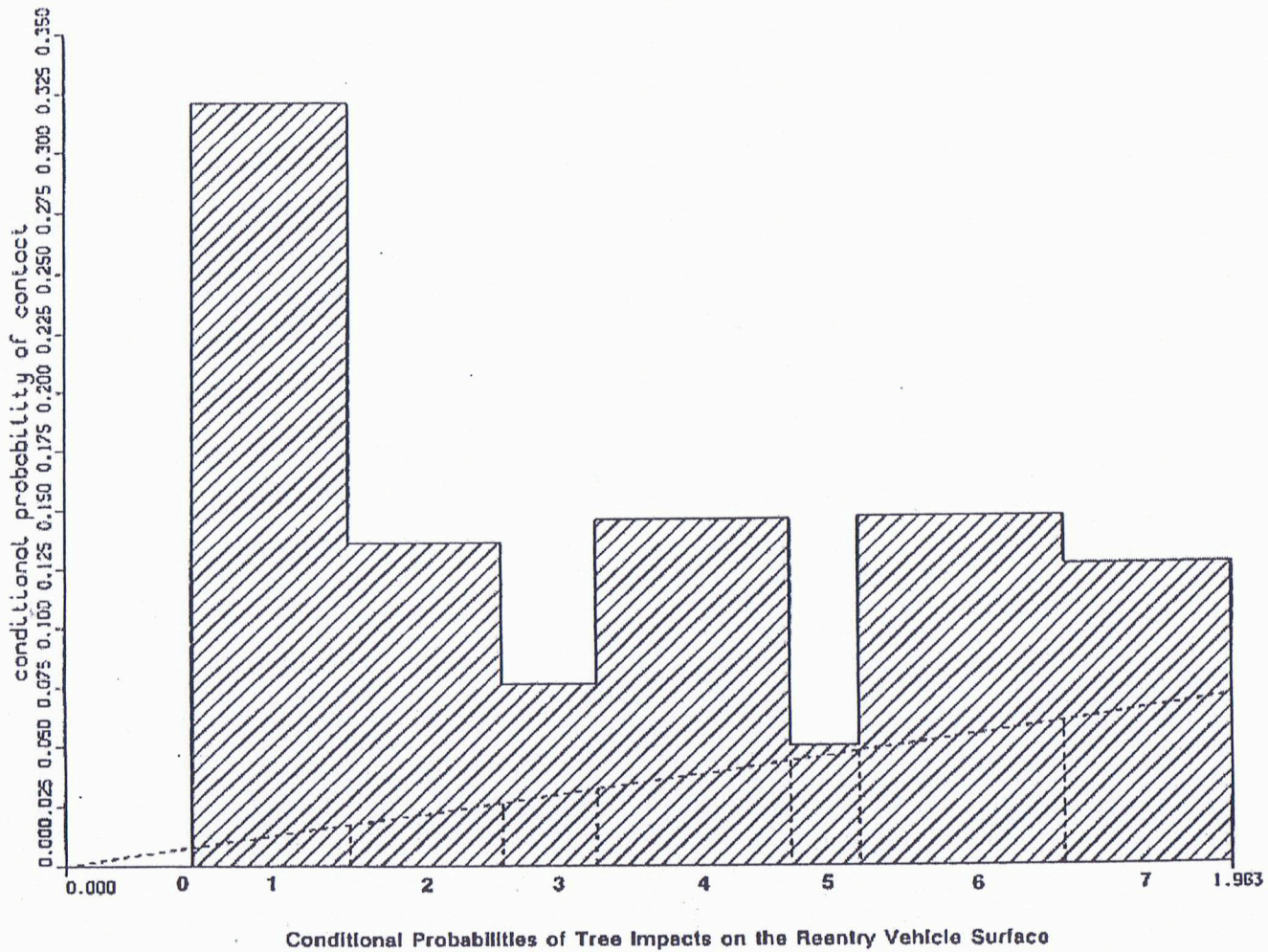


View for a 40° impact angle, P=0.54

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