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COMPARISON OF MECHANICAL PROPERTIES OF 105MM M68 GUN TUBE FORGINGS

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May 1980

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Cannon Tubes
ESR
Rotary Forging
Gun Steel

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

105mm M68 gun tube forgings are supplied at present by two vendors and the Watervliet Arsenal rotary system. A study was initiated to compare mechanical properties of the most recent vendor-supplied tubes with those supplied by them in the past. The vendor-supplied tubes were produced from vacuum degassed steel, whereas the rotary forged tubes were produced from electroslag remelted (ESR) steel. The study shows that the quality of tubes, in terms of mechanical properties varies between vendors, but that the quality from each vendor has remained fairly constant. The study also shows that the tubes produced from ESR are equivalent to those produced by conventional forging and heat treating techniques.

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ABSTRACT

105mm M68 gun tube forgings are supplied at present by two vendors and the Watervliet Arsenal rotary forge system. A study was initiated to compare mechanical properties of the most recent vendor-supplied tubes with those supplied by them in the past. The vendor-supplied tubes were produced from vacuum degassed steel, whereas the rotary forged tubes were produced from electroslag remelted (ESR) steel. The study shows that the quality of tubes, in terms of mechanical properties varies between vendors, but that the quality from each vendor has remained fairly constant. The study also shows that the tubes produced from ESR are equivalent to those produced by conventional forging and heat treating techniques.

Key Words

Cannon Tubes
ESR
Rotary Forging
Gun Steel

INTRODUCTION

Watervliet Arsenal is supplied with 105mm M68 gun tube forgings by two private industry vendors and by the rotary forge integrated line system. This study was initiated to compare the mechanical properties obtained by each method of production.

The two vendors use open die forged solid vacuum degassed ingots for their gun tube forgings, and trepan and rough machine prior to heat treatment. The rotary forging procedure in use when these data were generated was to first rotary forge a solid ingot to the preform outside diameter and then cut it to length to produce two preforms. The solids were trepanned and then hot rotary forged over a mandrel to the finished forging dimensions. The vendors also use annealing, normalizing, and rough machining operations prior to the hardening and tempering heat treatment of the tubes. In the rotary forge integrated line system, these steps are eliminated. Only a sawing operation is required to trim the tubes to heat treat length.

A comparison of the methods of production is shown in Chart I, giving typical procedures and times involved in each. It should be noted that the rotary forging system is a much faster method of producing gun tube forgings.

APPROACH

A random sampling of tubes from each source was used in the study. Since the first production of tubes by the rotary forge system was in 1977, the sampling from the vendors was taken from forgings supplied by them in the same year. A sampling of forgings was also taken from those supplied by them from 1970 to 1973.

The data used in the study were obtained from the certified vendors tests and from tests taken at Watervliet of the rotary forge forgings. These tests are in accordance with MIL-S-46119, ASTM-A370-65 and applicable Watervliet Arsenal drawings. The data involved are for yield strength, percent reduction in area, and impact energy.

RESULTS AND DISCUSSION

The data are shown by histograms in Graphs I-XV. A statistical analysis of the mechanical property data was made by computer. The results are summarized in Chart II. The means of the yield strength, reduction in area and Charpy impact, satisfied the specifications of 160,000 to 180,000 psi yield strength, 25% minimum reduction in area, and 15 ft/lb. minimum Charpy impact at -40°F. The forgings produced by the rotary forge system were equal to those of

vendor B and were, like vendor B's, better than those of vendor A. The reduction in area and impact strength of vendor B and the rotary forged forgings were higher than vendor A.

CONCLUSIONS

1. Both the rotary forge method and conventional forging supply high quality gun tube forgings.

2. The vendors, over the years, have consistently supplied a quality product.

3. The method of heat treatment, vertical or horizontal, is capable of producing the same mechanical properties.

CHART I

Vendor	Material	Forge Pre-Heat	Forging	Component	Preparation for Heat Treat	Heat Treatment	Completion of Product
A	Vacuum Degassed Ingot	Horizontal Furnace	Open Die	Solid Gun Tube Forging	Sub-Critical Anneal Rough Machine and Trepan	Vertical Furnaces Normalize Harden Temper	Finish Machine
B	Vacuum Degassed Ingot	Horizontal Furnace	Open Die	Solid Gun Tube Forging	Anneal Rough Machine and Trepan	Vertical Furnaces Normalize Harden Temper	Finish Machine
Rotary Forge Integrated Line	ESR Ingot*	Induction Heater	Rotary Forge	Hollow Gun Tube Forging	Cut to Heat Treat Length	Horizontal Continuous Barrel Line Furnace Harden and Temper	Finish Machine

*Rotary forged to a solid preform, trepanned into a hollow preform, and rotary forged into a tube.

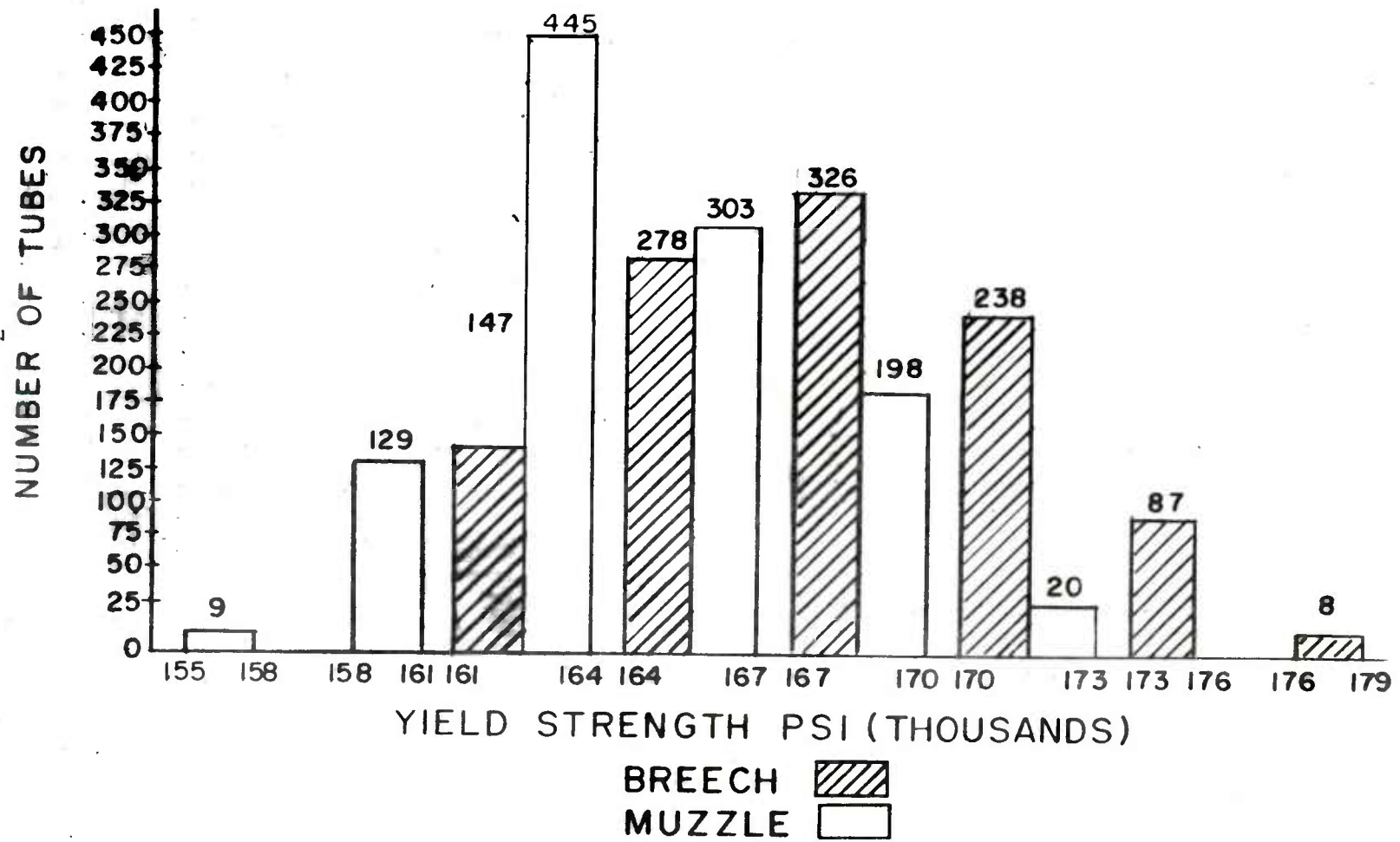
CHART II

	VENDOR A		VENDOR B		ROTARY FORGE
Yield Strength	1970-1973	1977	1970-1973	1977	1977
Breech End(Range)	160.0/185.5	164.5/178.0	160.5/179.0	162.0/173.0	162.6/179.5
Average	168.4	171.5	169.3	167.7	170.5
Muzzle End(Range)	157.0/182.7	163.5/174.0	160.2/176.5	161.0/174.5	156.6/172.2
Average	168.4	169.6	168.5	167.1	164.6

	VENDOR A		VENDOR B		ROTARY FORGE
RA %	1970-1973	1977	1970-1973	1977	1977
Breech End(Range)	25/46	28/44	32.2/55.6	32/54	35/52
Average	34.8	34.7	45.5	46.2	44.7
Muzzle End(Range)	25/46.9	25/42	36.3/55.9	37/55	32/58
Average	34.8	34.3	47.5	46.8	45.8

	VENDOR A		VENDOR B		ROTARY FORGE
Cv-40°	1970-1973	1977	1970-1973	1977	1977
Breech End(Range)	12.5/25.5	15/23	16.5/37.5	18/34	18/34
Average	17.7	18.7	27	27.5	25.2
Muzzle End	11/24	15/23	17.5/40	18/38	19/35
Average	17.2	18	28.1	27.4	27

GRAPH I
MECHANICAL PROPERTIES
VENDOR A (1970-1973)
105mm. GUN TUBES



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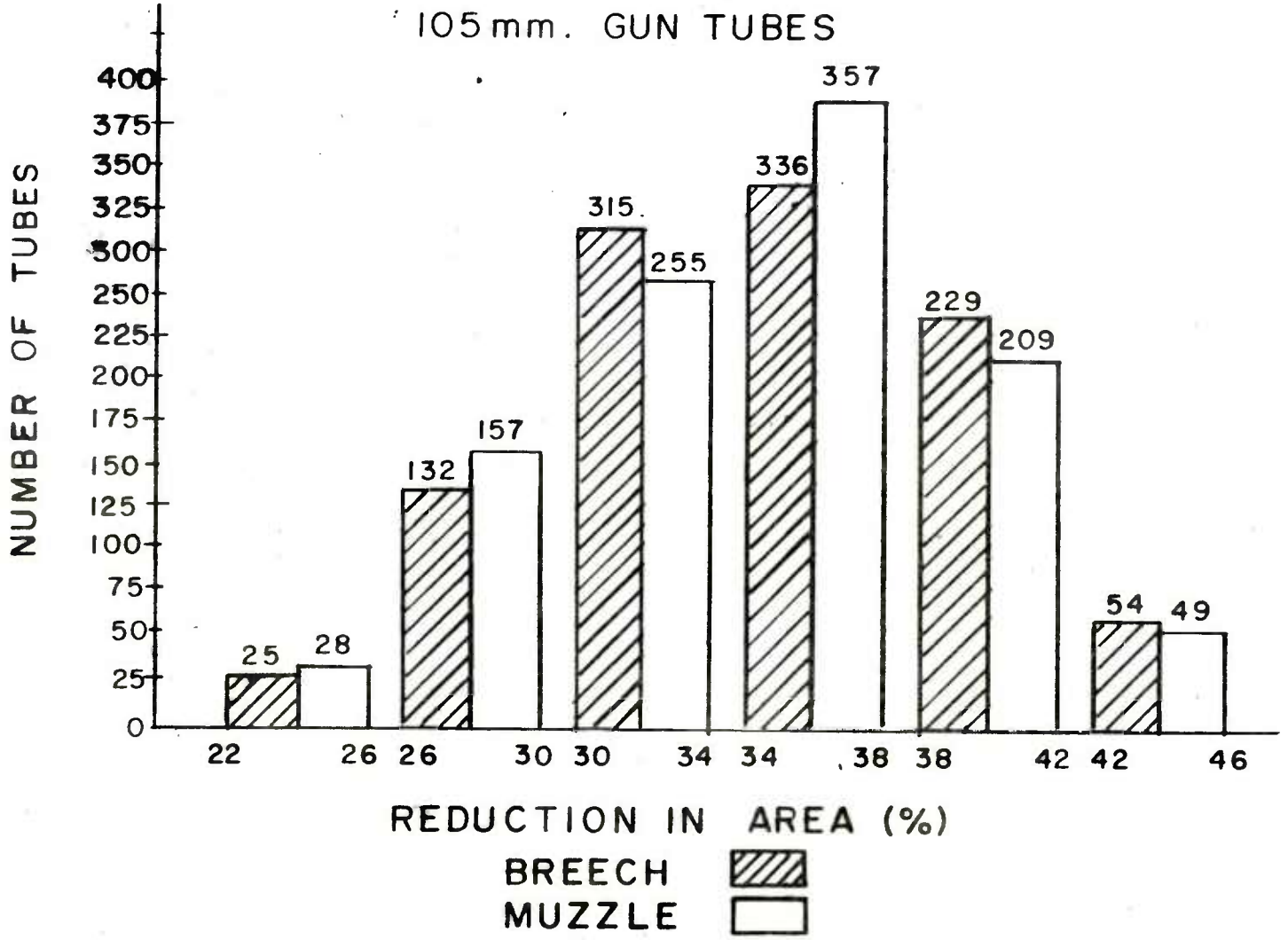

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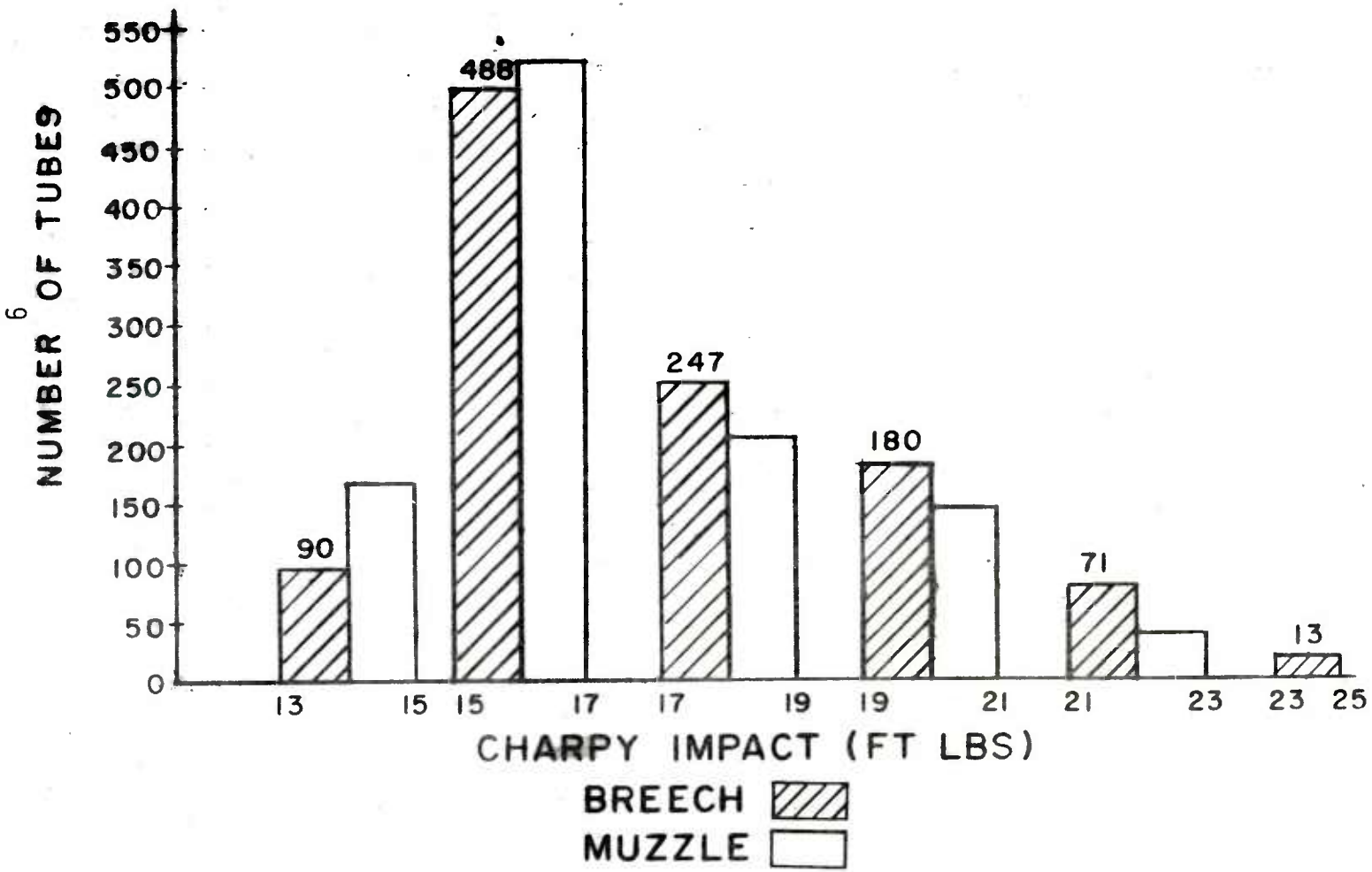

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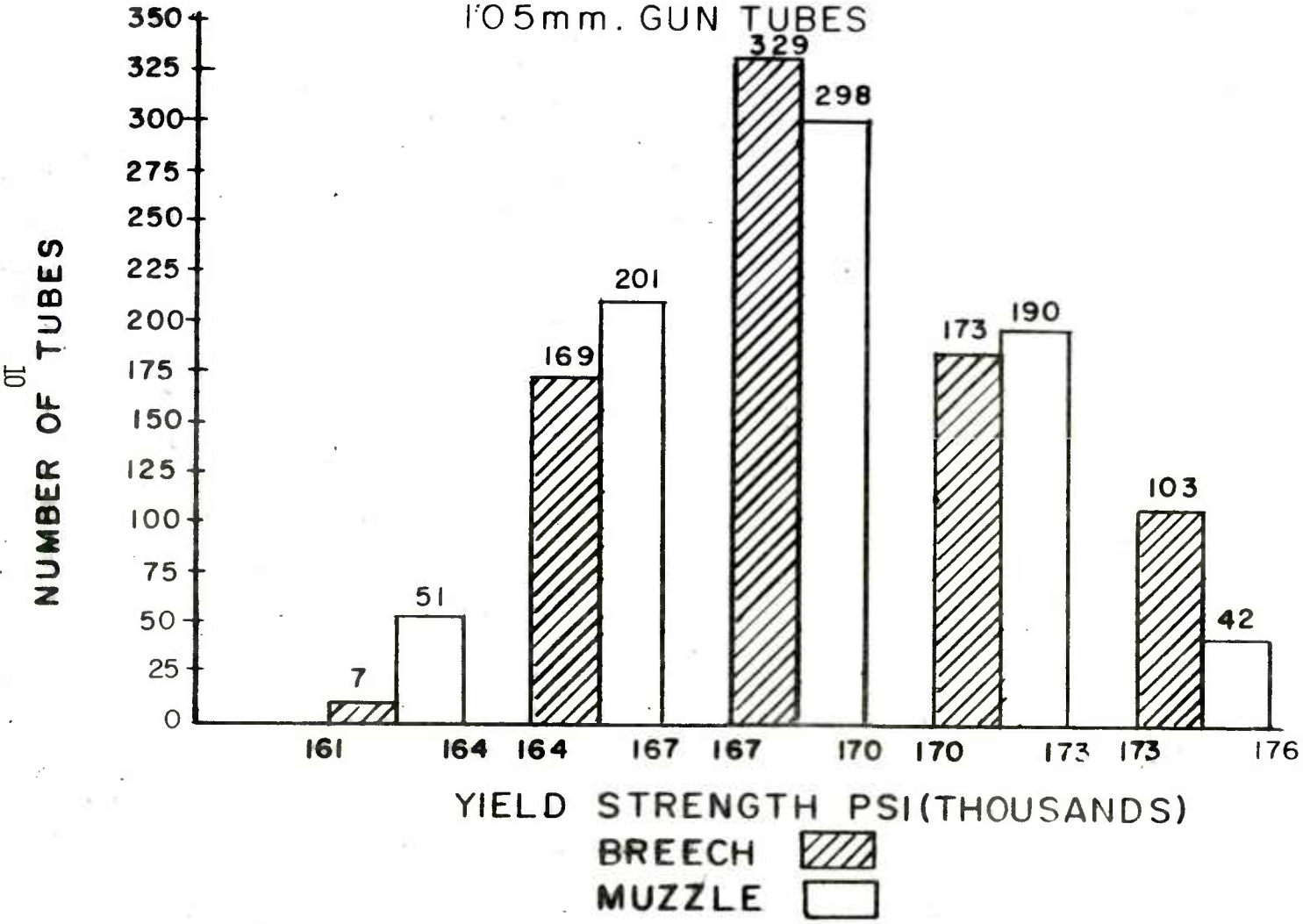

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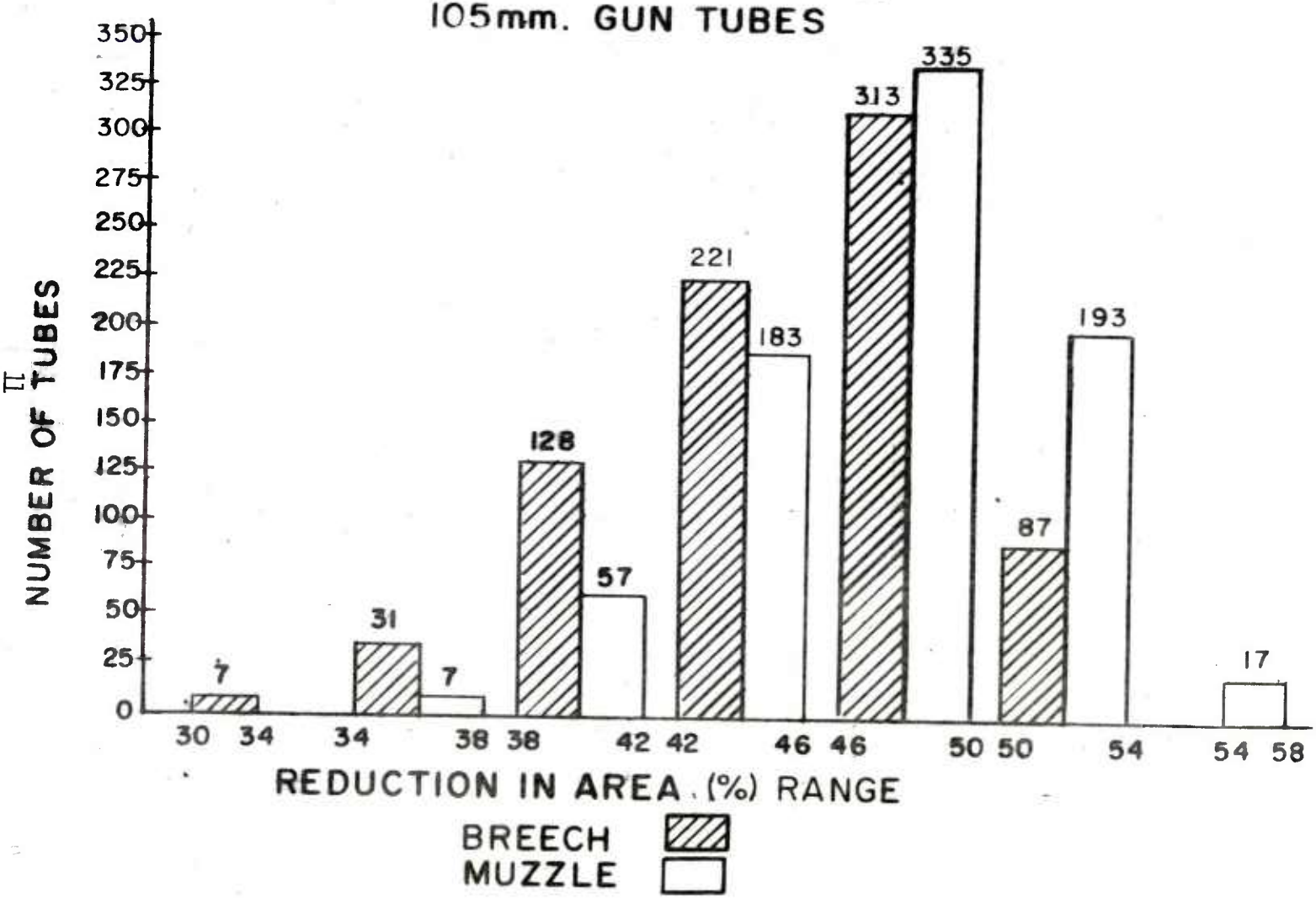

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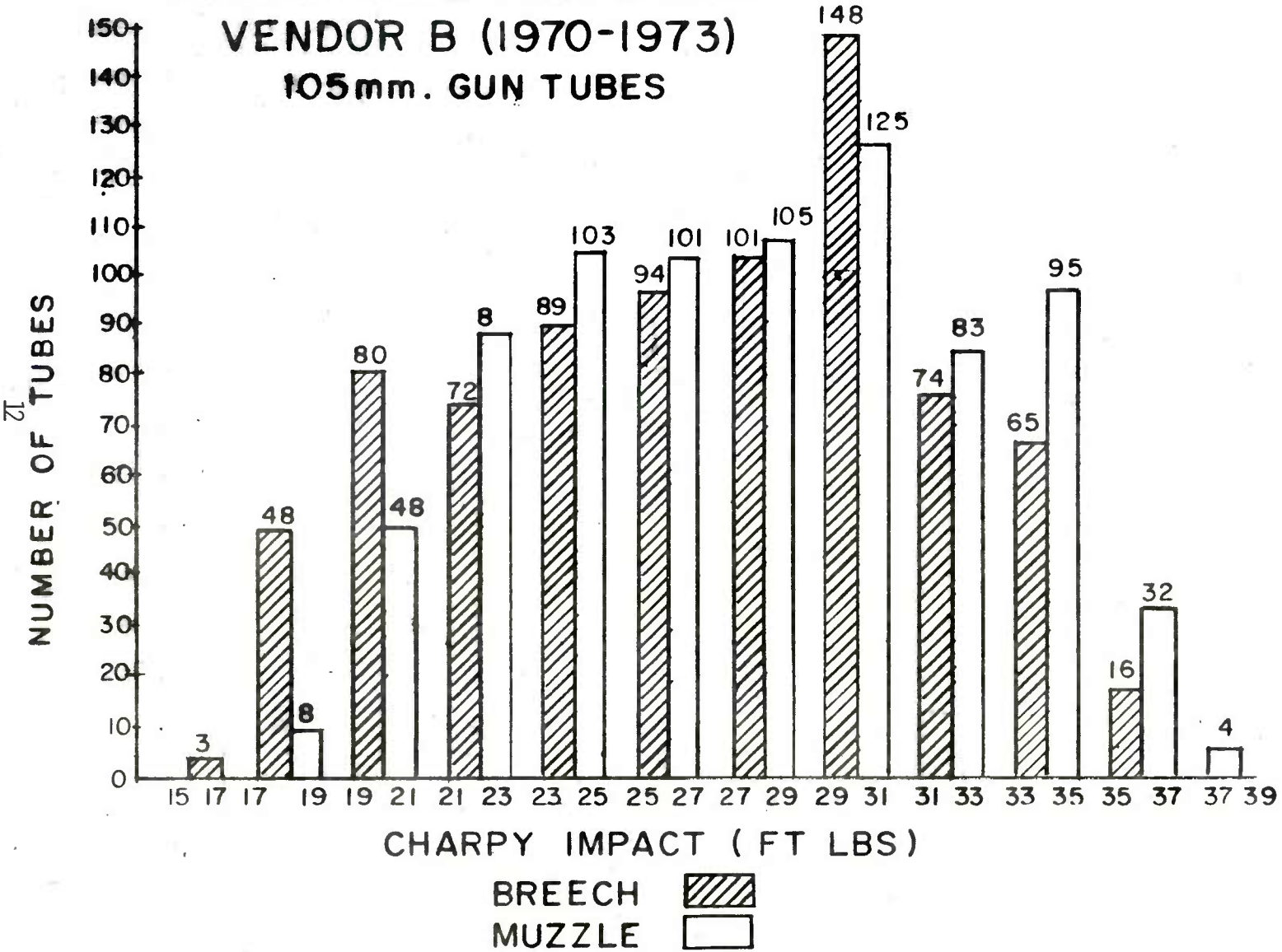

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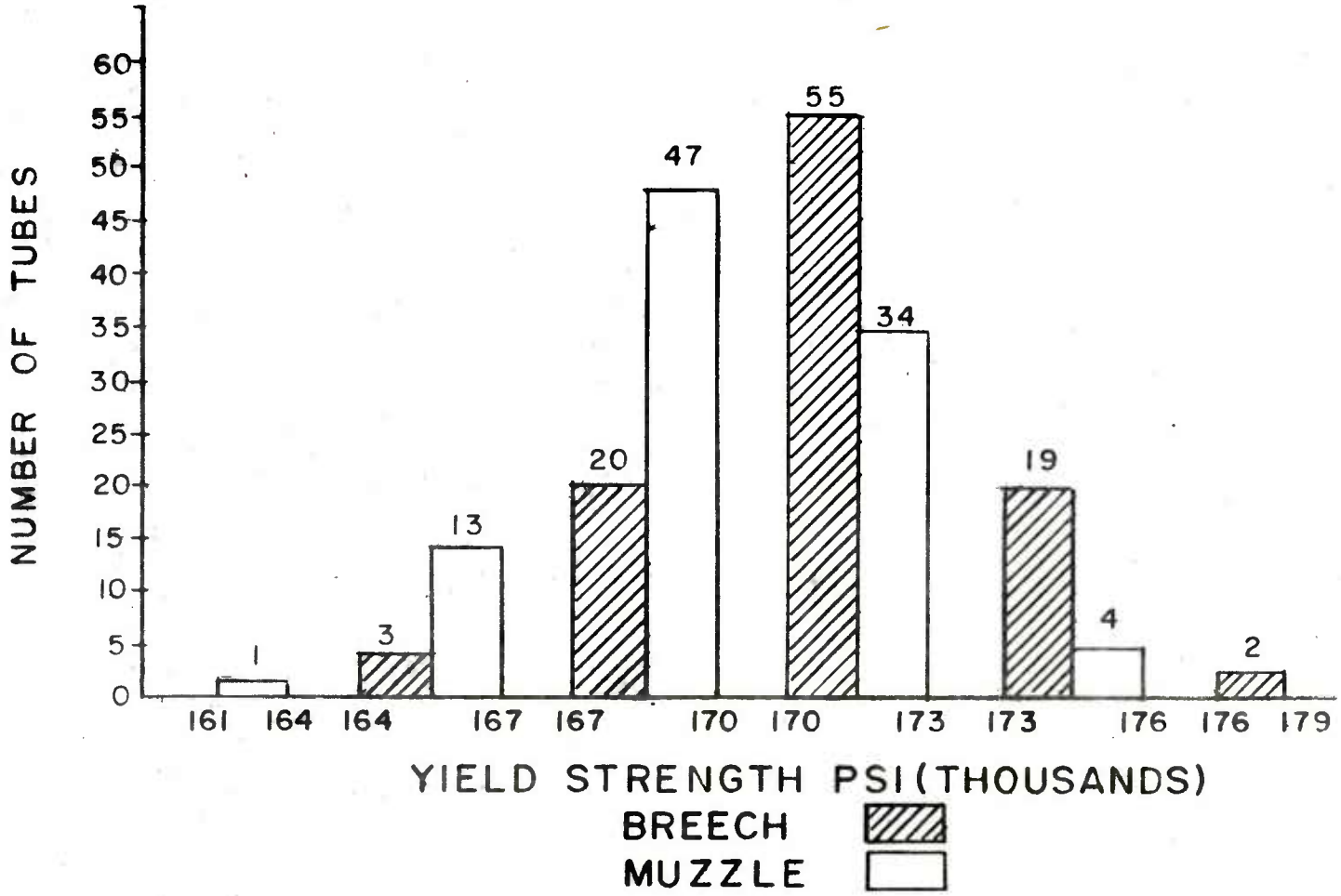

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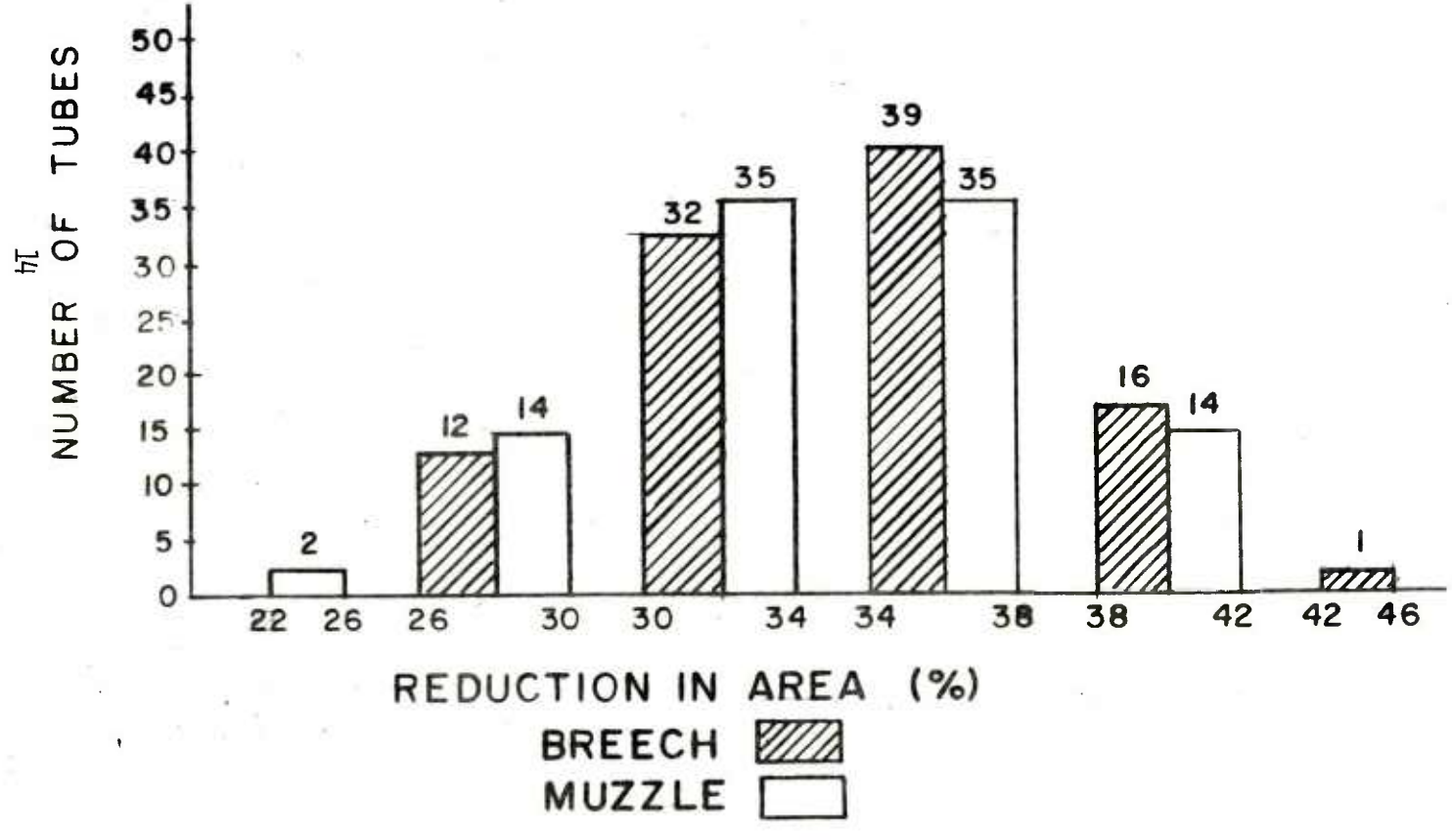

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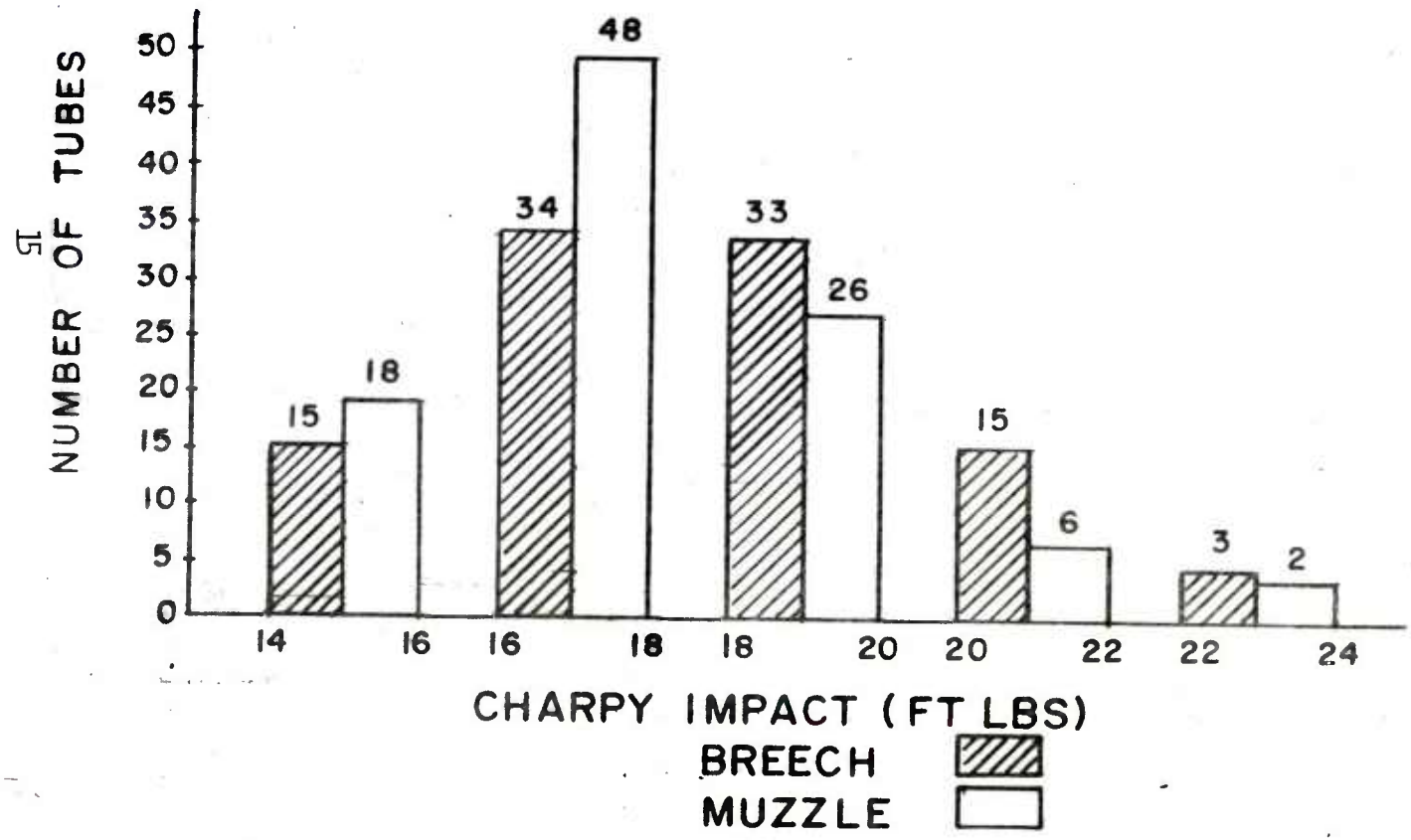

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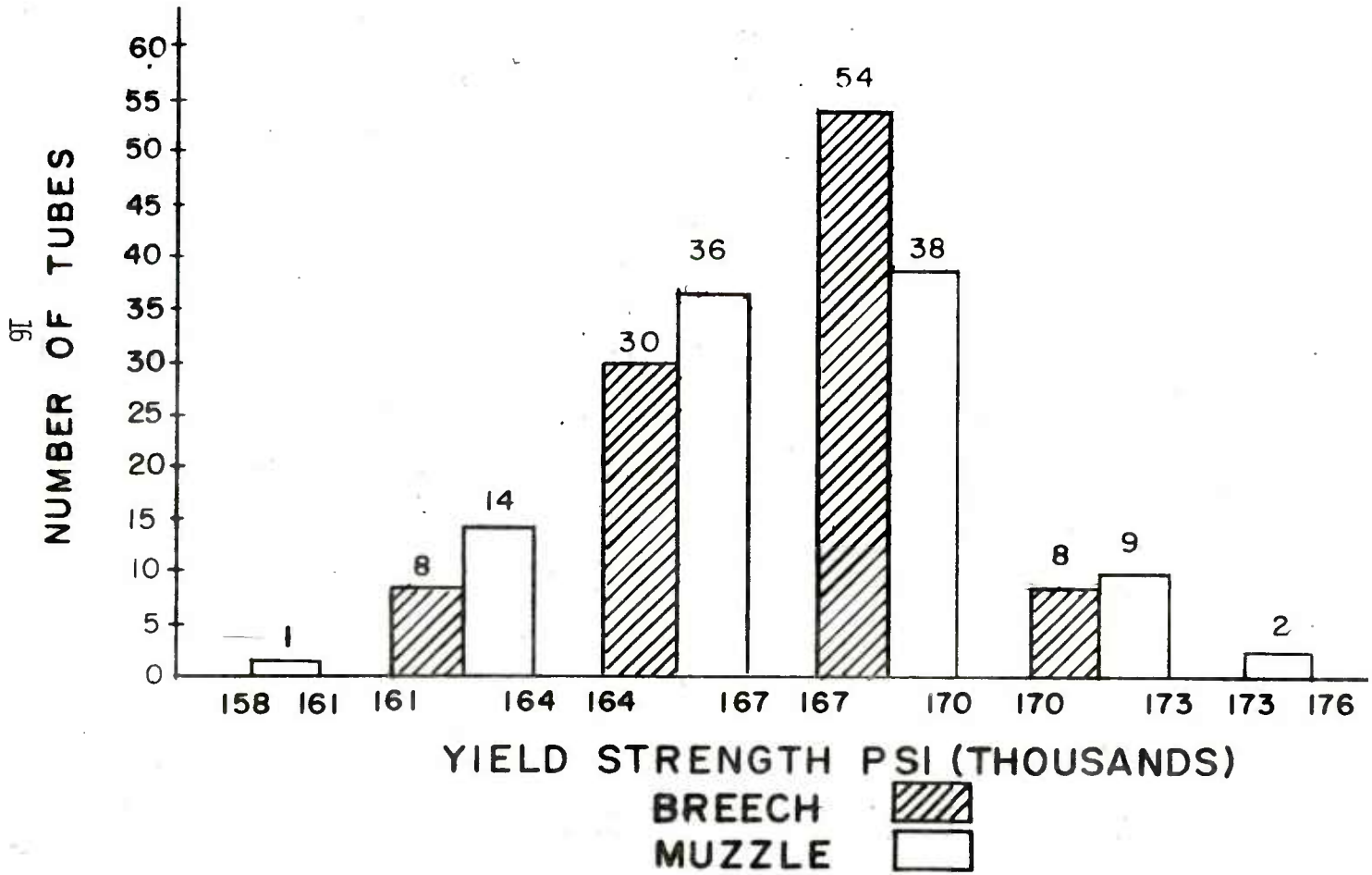

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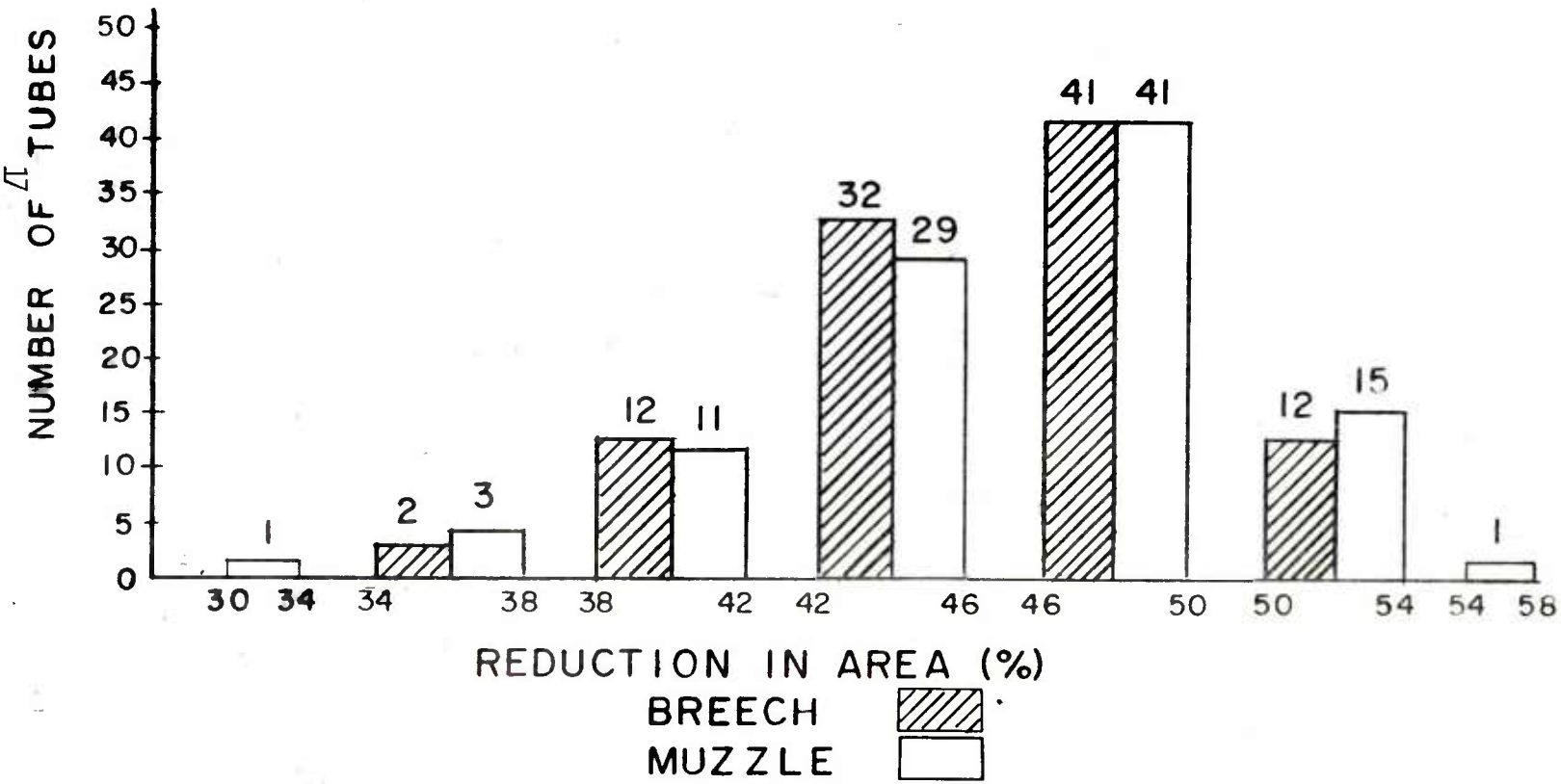

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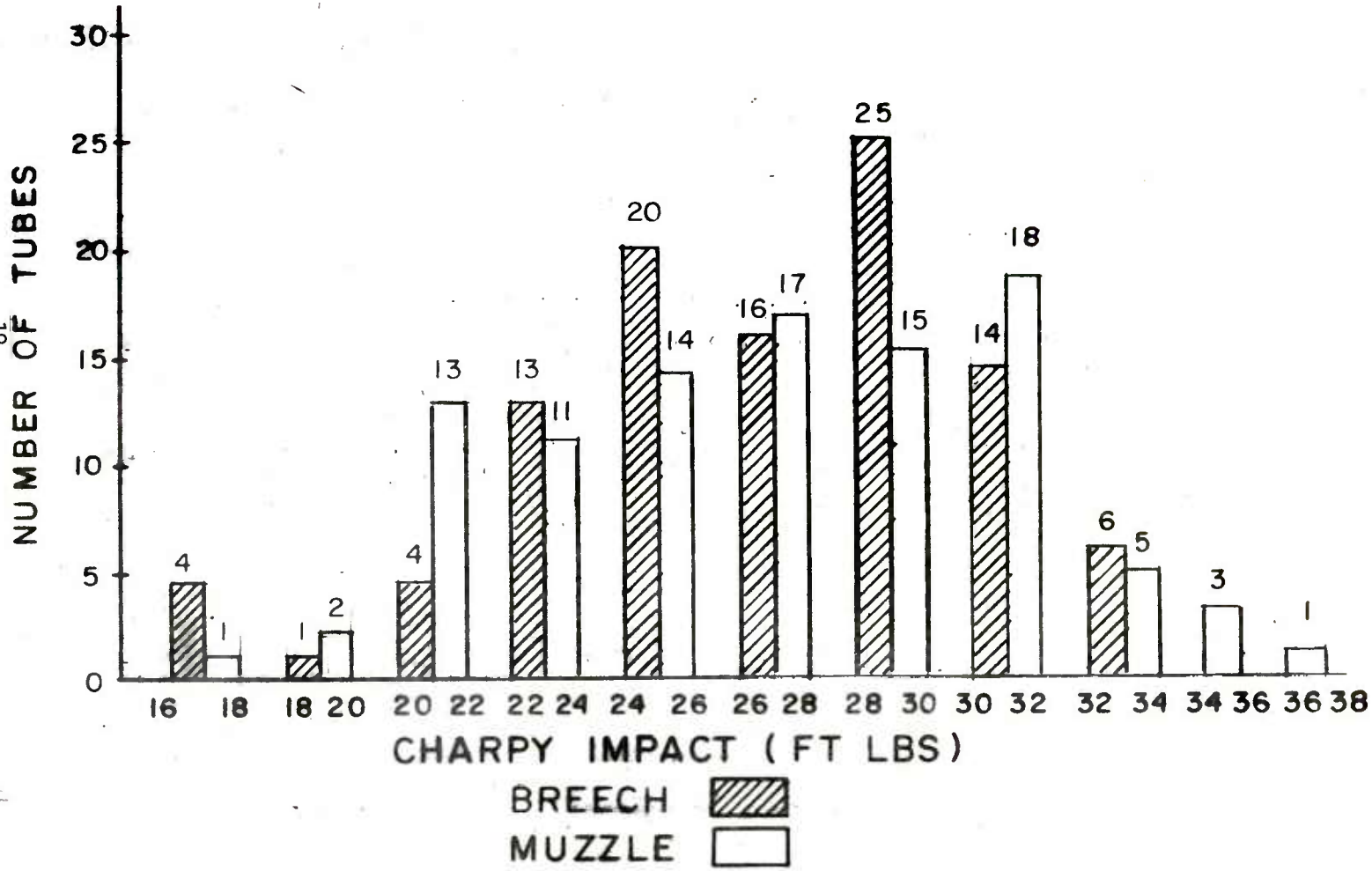

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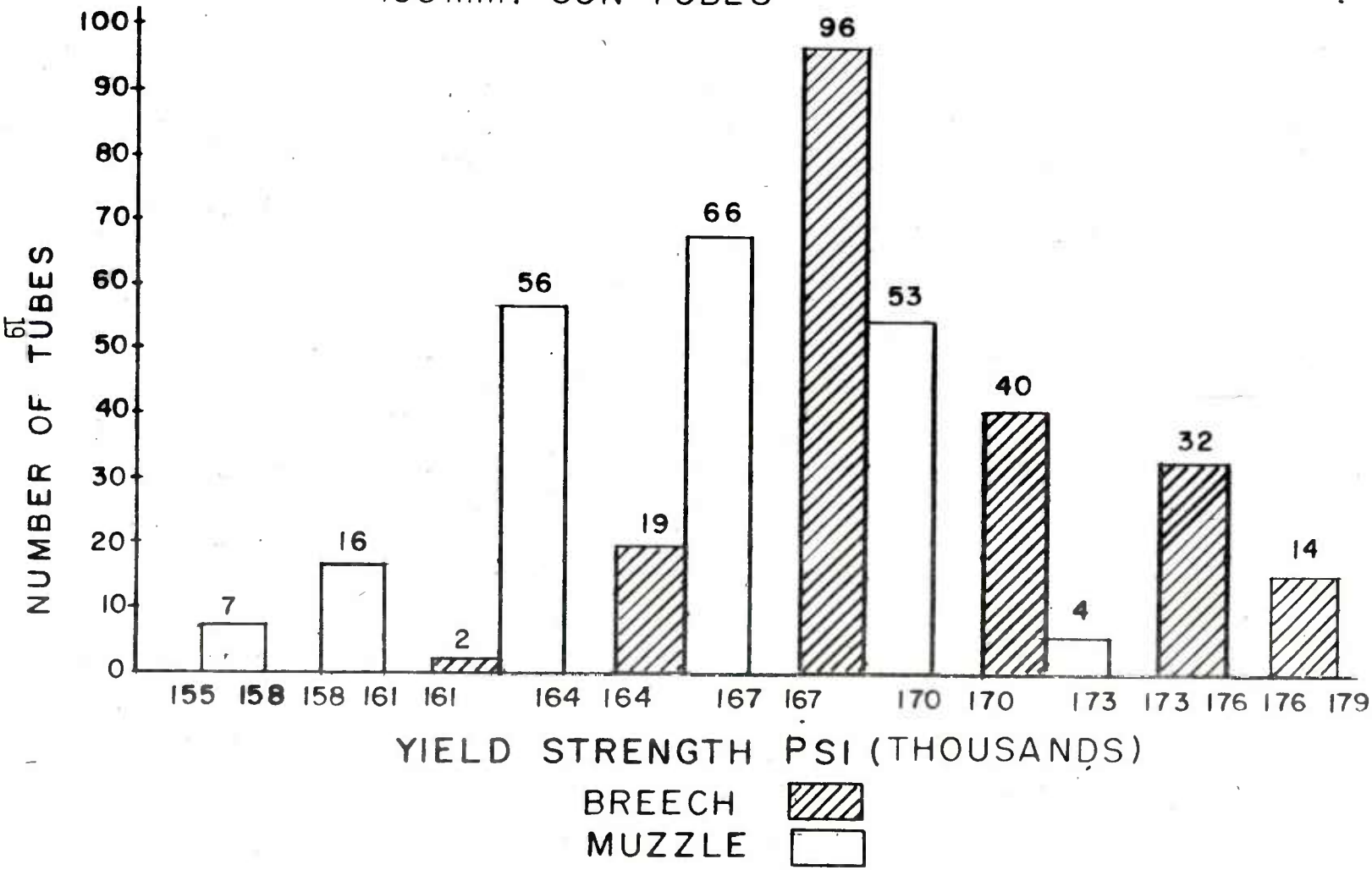

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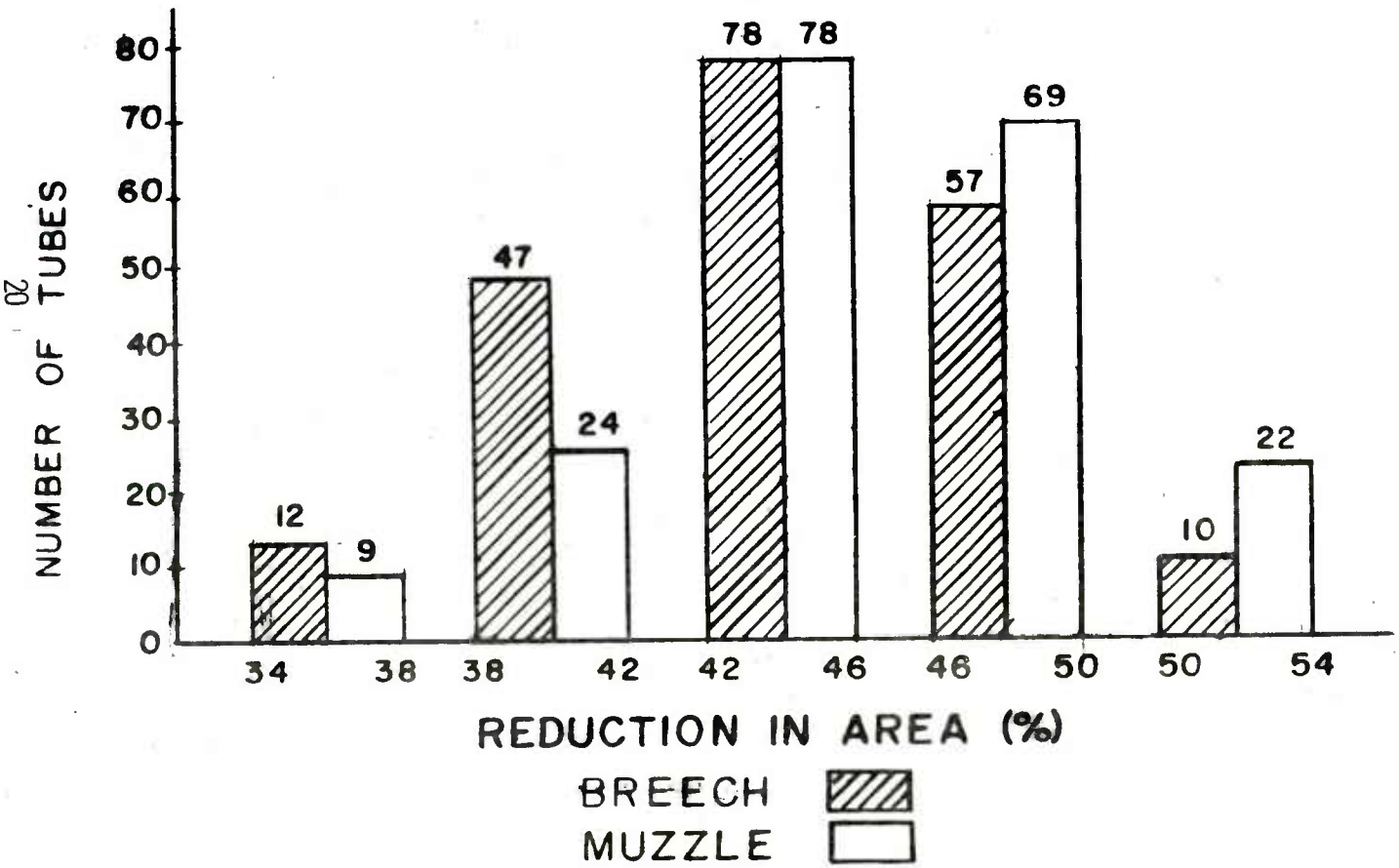

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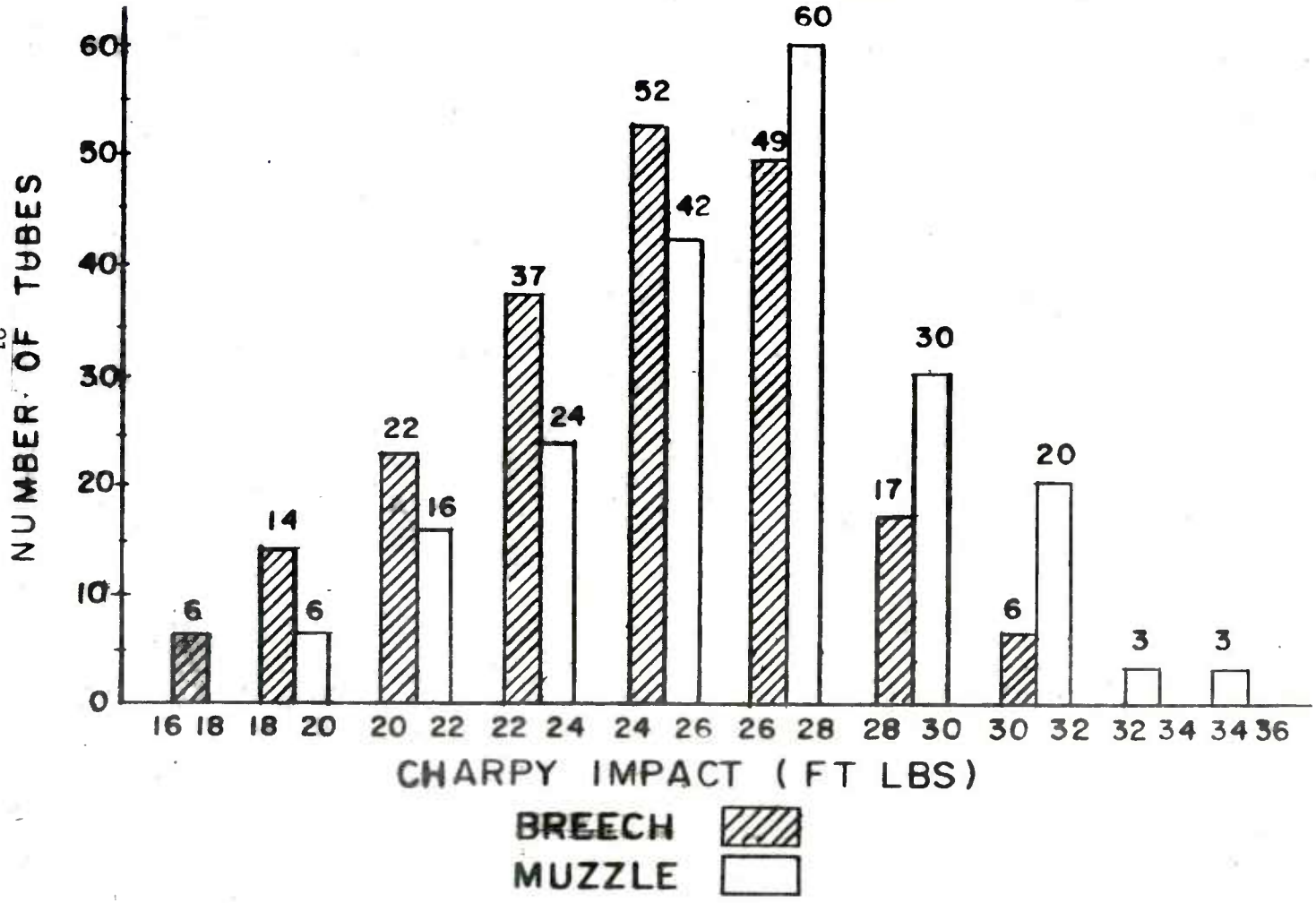

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