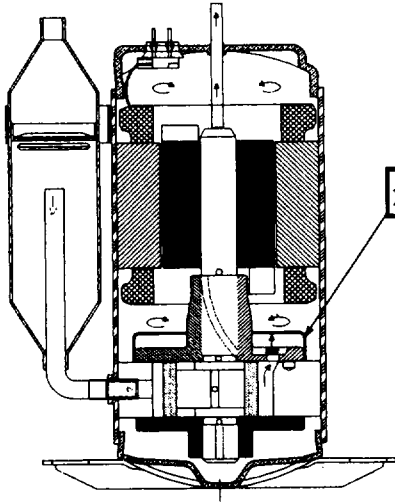


머플러 음향 특성 향상 연구

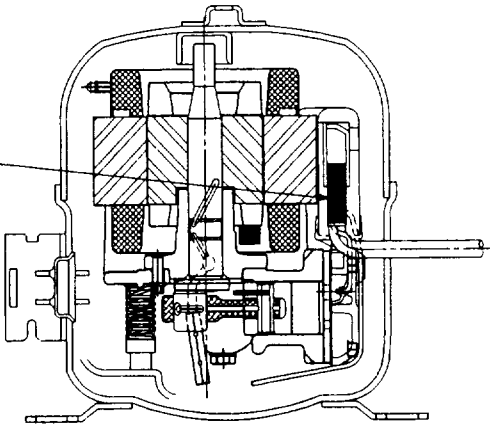
2000. 11.

오 상 경
(삼성전자)

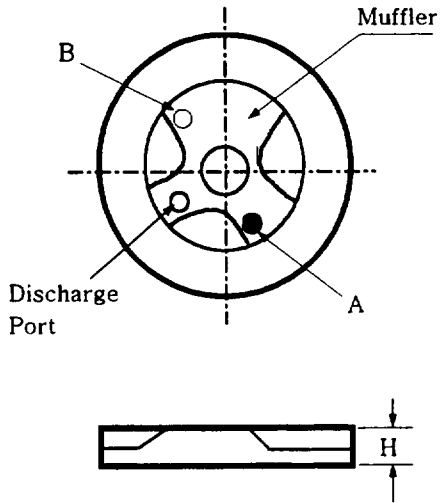
COMPRESSOR CHARACTERS



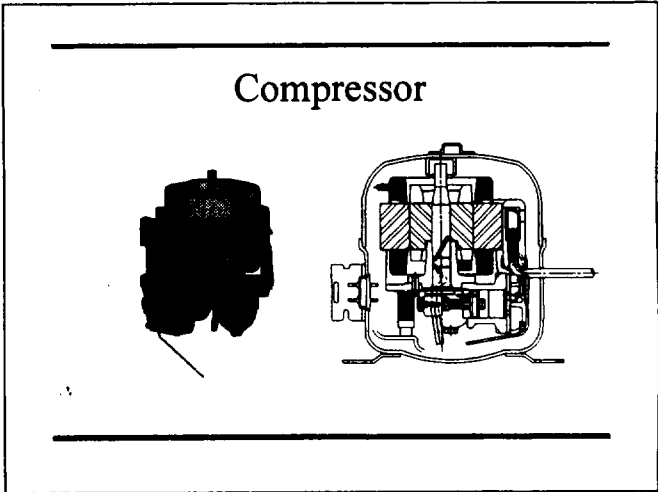
ROTARY COMPRESSOR



RECIPROCATING COMPRESSOR

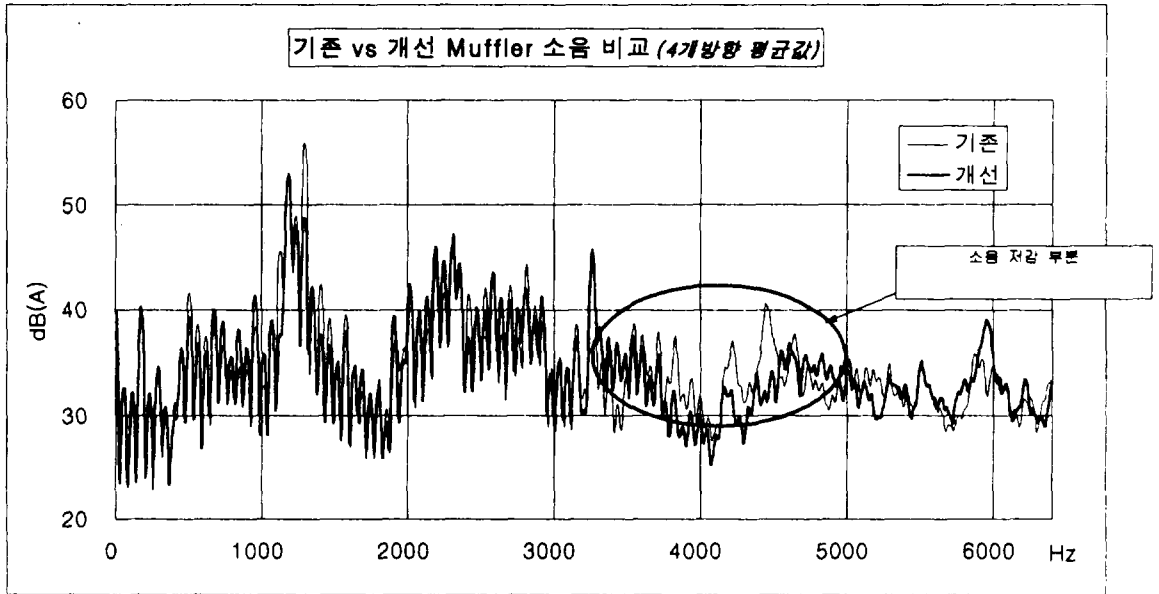


Rotary Compressor

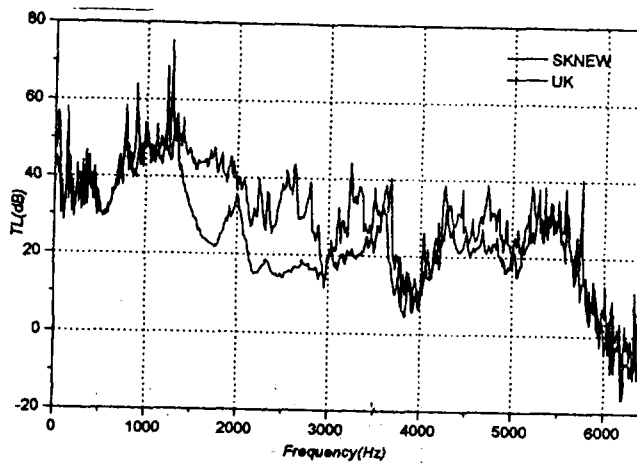


Reciprocating Compressor

NOISE CHARACTERS OF ROTARY COMPRESSOR



NOISE CHARACTERS OF RECIPROCATING COMPRESSOR

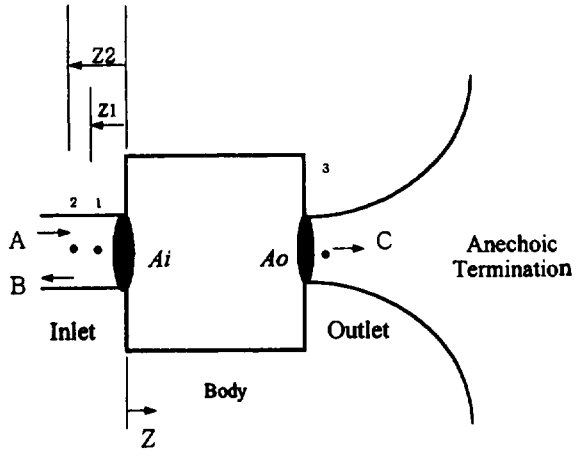


EXPERIMENTAL METHOD FOR MUFFLER

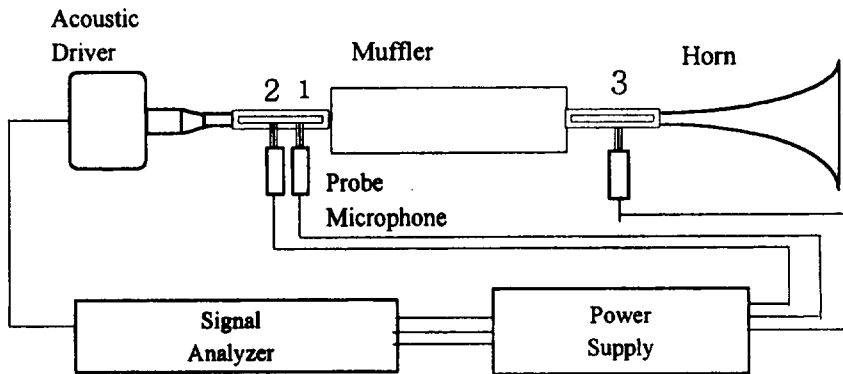
Transmission Loss ; TL

$$TL = 10 \log \frac{A_1 S_{AA}(f)}{A_0 S_{CC}(f)}$$

S_{AA}, S_{CC}: Autospectrum
at inlet and
outlet



Typical muffler and sound waves



Experimental setup for sound wave separation
by two - microphone method

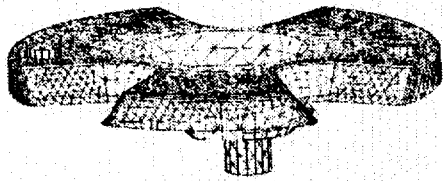
$$S_{AA}(f) = (S_{11} + S_{22} - 2\cos k(Z_1 - Z_2) + 2Q_{12} \sin k(Z_1 - Z_2)) / (4 \sin^2 k(Z_1 - Z_2))$$

$$S_{BB}(f) = (S_{11} + S_{22} - 2\cos k(Z_1 - Z_2) - 2Q_{12} \sin k(Z_1 - Z_2)) / (4 \sin^2 k(Z_1 - Z_2))$$

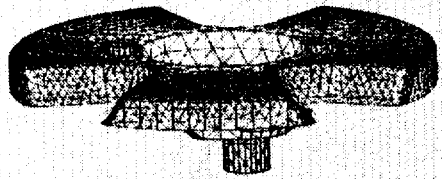
$$S_{CC}(f) = S_{33}$$

여기서,

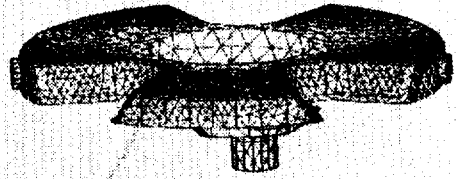
- A : 입사파 A_i : 머플러 입구 단면적 A_o : 머플러 출구 단면적
 B : 반사파 C : 출력파 k : 음파 상수 ($= 2\pi f/a_0$) a_0 : 음속
 Z_1 : 머플러 입구에서 1점까지의 거리 Z_2 : 머플러 입구에서 2점까지의 거리
 $S_{in}(f)$: 머플러 입구 음파의 입력 파워스펙트럼
 $S_{ref}(f)$: 머플러 입구 음파의 반사 파워스펙트럼
 $S_{out}(f)$: 머플러 입구 음파의 출력 파워스펙트럼
 $S_{11}(f)$: 1점 음파의 자기상관-스펙트럼 $S_{22}(f)$: 2점 음파의 자기상관-스펙트럼
 $S_{33}(f)$: 3점 음파의 자기상관-스펙트럼
 $C_{12}(f)$: 1,2점 사이의 상호상관-스펙트럼의 실수부
 $Q_{12}(f)$: 1,2점 사이의 상호상관-스펙트럼의 허수부



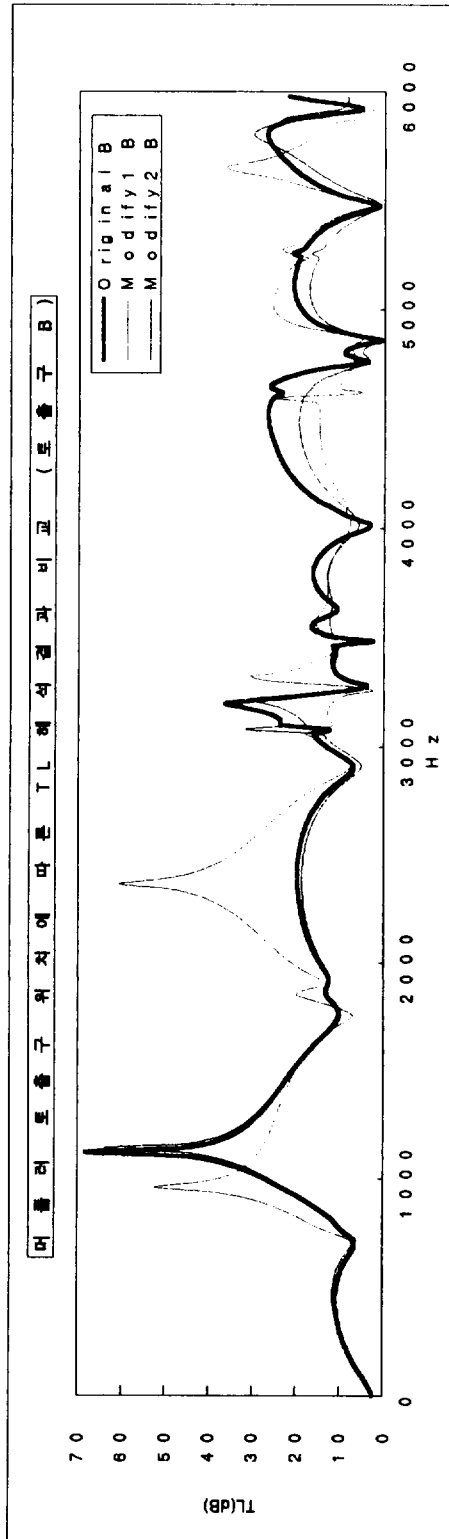
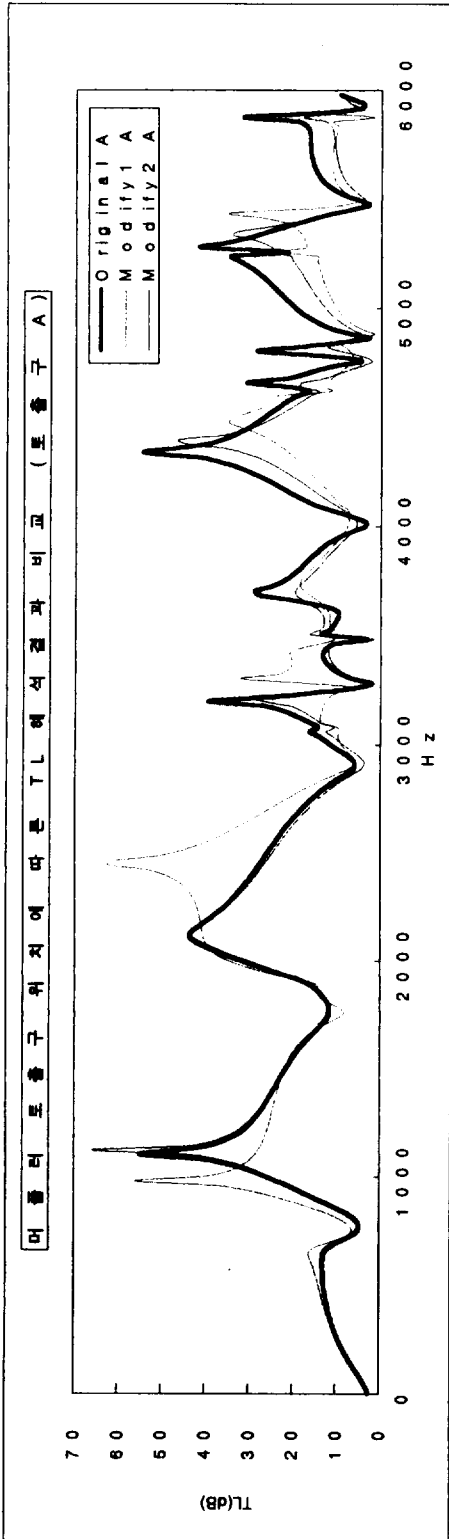
(1) 기존 개선 muffler



(2) 개선 전 muffler의 토출구 위치를 반경 안쪽으로 이동



(3) 개선 전 muffler의 각 토출구 위치를 반경 옆으로 이동



Analyzing Method

1. Field equations

— WAVE EQUATION

$$\frac{\partial}{\partial x} \left[\frac{1}{\rho} \frac{\partial p}{\partial x} \right] + \frac{\partial}{\partial y} \left[\frac{1}{\rho} \frac{\partial p}{\partial y} \right] + \frac{\partial}{\partial z} \left[\frac{1}{\rho} \frac{\partial p}{\partial z} \right] = \frac{1}{\chi} \frac{\partial^2 p}{\partial t^2}$$

— STRESS EQUILIBRIUM FOR X-DIRECTION

$$\frac{\partial}{\partial x} [\sigma_{xx}] + \frac{\partial}{\partial y} [\tau_{xy}] + \frac{\partial}{\partial z} [\tau_{xz}] = \rho \chi \frac{\partial^2 U_x}{\partial t^2}$$

— EQUILIBRIUM EQUATION

$$\nabla p + \rho \vec{\ddot{w}} = 0$$

2. SIMILARITIES

$$U_x = p$$

$$\rho_s = 1 / \chi$$

$$\sigma_{xx} = 1/\rho [\partial p / \partial x] = - \ddot{w}_x$$

$$\tau_{xy} = 1/\rho [\partial p / \partial y] = - \ddot{w}_y$$

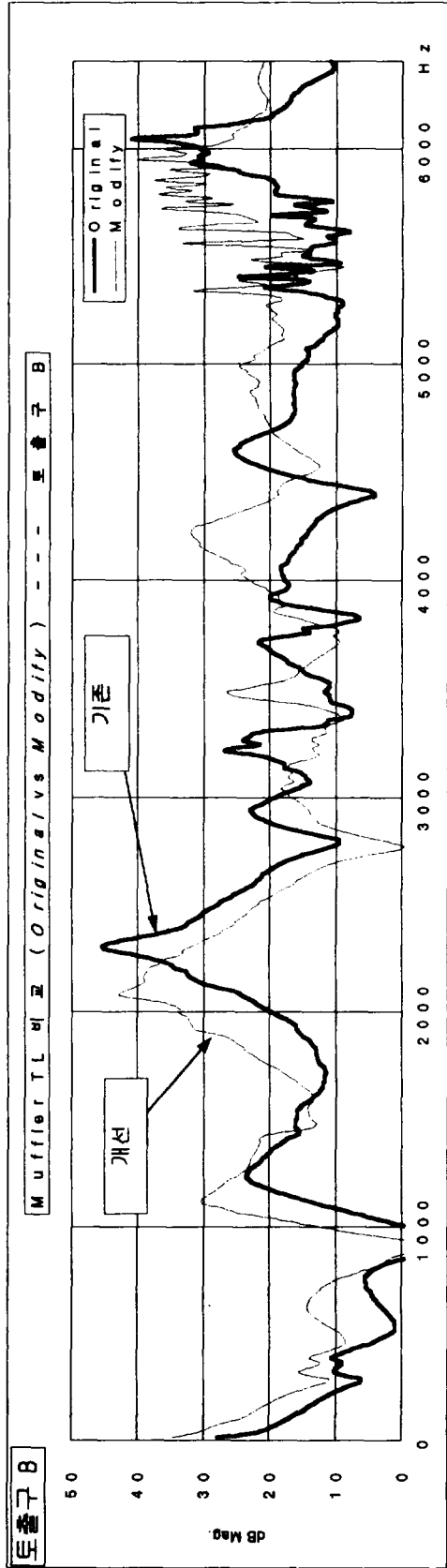
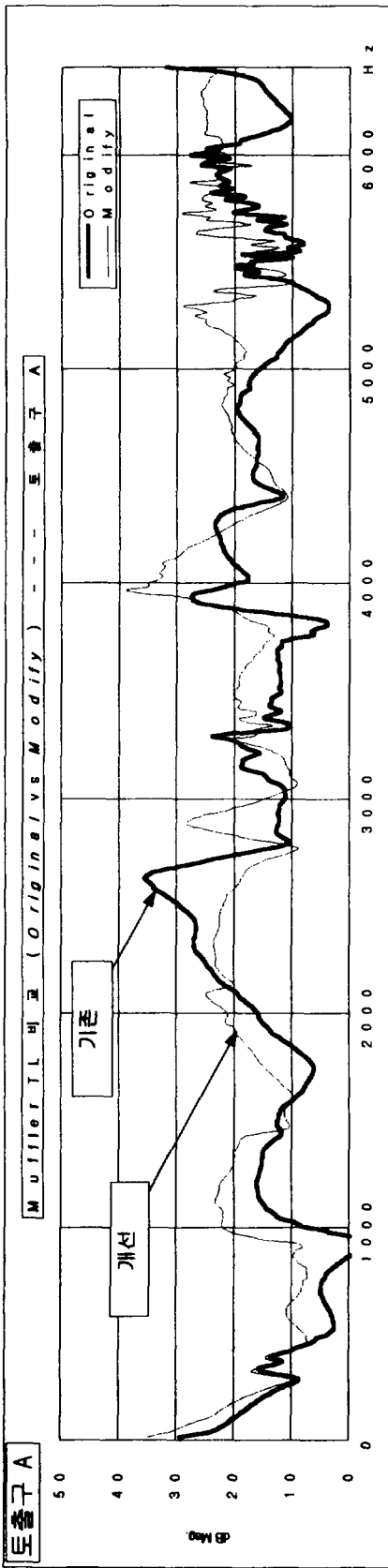
$$\tau_{xz} = 1/\rho [\partial p / \partial z] = - \ddot{w}_z$$

BOUNDARY CONDITIONS

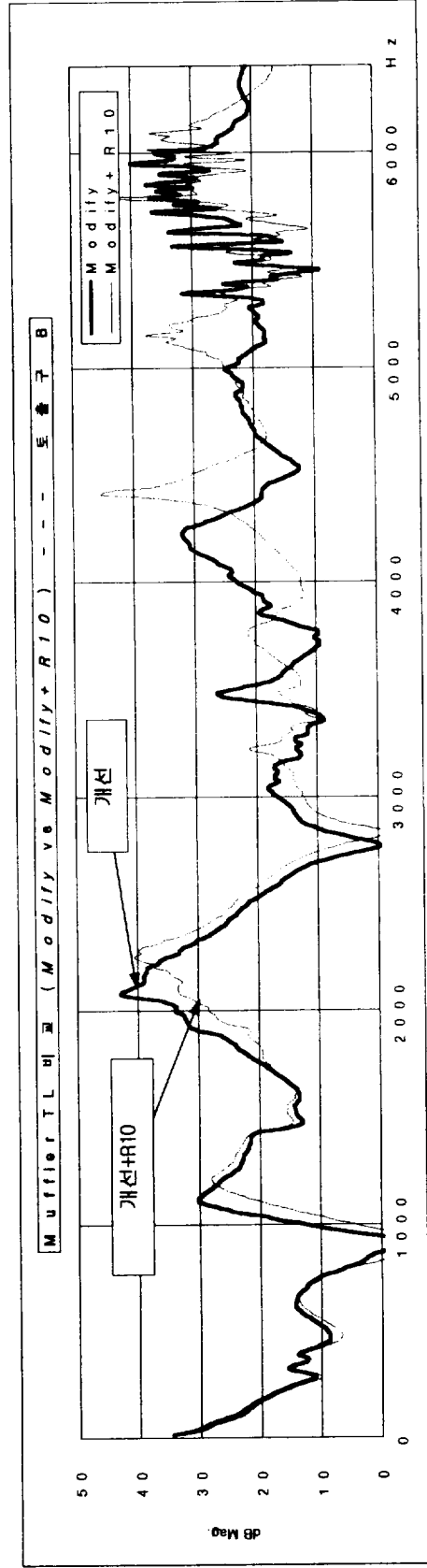
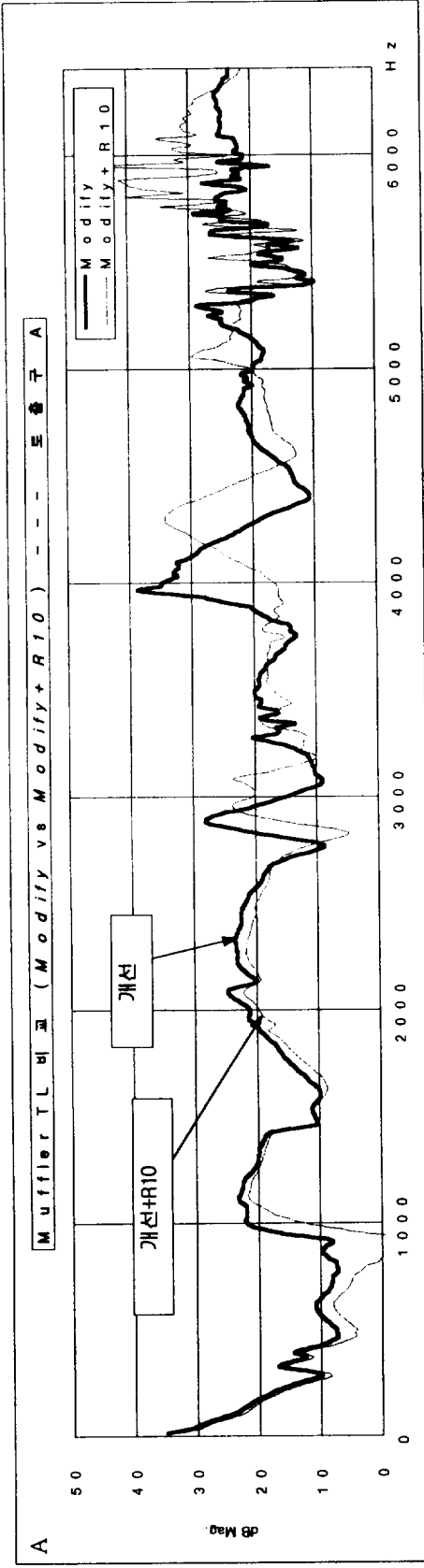
Λ ; reflected wave

$\Lambda = A_n / (\rho a_0)$ A_n ; area associated with grid points

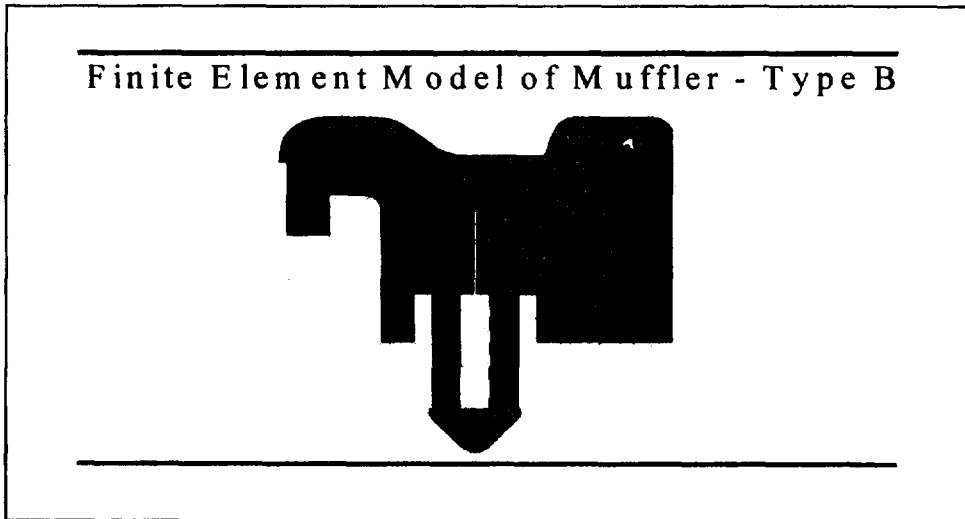
ROTARY COMPRESSOR (original to modified 1)



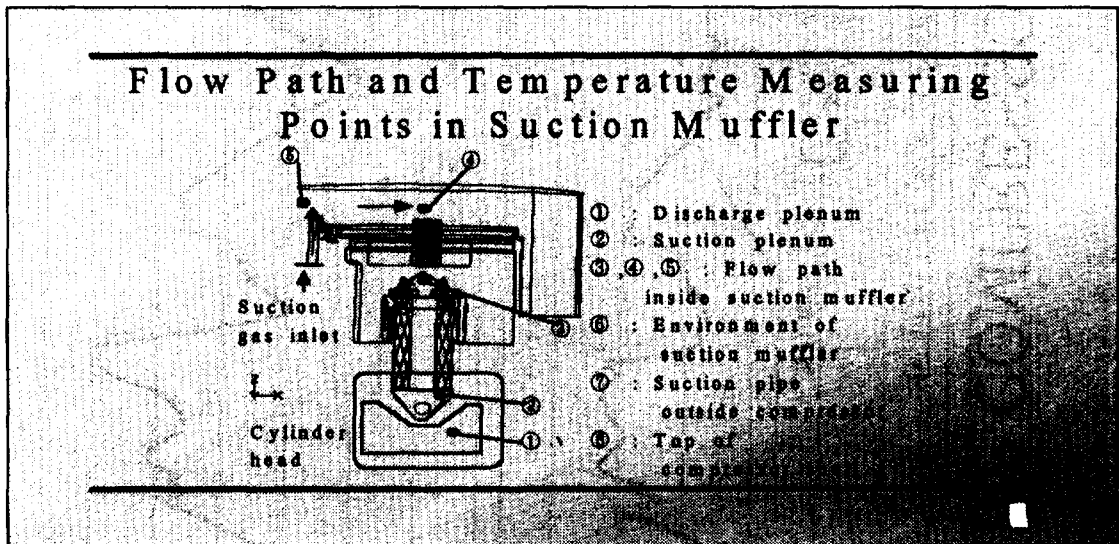
ROTARY COMPRESSOR(modified 1 to modified 2)



RECIPROCATING COMPRESSOR(1)



RECIPROCATING COMPRESSOR(2)



RECIPROCATING COMPRESSOR(3)

Acoustic Analysis

- Finite elements are created using solid model.
- Sound field analysis are solved by SYSNOISE.

$$TL = 20 \log [0.5 (|A_{11}| + |A_{12}| / (\rho c) + |A_{21}| \rho c + |A_{22}|)]$$

$$A_{11} = P_1 / P_0, \quad V_2 = 0$$

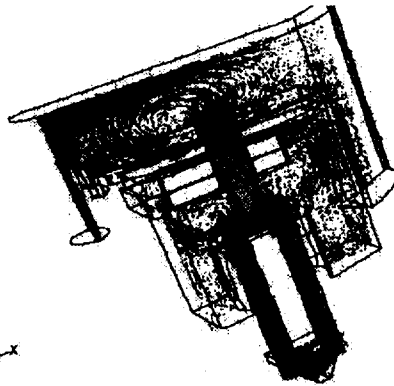
$$A_{12} = P_1 / V_0, \quad P_2 = 0$$

$$A_{21} = V_1 / P_0, \quad V_2 = 0$$

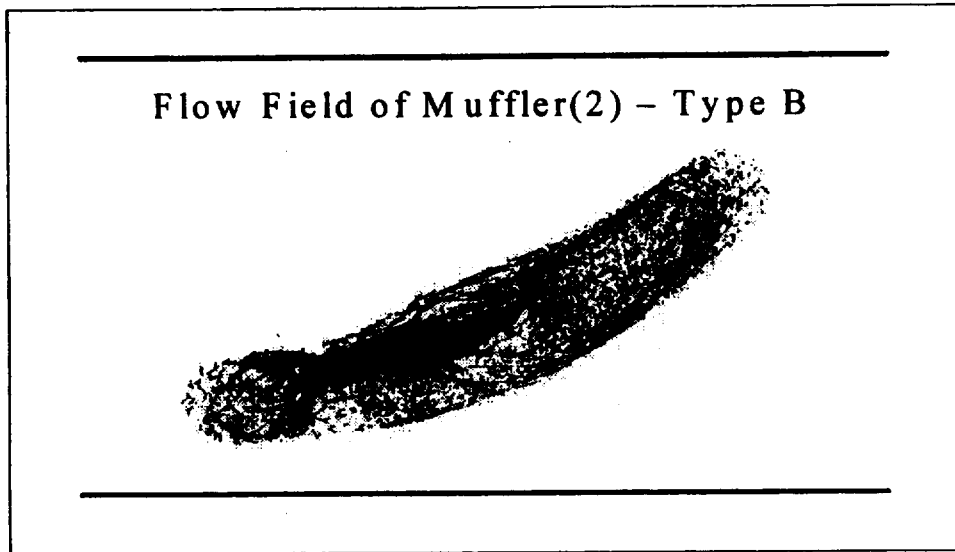
$$A_{22} = V_1 / V_0, \quad P_2 = 0$$

RECIPROCATING COMPRESSOR(4)

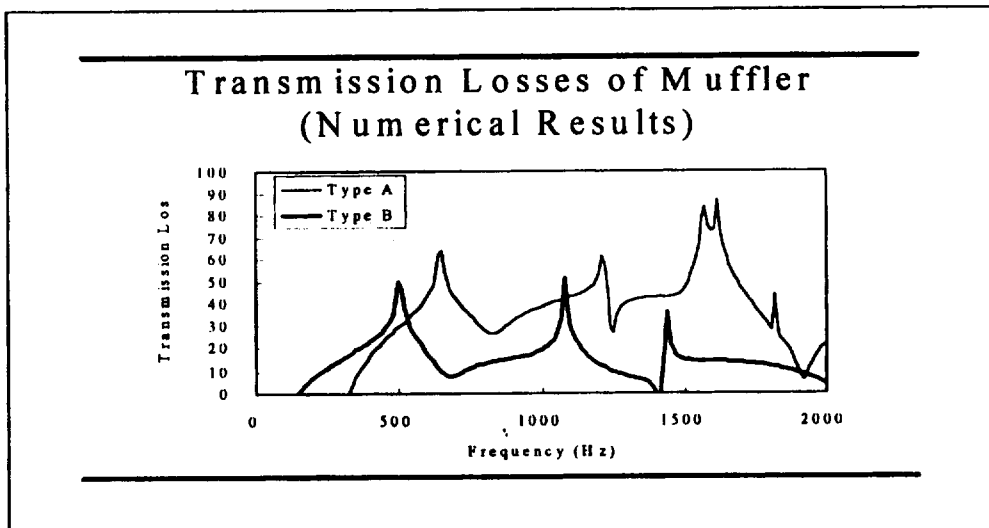
Flow Field of Muffler(1) – Type A



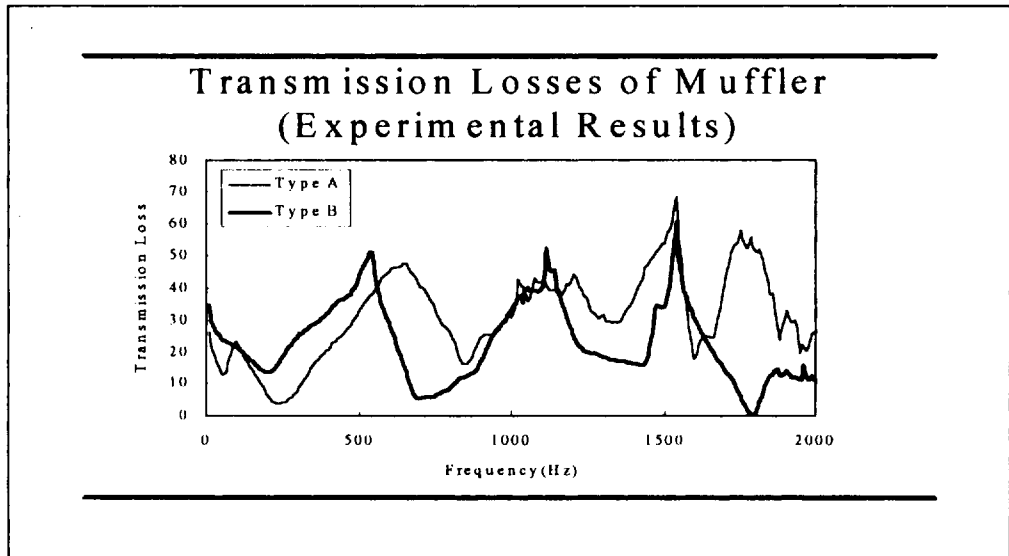
RECIPROCATING COMPRESSOR(5)



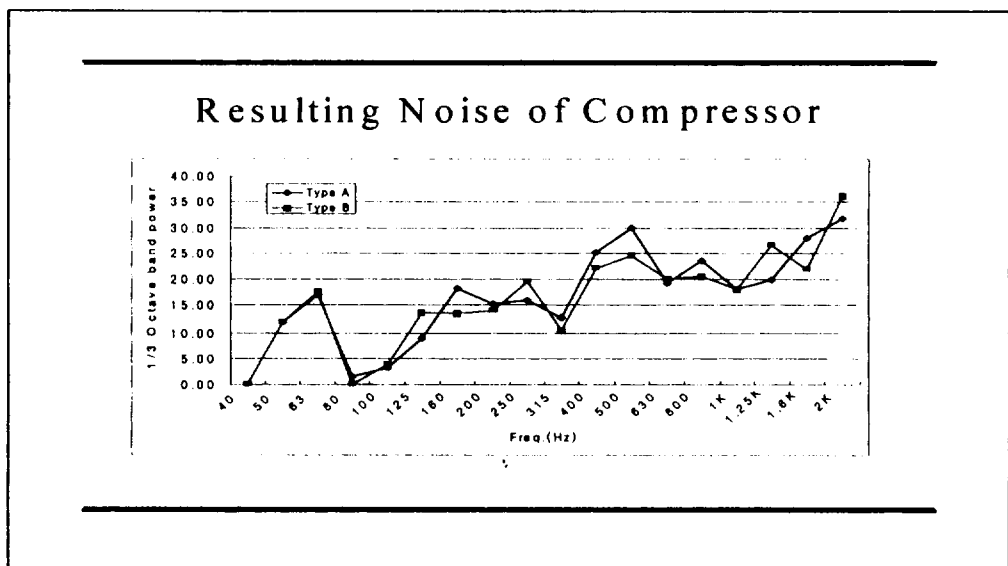
RECIPROCATING COMPRESSOR(6)



RECIPROCATING COMPRESSOR(7)



RECIPROCATING COMPRESSOR(8)



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- 2.주재만,최진규,오상경,박성우,"Smart Suction Muffler for a Reciprocating Compressor,"한국소음진동 공학회창립10주년기념 소음진동학술대회 논문집 ,pp.1429 ~ 1436,2000
- 3.압축기 진동 소음 연구 vol.1~7, 삼성전자 과제 완료 보고서,1991 ~1996