EFFECT OF VOLUME CONTROL ON FREQUENCY RESPONSE (PEAK FREQUENCY) OF BODY LEVEL HEARING AIDS

Register NO.M8909

AN INDEPENDENT PROJECT WORK SUBMITTED IN PART FULFILMENT FOR FIRST YEAR MASTER OF SCIENCE (SPEECH AND HEARING), UNIVERSITY OF MYSORE

ALL INDIA INSTITUTE OF SPEECH AND HEARING: MYSORE - 570006

MAY 1990

GRANDPARENTS

AMMA **APPA**

ANNA

WITH LOVE AND REGARDS

CERTIFICATE

This is to eertify that the Independent Project entitled: Effect of volume control en Frequency Response (Peak frequency) of Body Level Hearing Aids is the bonafide work on part fulfilment for the Degree of Master of Science (Speech and Hearing) of the student with Register No.M8909.

Mysore

May, 1990

Director
All India Institute of
Speech and Hearing
Mysore-6.

CERTIFICATE

This is to certify that the Independent Project entitled: Effect of Volume Control On Frequency Response (Peak Frequency) of Body Level Hearing Aids has been prepared under my supervision and guidance.

Mysore
May, 1990

GUIDE

DECLARATION

I hereby declare that this Independent Project entitled: Effect of Volume} Control on Frequency Response (Peak Frequency) of Body Level Hearing Aids is the result of my own study under the guidance of Dr.(Miss) S.Nikam, Prof, and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore has not been submitted earlier at any University for any other Diploma or Degree.

Mysore

May 1990 Reg. NO.M8909

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TABLE OF CONTENTS

CHAPTER		Page No.
I.	INTRODUCTION	1 - 4
II.	METHODOLOGY	5 - 9
III.	RESULTS AND DISCUSSION	10 - 11
IV.	SUMMARY	12 - 13
V.	BIBLIOGRAPHY	14
	APPENDICES	

INTRODUCTION

Hearing is the key; for normal development of speech and language an individual should have normal auditory system. The hard of hearing child is handicapped in many activities because he has a hearing impairment. The problems that a hard-of-hearing child exhibits in speech and language production, and perception, and academic achievement, are related to his hearing loss. Hearing loss occurs after the speech and language development, the individual will not face as many difficulties as a pre-lingual hard-of-hearing person faces.

The major eause of the handicap, both for prelingual and poatlingual individuals is hearing? and the major avenue through which the handicap can best be minimized or overcame. It is the hearing aid which can minimize or overcome this handicap.

Hearing loss can be differentiated depending upon the pathology, and degree of loss. Depending on pathology, it can be divided into conductive hearing loss, sensorineural hearing loss, mixed hearing loss, and central hearing loss.

Depending upon degree, according to ISO, 1964, normal hearing level (-10 - 26 dB HL), mild hearing loss (27 - 40 dB HL), moderate hearing loss (41 - 55 dB HL), moderately severe hearing loss (56 - 70 dB HL), severe hearing loss (71 - 90 dB HL) and profound hearing loss (91 and above dB HL). Sometimes boarderline categories of hearing impairment are described with a combination of terms sach as "moderately severe" hearing loss.

Hearing aid is found more useful in moderate loss patients and little useful in/people with profound hearing loss. The first hearing aid which employed electricity for amplification were introduced around the beginning of the 20th century. Commercial electric hearing aidswere first produce in 1903 (Berger, 1970). Since then the hearing aid industry developed both in terms of sophistication and also in utility.

Among different electroacoustic characteristic frequency response of a hearing aid is one of the important electroacoustic characteristics that has to be considered While knowing about the hearing aid. Due to nature of the components of a hearing aid, some frequencies are amplified more efficiently than are others. Thus, the relation between frequency and amplification constitutes one area of interest in specifying electroacoustic behaviour of hearing aids.

Frequency response characteristics of hearing aids have been related to studies of speech discrimination and speech reception thresholds in normals and subjects with various types of hearing loss. Frequency response range tends to be of significance but selective frequency response for specific hearing losses tends to be more controversial. Davis, et al (1947) reported that subjects with conductive and sensorineural hearing losses performed best by speech intelligibility measures with an essentially flat frequency response characteristic.

Extended high frequency response hearing aids appeared to be of value for persons who have precipitous high frequency loss (Reddell and Calvert, 1966) and also for speech intelligibility in noise (Schwartz, et al. 1979). Extended low frequency response hearing aids have proved beneficial in persons whose hearing range is restricted.

Many studies have been done on effective frequency response of hearing aids to study the effect on speech intelligibility. So, for a hearing aid to function effectively it should cover low, mid, and high frequencies at atletst should have a range which can accommodate speech frequencies. Different hearing aids might be hating different frequency responses and even the same hearing aid might be having different frequency response at different volume control settings.

The main aim of this study was to know:

(i) Is there any change in frequency response with a change in volume control?

(ii) Is there any change in frequency range with change in volume control at constant voltage (1.5 v) .

Need for the study:

This study wiii enable us to know -

- The frequency characteristics of a hearing aid consequent to a change in volume control setting.
- Frequency range/response provided at each volume control setting.

This study helps in bringing awareness among the audiologists. regarding the frequency response/range of a hearing aid at each volume control setting. Also helps in counselling the case, i.e. counselling him regarding the volume control setting and in what volume control setting he can make maximum use of hearing aid.

NOTE: In this study frequency at Which there is maximum output is taken into consideration and has been mentioned as "peak frequency response".

METHODOLOGY

Selection of hearing aids:

A total of 60 hearing aids were taken for the study. (Out of these, 60, 20 hearing aids were those newly received from the manufacturers while the rest belonged to the used group (hearing aids were brought for trial basis approximately 3 years back and have been in use since then.

Of these 60 hearing aids, 35 belonged to the strong category, and 25 belonged to the moderate category (IS:10775-1984).

The hearing aids selected were from ten Indian manufacturers:

Test environment:

Test was carried out in an air conditioned sound treated room. The ambient noise levels in-side the room were within permissible limits.

Instrumentation:

1. Insertion Gain Optimizer - IGO-HAT-1000
2. HAT 500 Text Box
3. 1/2" Text Microphone
4. A Dummy Microphone
5. A 2 cc. coupler (Type DB 0138).

Connections:

Instruments were connected as shown in the Appendix-A. Inside the HAT 500 Text Box connections were made with the teat microphone.

"Testing hearing aid" was selected from the "Main Menu" to start the experiment. "Test site calibration" was selected to dalibrate.

Calibration:

HAT speaker push batten on the front of the HAT 500 was depressed. The dummy microphone was inserted into the 2 cc. coupler. The receiver of the hearing aid was also inserted into 2 cc. coupler. The test microphone was placedat a distance of 5 mm. from the hearing aid microphone facing each other. Lid of HAT 500 was then closed. The placement of dammy microphone, test microphone and hearing aid are as shown in the Appendix-B.

"Enter" on the operating pannel was pressed to calibrate the instrument.

NOTE: The hearing aid was in off position.

The dummy microphone and text microphone were interchanged as shown in Appendix-C. Hearing aid was switched on and volume control was set to full on position.

NOTE: Protection grid of the test microphone was removed before connecting it with 2 ee. coupler.

On the operating pannel 'Menu' was pressed to select "Automatic Test (Tone"). Then "Enter" on the operating pannel was pressed. After recording (saturation sound pressure level (SSPL)-90 curve, "Eater" was once again pressed on the operating pannel to get SSPL-60 curve. The frequency at which there is maximum output was displayed on the screen which was then recorded.

At different volume settings (8, 6, 4, 2; 5, 4, 3, 2, 1? 6, 4, 2 depending upon the volume control settings provided in the hearing aid) values were recorded for 16 models of hearing aids.

The results are represented in the following tables and graphs.

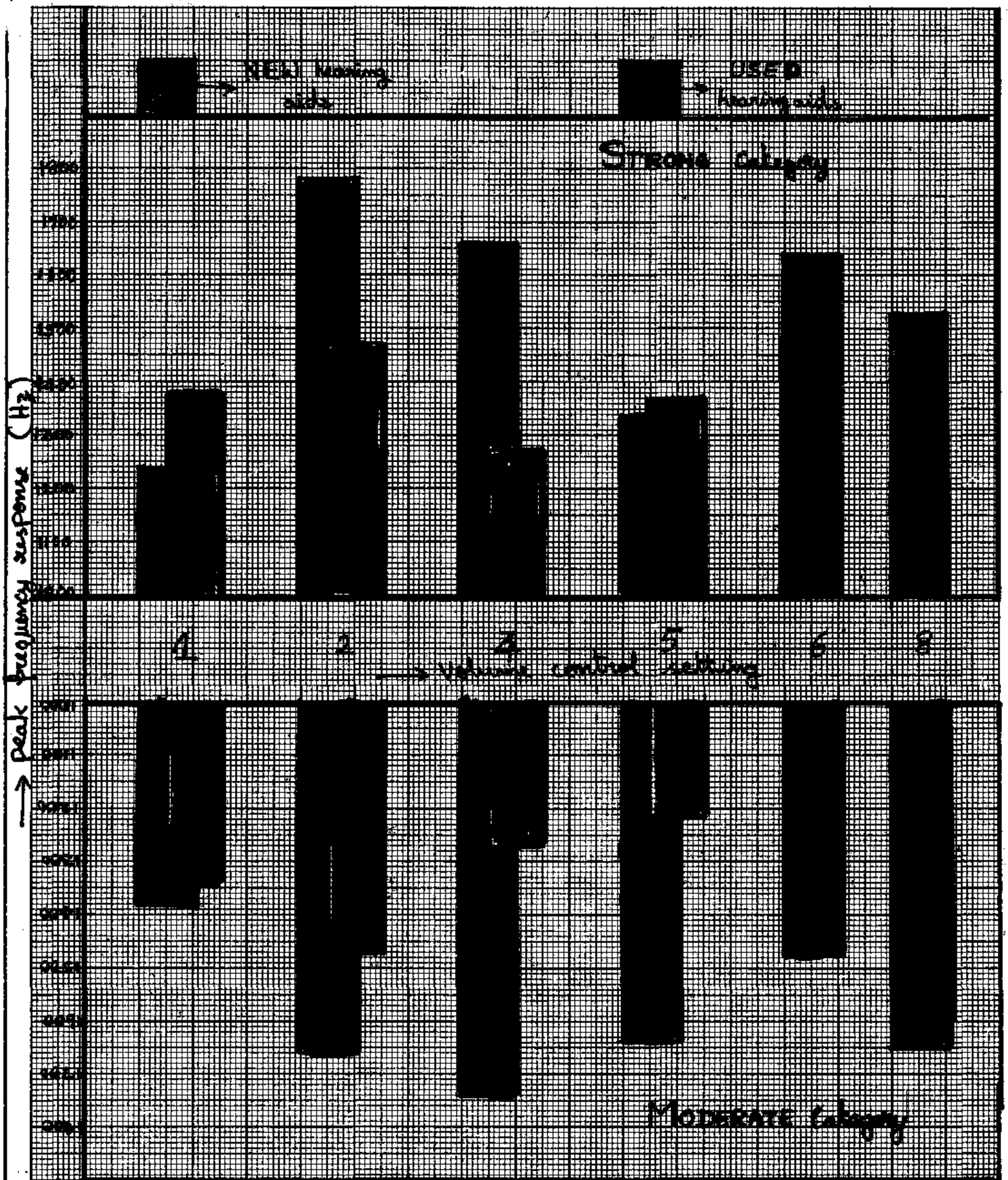
Table-1; Shows total number of hearing aids of different models that were used for the study.

Sl. No.	Models	Number of hearing aids tested	
		Old	New
1.	Model 1	2	10
2.	Model 11	2	-
3.	Model III	3	-
4.	Model IV	1	-
5.	Model V	3	-
6.	Model VI	2	-
7.	Model VII	2	-
8.	Model VIII	2	-
9.	Model IX	1	
10.	Model X	3	10
11.	Model XI	2	-
12.	Model XII	1	-
13.	Model XIII	6	-
14.	Model XIV	5	-
15.	Model XV	4	-
16.	Model XVI	1	-
		40	20

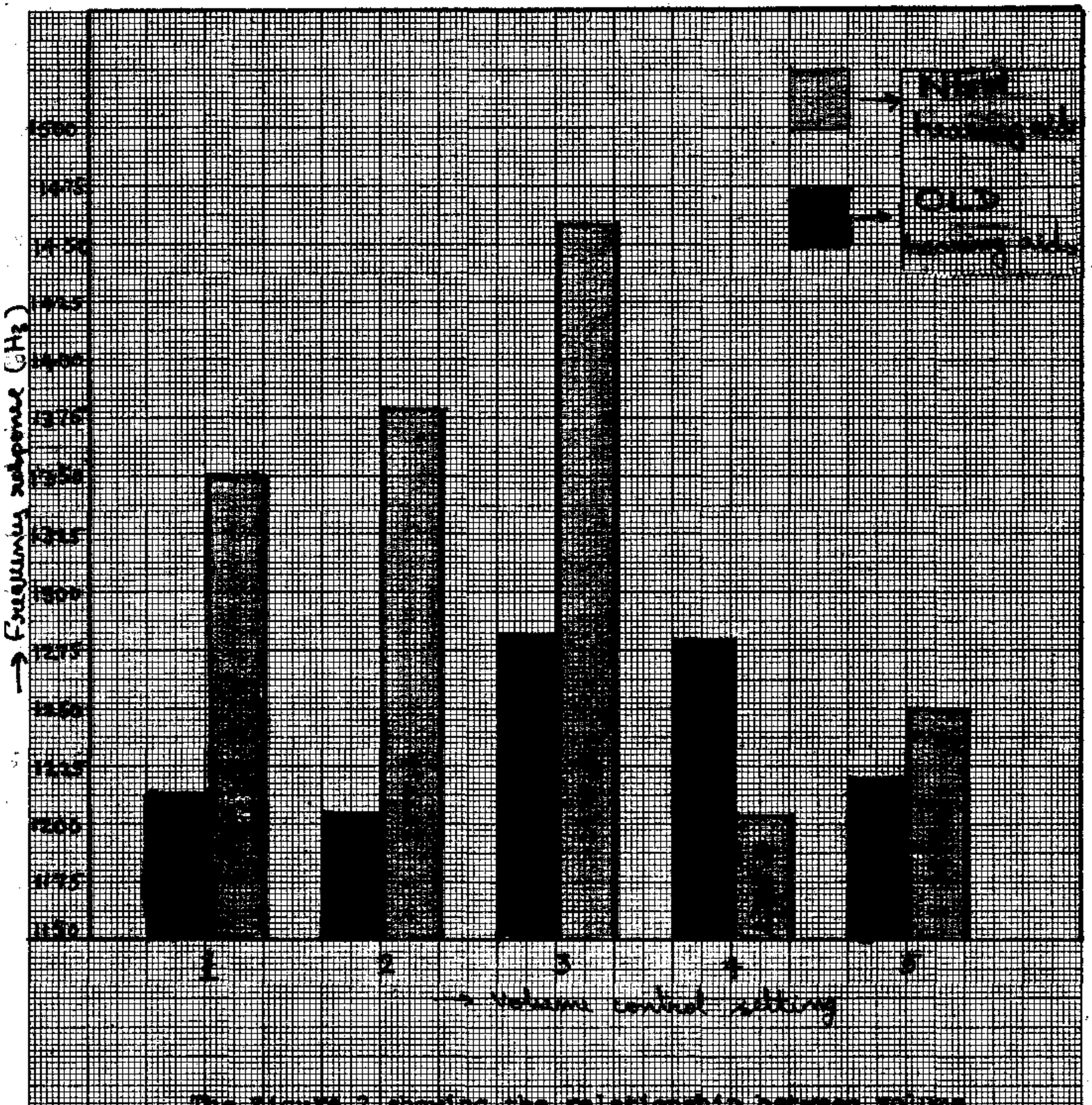
Total number of hearing aids = 60

Table-11: shows peak frequency (Frequency at which there is maximum output) for different models.

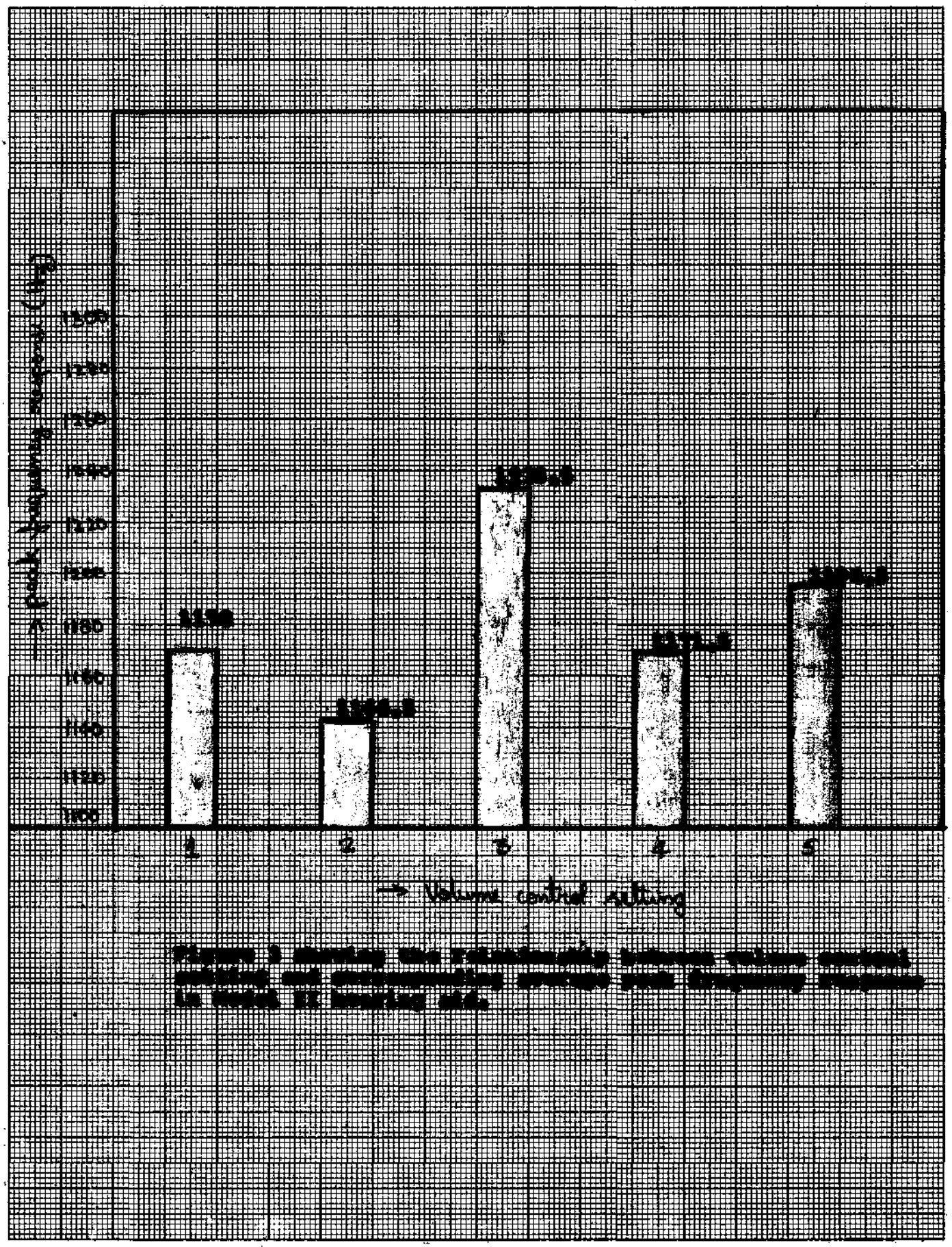
Sl. No.	Models	Average peak frequency (frequency at which there is maximum output) in Hz.						
		1.	2.	3.	4.	5.	6.	7.
1.	Model IB	1214.5	1208.5	1283	1274	1221.5		
2.	Model IN	1355.9	1379.6	1470.3	1202.6	1249.2		
3.	Model 11	1170.0	1146.5	1238.5	1171.5	1196.5		
4.	Model III		1416.5		1333		1383	1335.5
5.	Model IV	1333	1418	1600	1500	1500		
6.	Model V		1418		1450		1251.3	1330
7.	Model VI		1344		1169		1244	
8.	Model VII		1237		1208		1257	
9.	Model vIII		1453		1250		1378	
10.	Model IX		1193		1139		1127	
11.	Model XO	1456	1512		1493	1400.5		
12.	Model XN	1371.7	1475.1		1380.2	1365.3		
13.	Model XI		1509		1331.5		1459	
14.	Model XII		1250		1063		1063	
15.	Model xIII		1427.3		1326.6		1377.8	1370.3
16.	Model XIV		1600.6		1421.2		1455.6	1527
17.	Model XV		1349.0		1225.7		1240.5	1159.5
18.	Model XVI		1293.0		1093		1193	1115

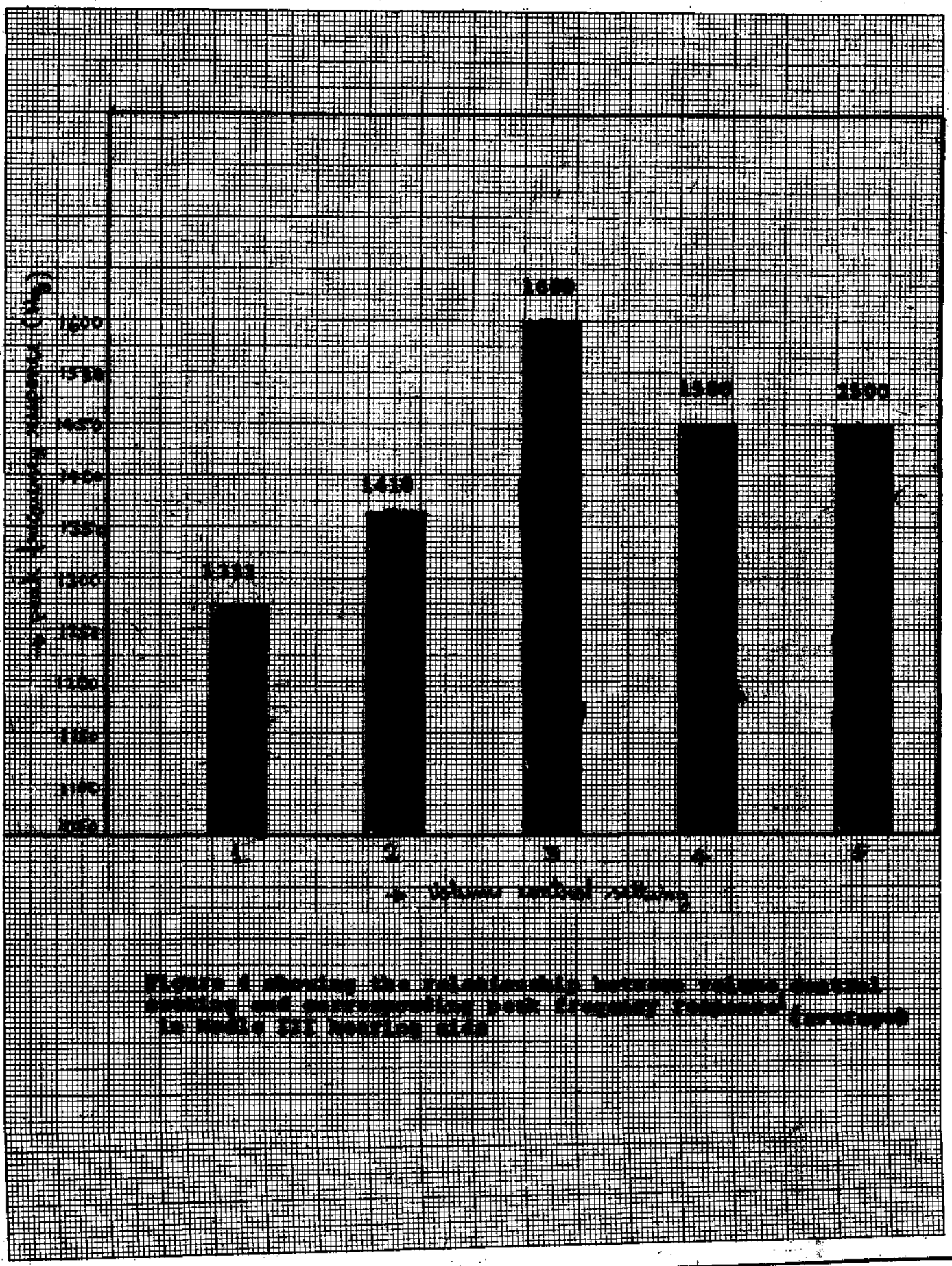


The upper and lower part of the Figure 1 shows the relationship between volume control setting and corresponding peak frequency response in strong and moderate hearing aid categories respectively.



The Figure 2 showing the relationship between volume control setting and corresponding peak frequency response in Model I hearing aid.


1500
1400
1300
1200
1100
1000
900
800
700
600
1
2
3
4
5
→ Volume control setting


1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
4
5

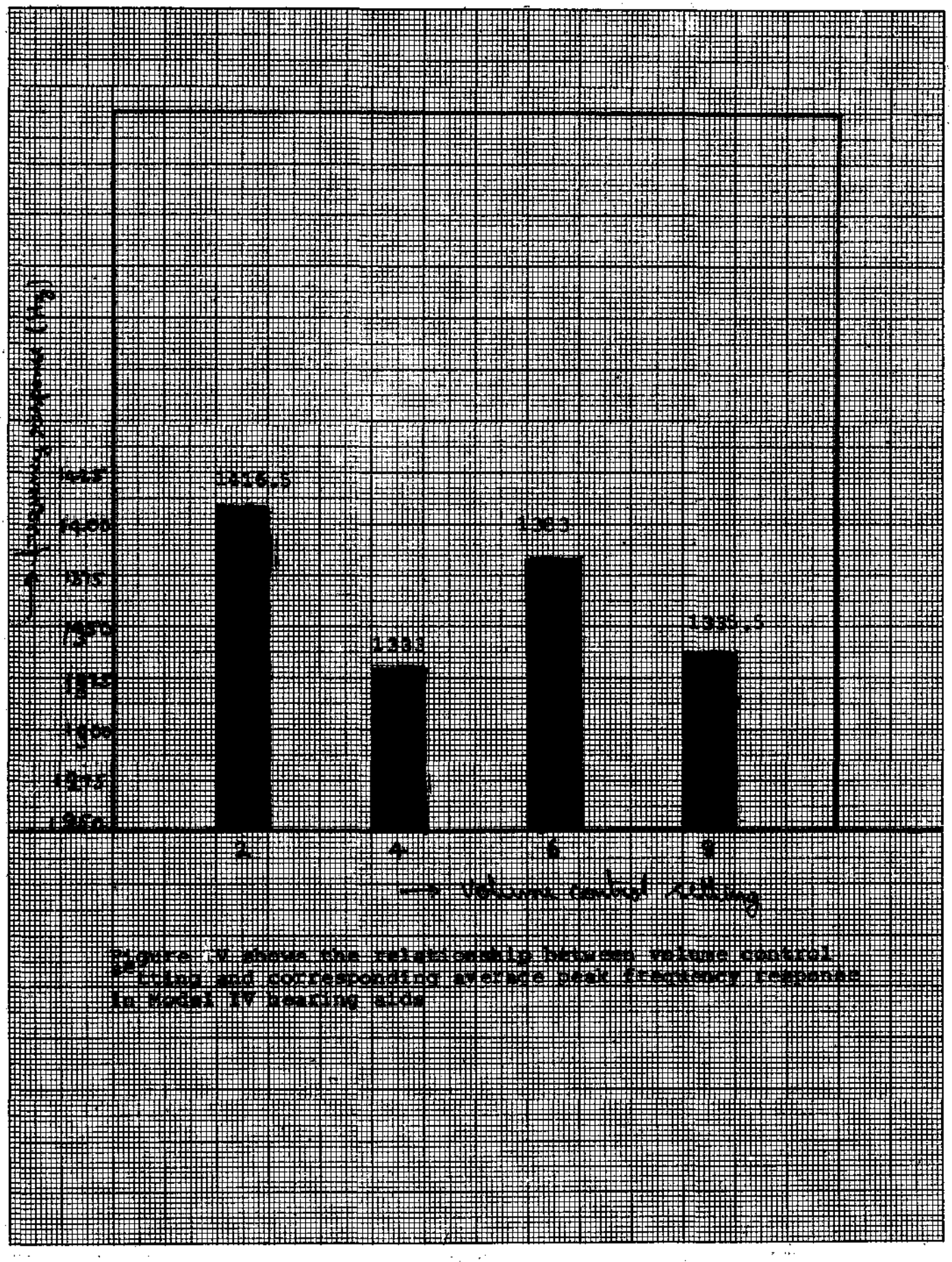


Figure 7 shows the relationship between volume control
[illegible] and corresponding average peak frequency response
in Widex FV hearing aids

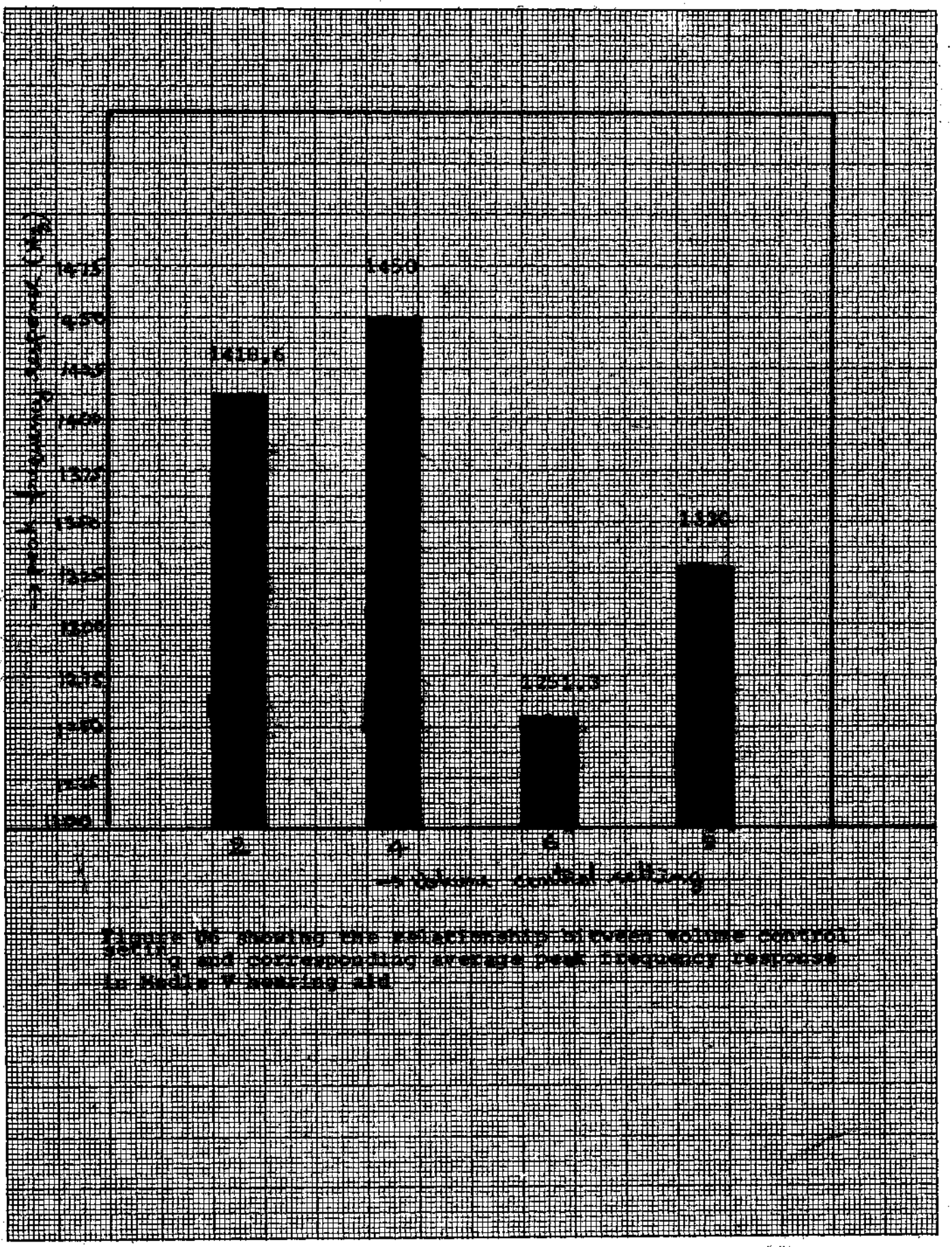
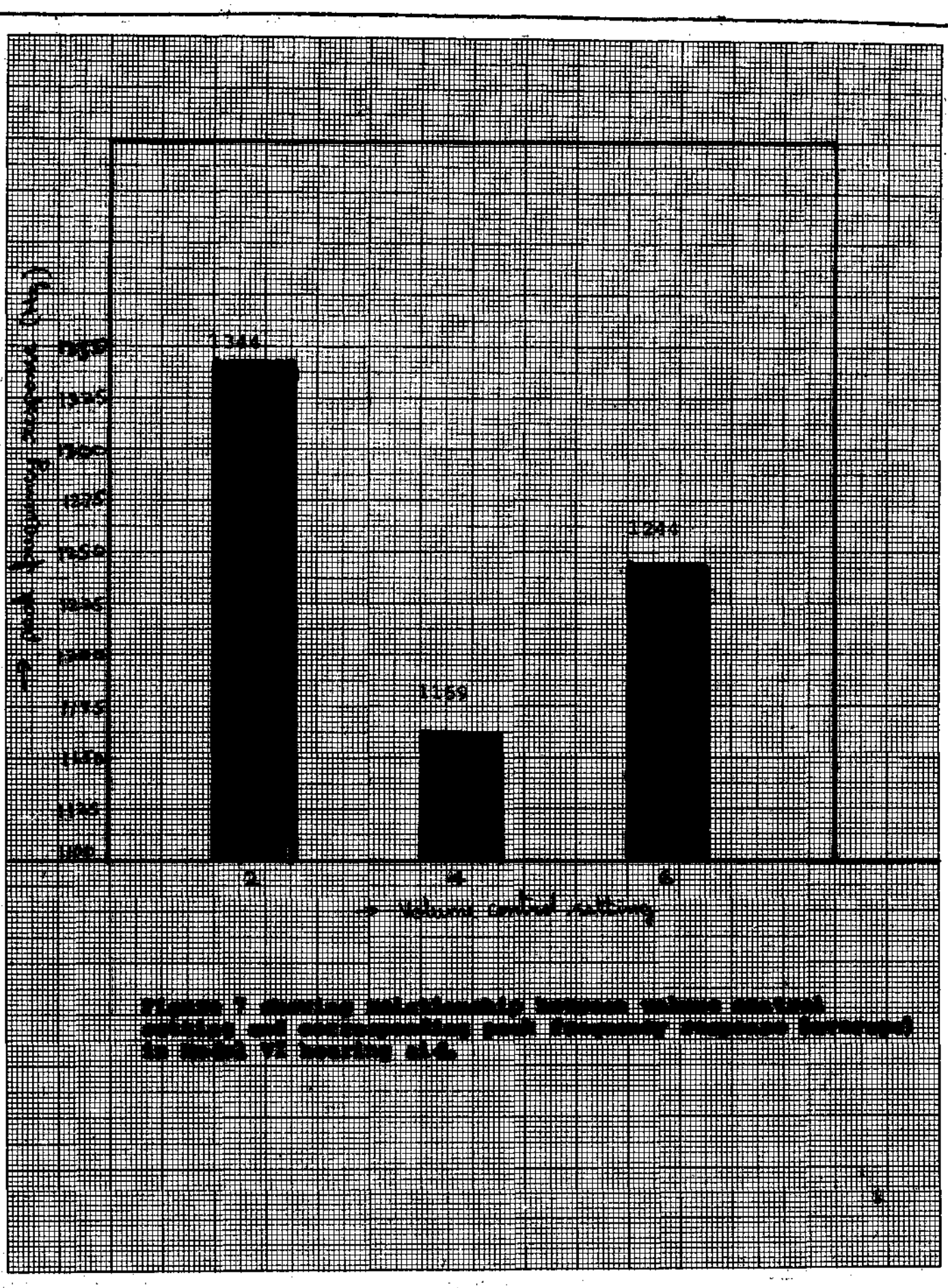
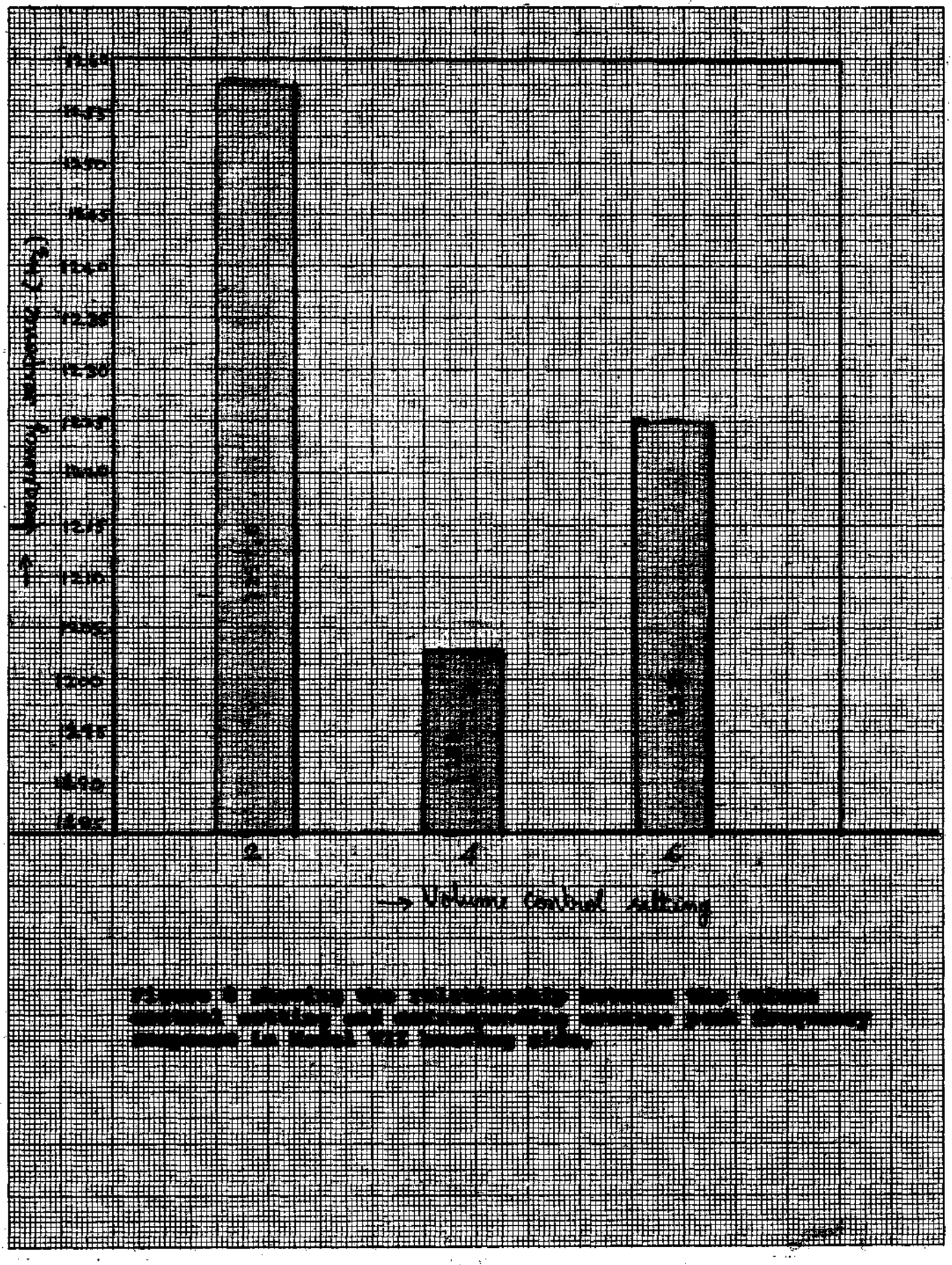
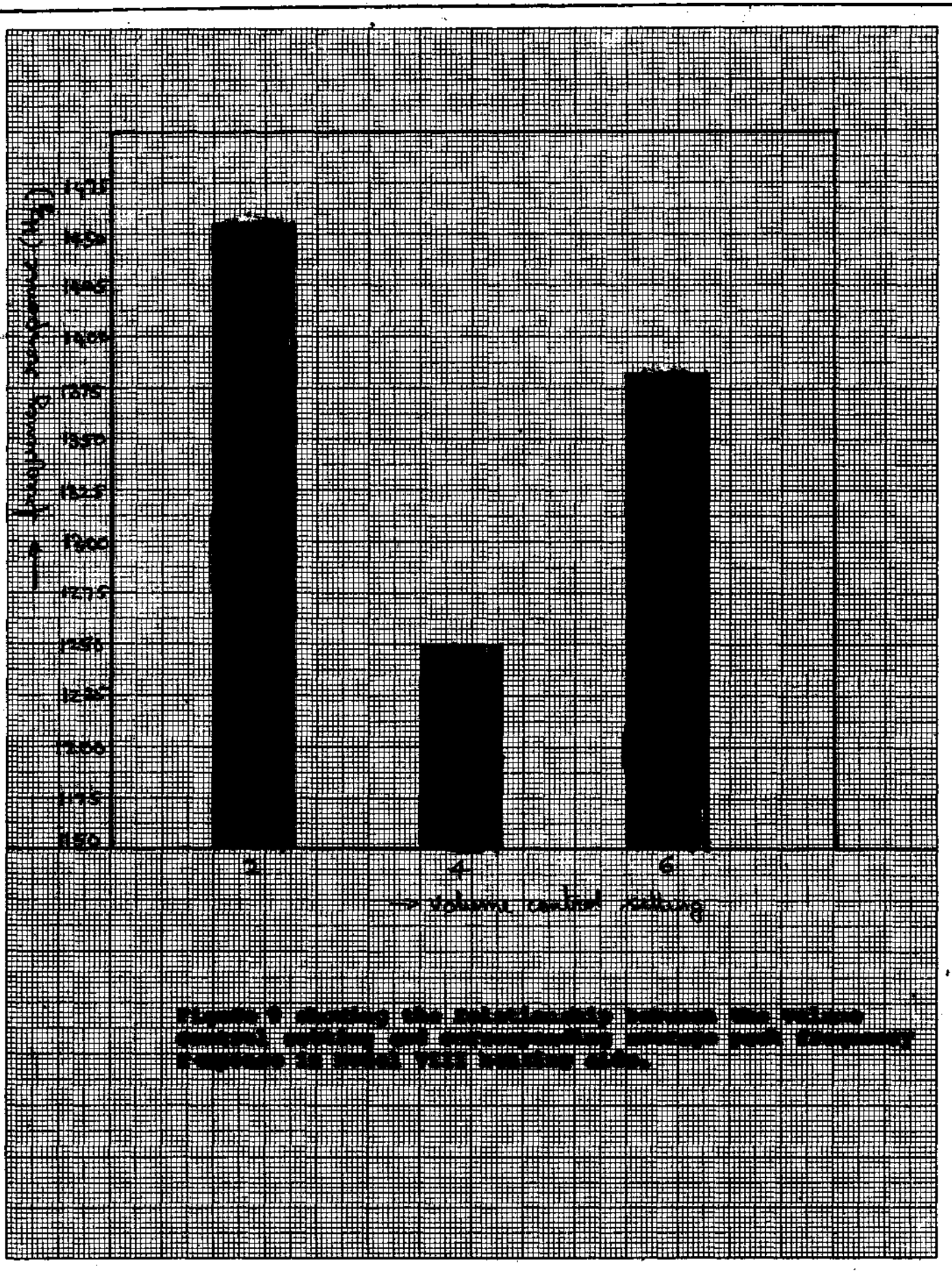
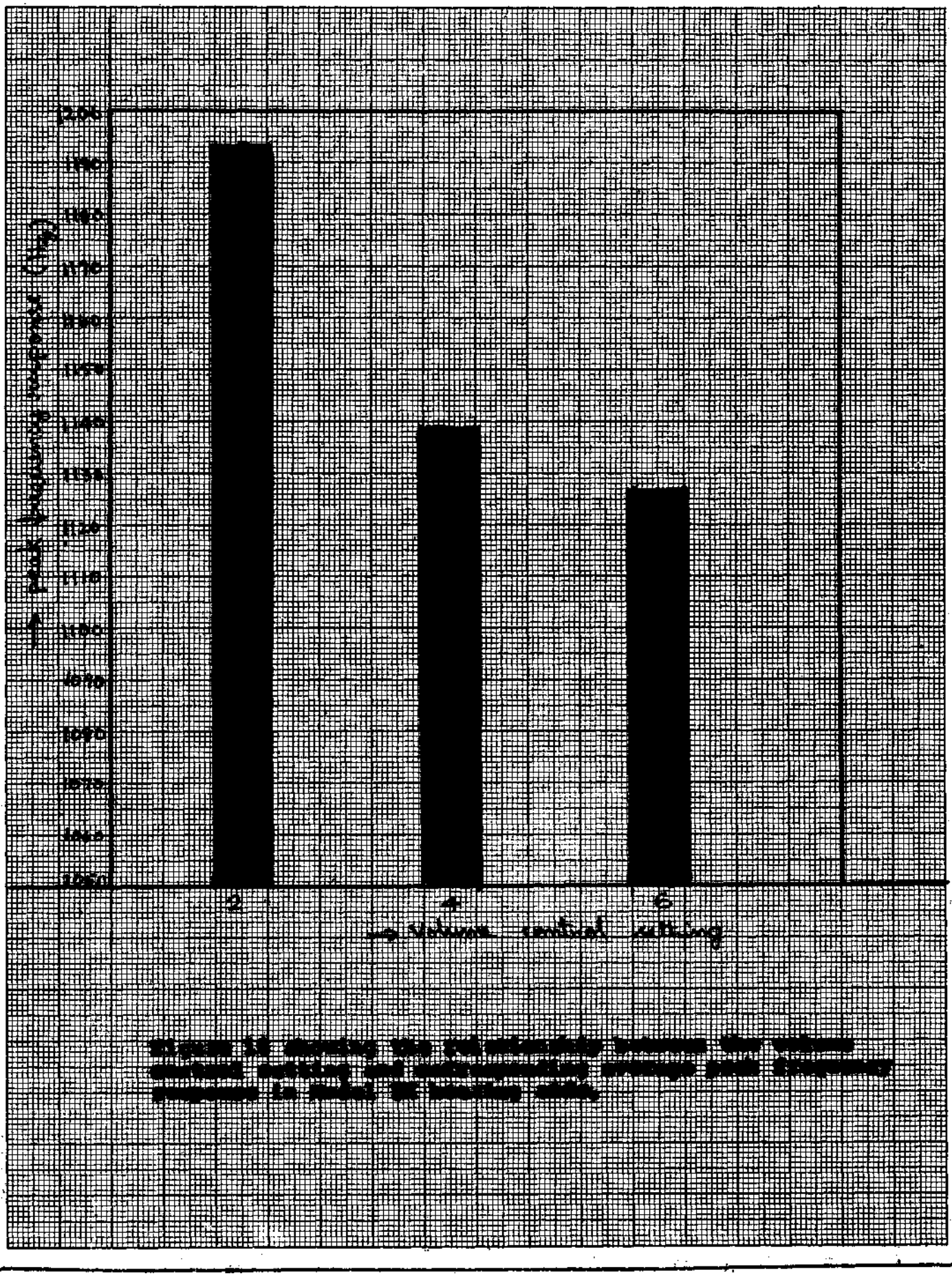


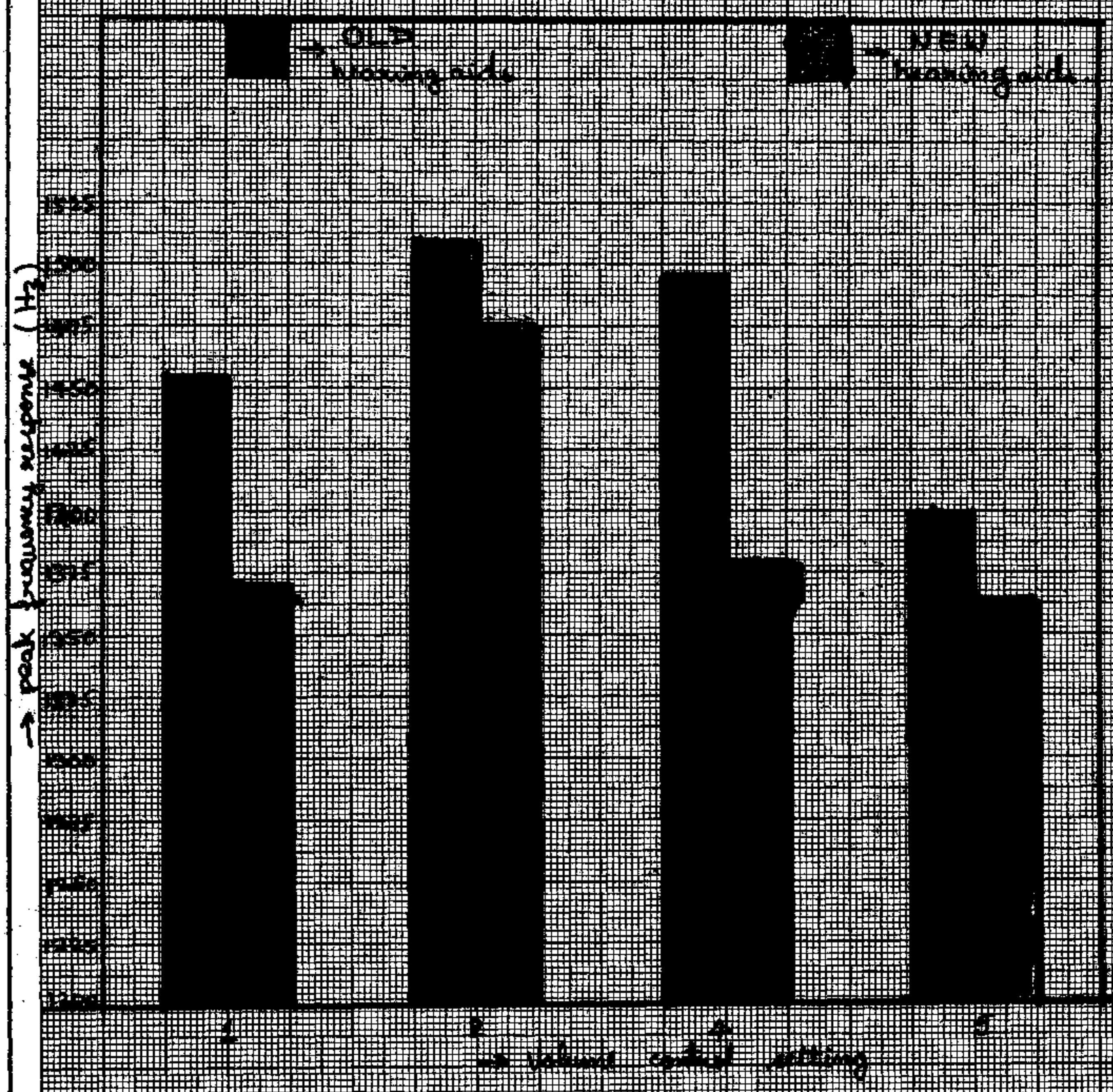
Figure 6: showing the relationship between volume control setting and corresponding average peak frequency response in audio frequency.

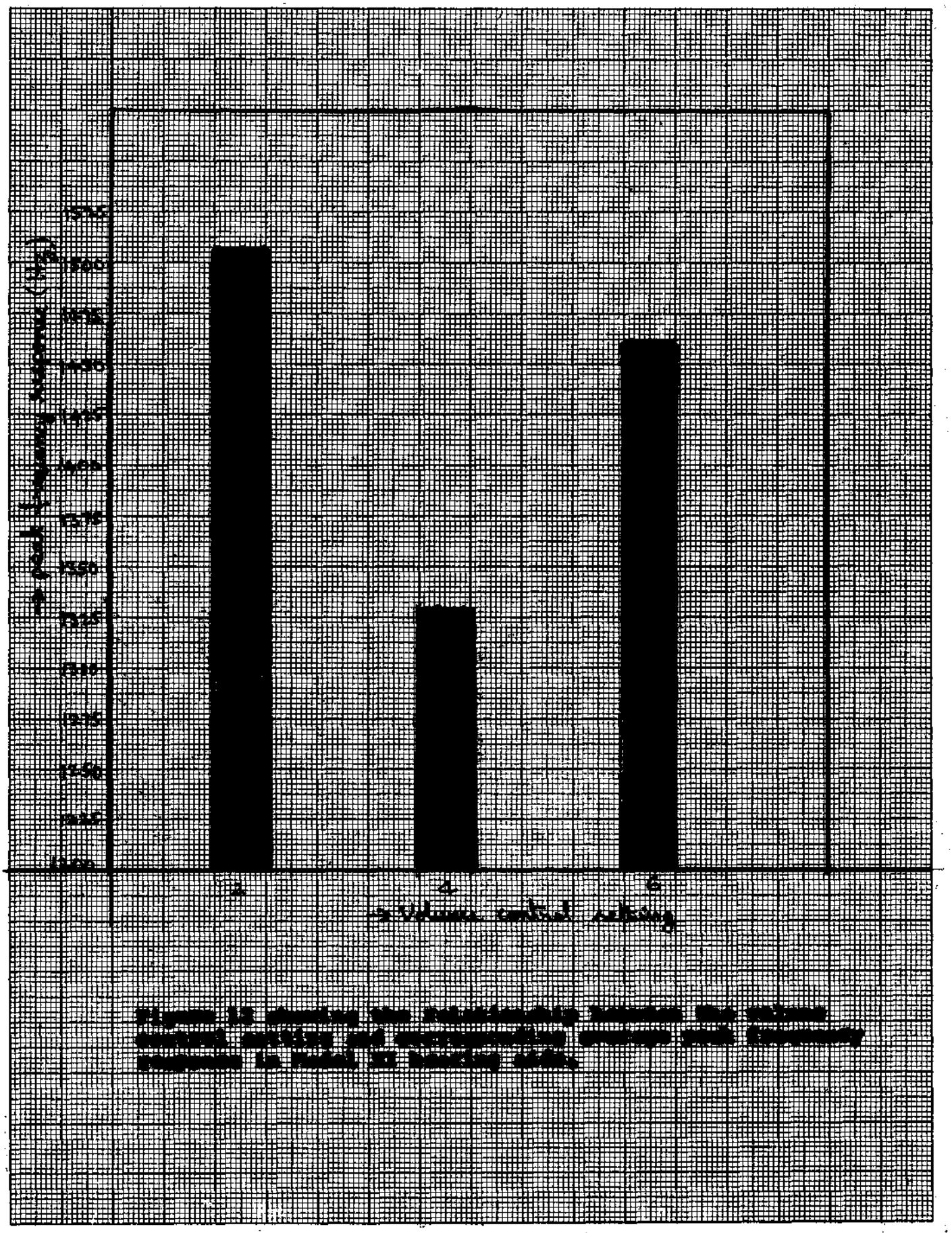

1344
1159
1244


Temperature (°C)
Volume (cm³)


3
4
6




OLD hearing aids
NEW hearing aids
peak frequency response (Hz)
volume control setting



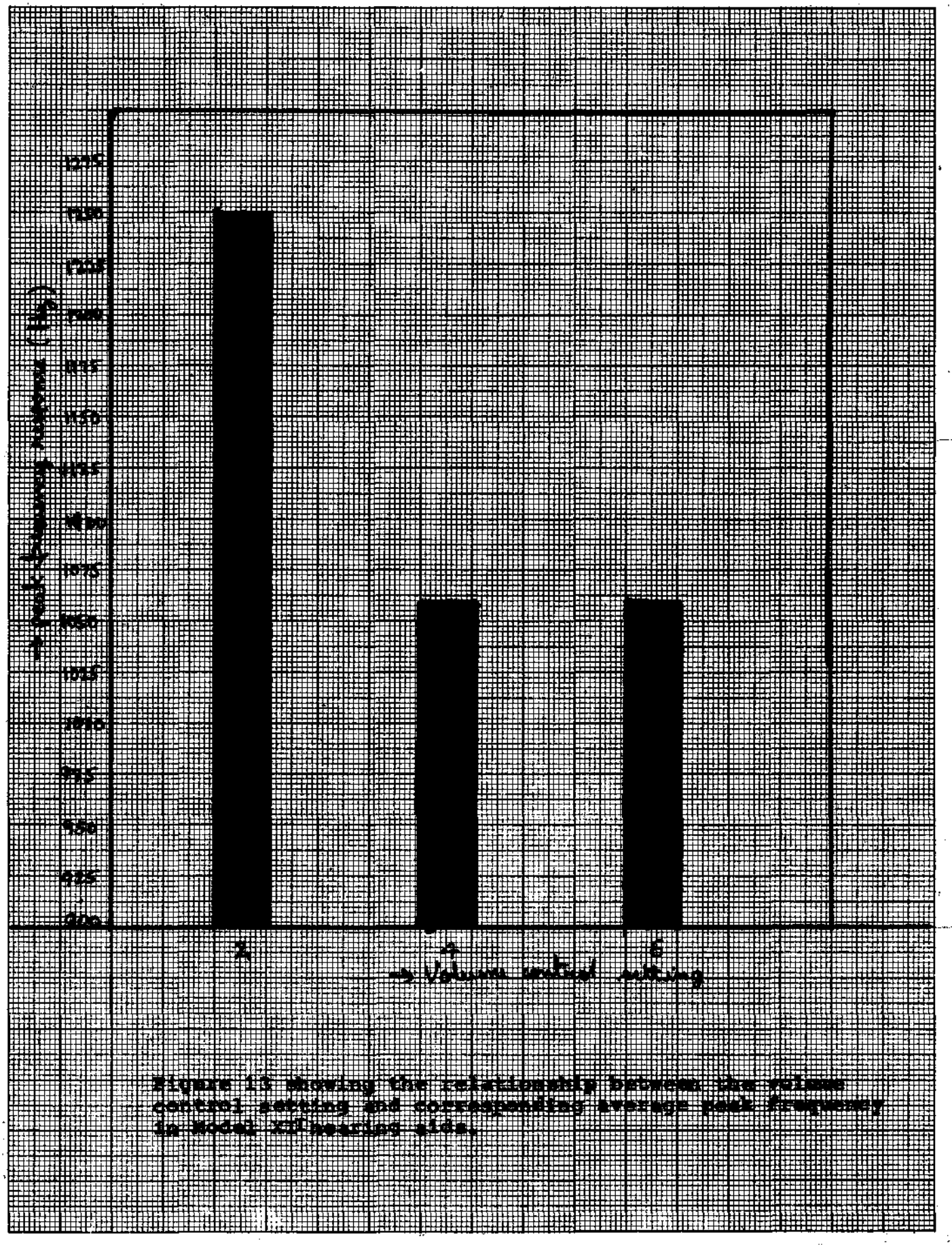
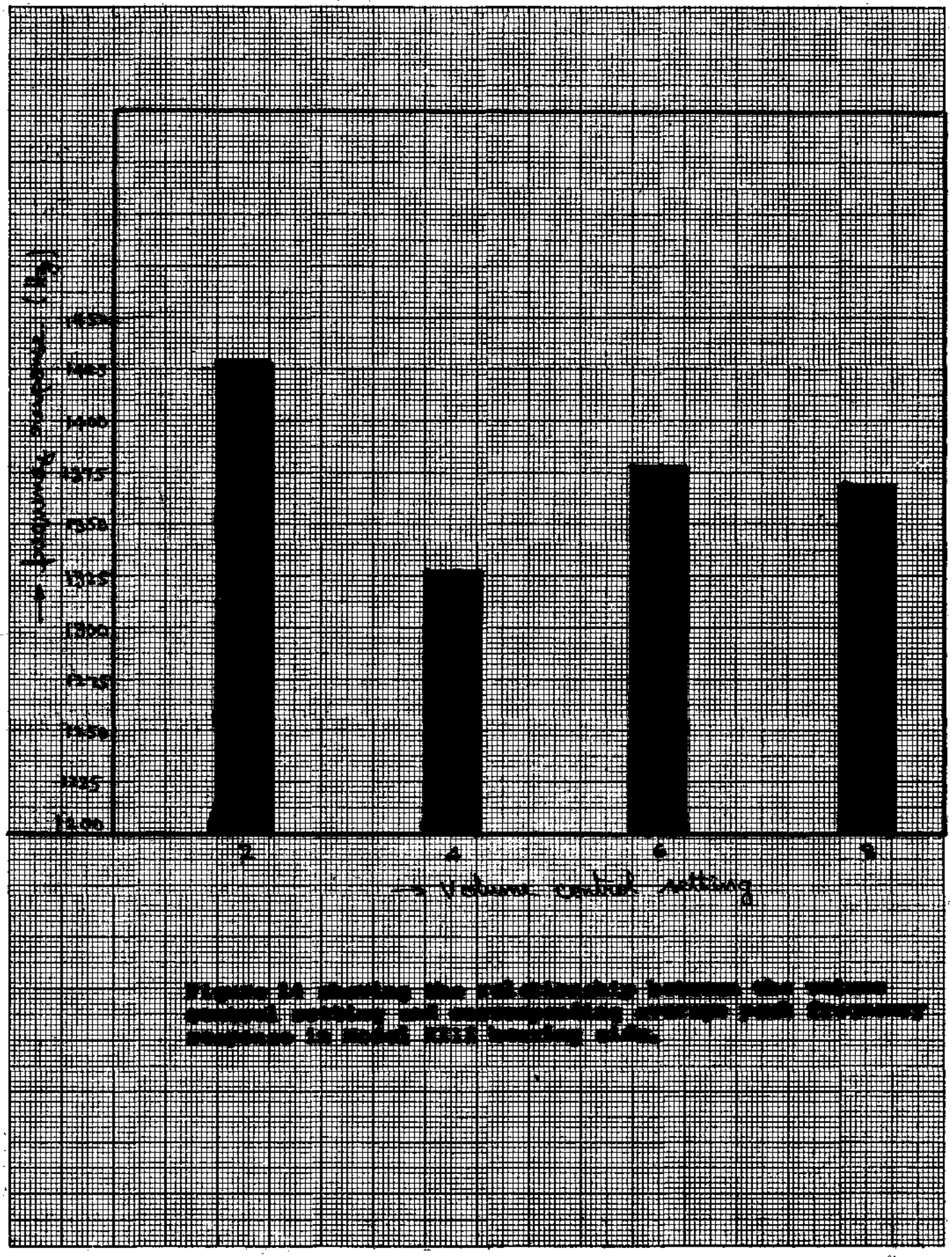
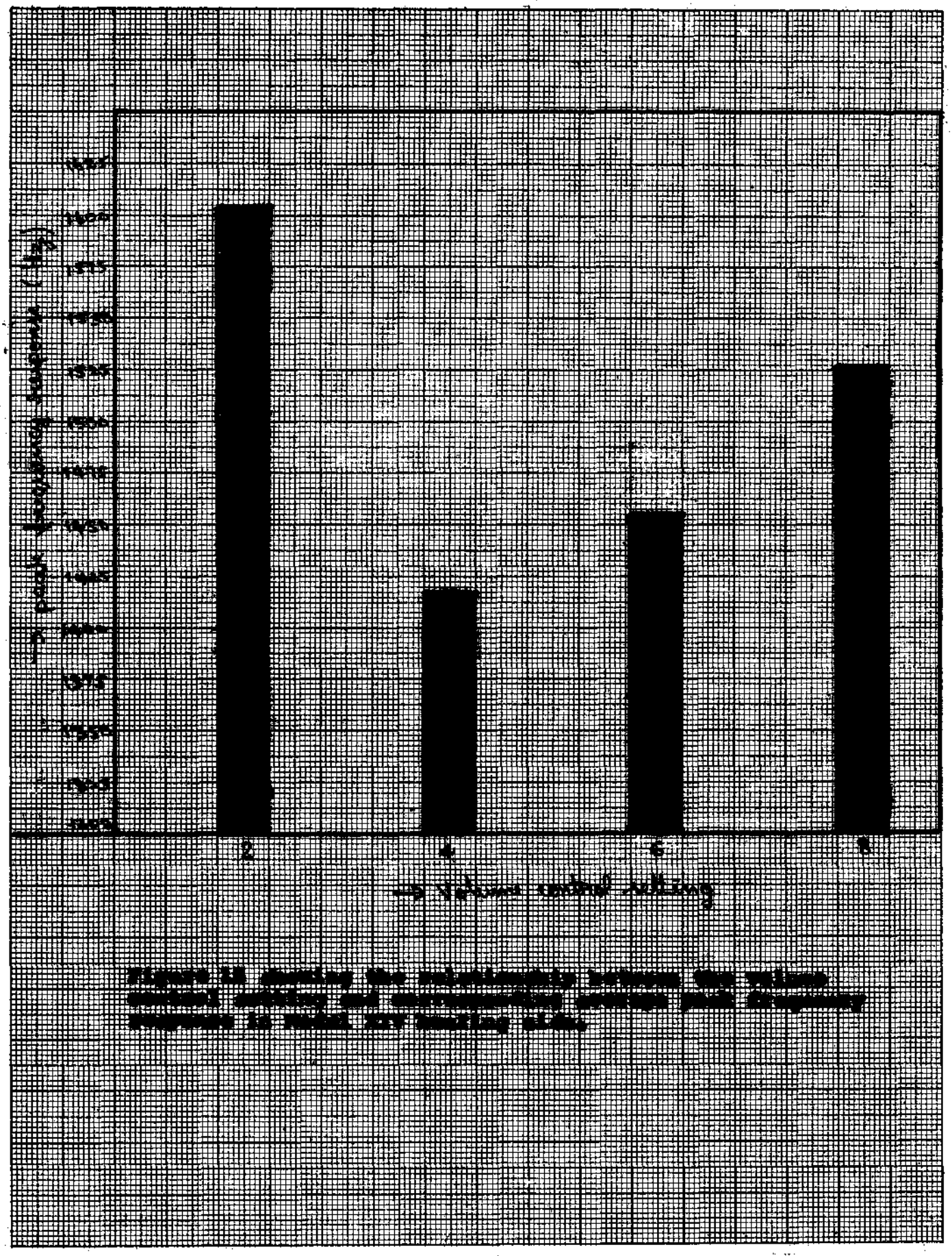


Figure 13 showing the relationship between the volume control setting and corresponding average peak frequency in model XM hearing aids.


2
4
6
8


2
4
6
8

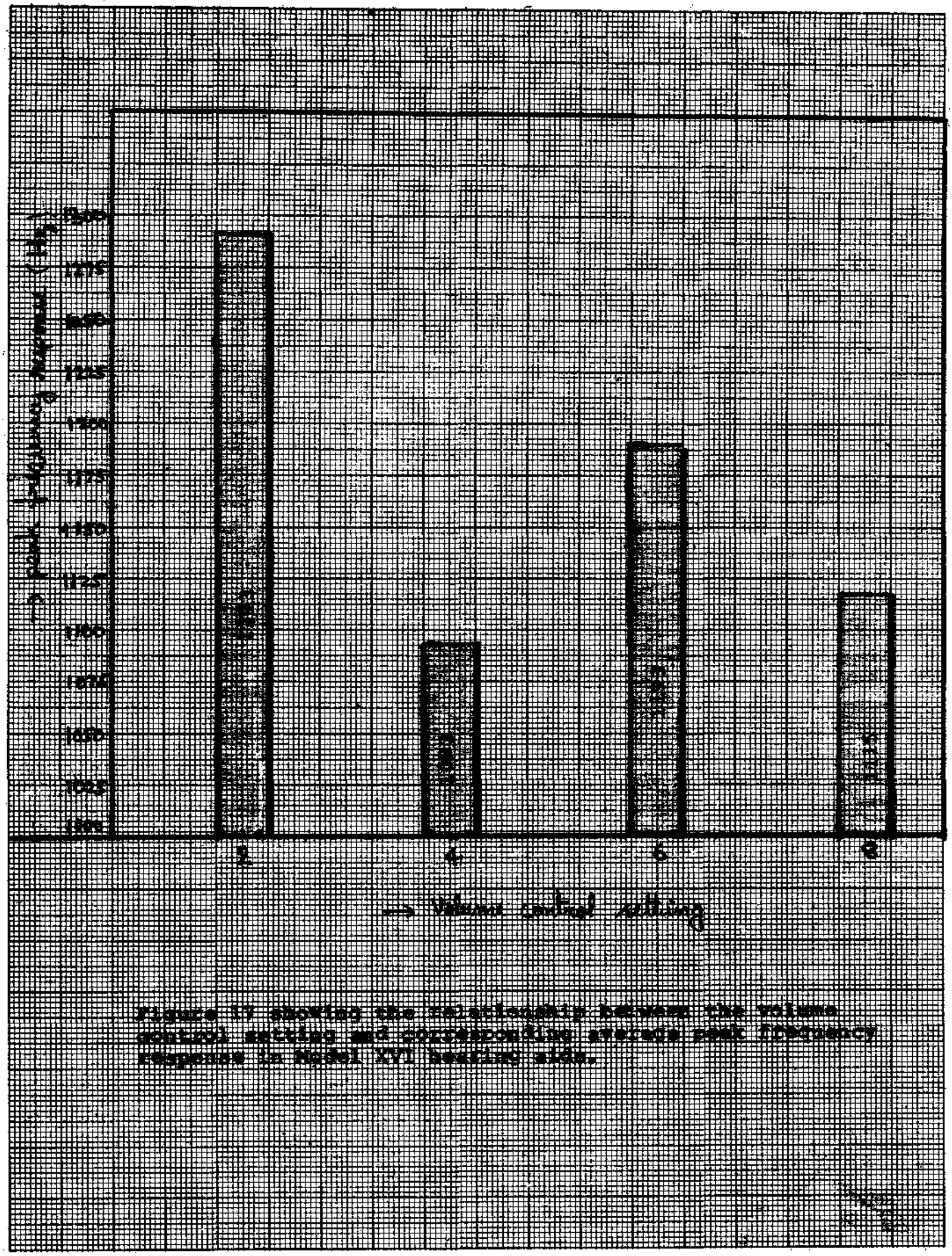


Figure 17 showing the relationship between the volume control setting and corresponding average peak frequency response in Model XVI hearing aids.

RESULTS AND DISCUSSION

In Graph-1, shows average peak frequency response of moderate and strong category hearing aids. Out of 60 hearing aids, 25 strong category hearing aids and 10 moderate category hearing aids the average peak frequency response is seen at volume control setting '2', but in 25 moderate hearing aids, the average peak frequency response is seen at volume control setting '4'. This shows that a majority of the hearing aids have their maximum peak frequency response at volume control setting '2'.

In comparing the 15 old and 10 new hearing aids under the strong category, it was found that the old hearing aids exhibited a variation in average peak frequency response by 645 Hz whereas the new hearing aids exhibited a variation of ll0Hz. Under the moderate category, 25 old and 10 new hearing aids were considered. The new hearing aids exhibited a relatively lesser variation in average peak frequency response in comparison with the old hearing aids,the variation being 280 Hz and 350 Hz for the new and old hearing aids respectively. The variation between hearing aids under the strong category in average peak frequency response was 645 Hz whereas variations between hearing aids under the moderate category was 550 Hz with respect to average peak frequency response.

From Table-11 and figures 2 to 17 have been drawn. It can be seen that out of 16 models of hearing aids 13 models showed their average peak frequency response at volume control setting 2 three models showed average peak frequency response at volume control setting 3.

The results show that old hearing aids have greater variation than the new hearing aids. It also can be inferred that the strong category hearing aids have greater peak frequency response than the moderate category. The average peak frequency response values for all models of hearing aids at volume control setting 2 and 3 are within the speech frequency range (500 to 2000 Hz). From these results, it would seam that, volume control settings 2 or 3 are ideal for obtaining maximum use from the hearing aid.

SUMMARY

A total of 60 hearing aids were tested. Out of these 60, 20 hearing aids were those newly received from the manufacturers, while the rest belonged to the used group.

Of these 60 hearing aids* 35 belonged to the strong category and 25 belonged to the moderate category.

Both strong and moderate category hearing aids have shown the peak frequency response at volume control setting 2 or 3. Though, no appreciable difference is observed in peak frequency response values of both category hearing aids, strong category hearing aids showed higher peak frequency values. Different models of hearing aids also showed the same results.

Old hearing aids showed inconsistent responses when compared with new hearing aids.

These results, not only remainds us the importance of volume control setting but also supports previous studies.

Recommendations:

1. To study the same parameters ia an instrument which satisfies Indian Standards, this helps us in knowing how many hearing aids to really meet the standards and how many do not.

2. More number of healing aids to be taken from old and new under strong, moderate and mild category and to repeat the measurements.

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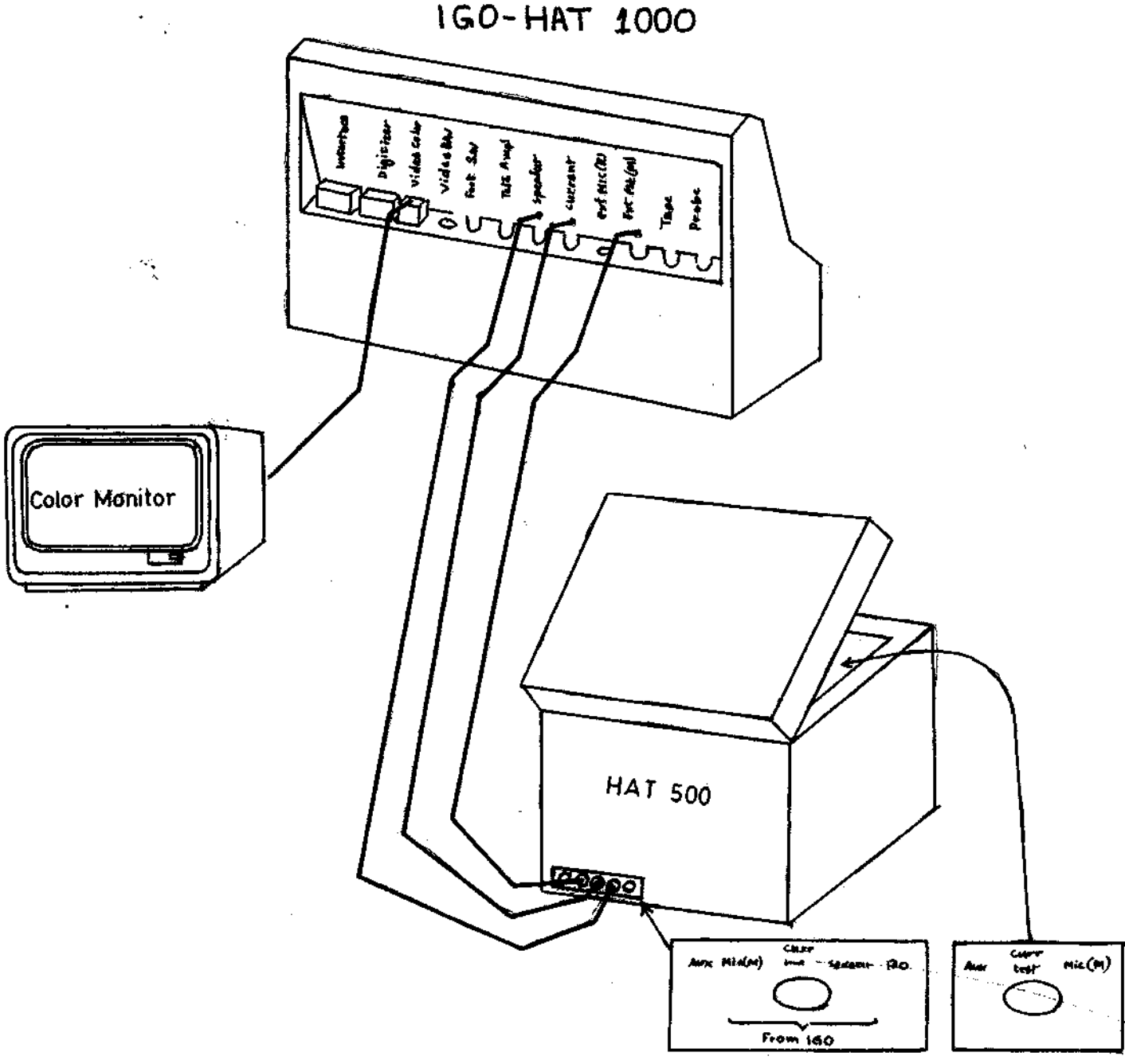
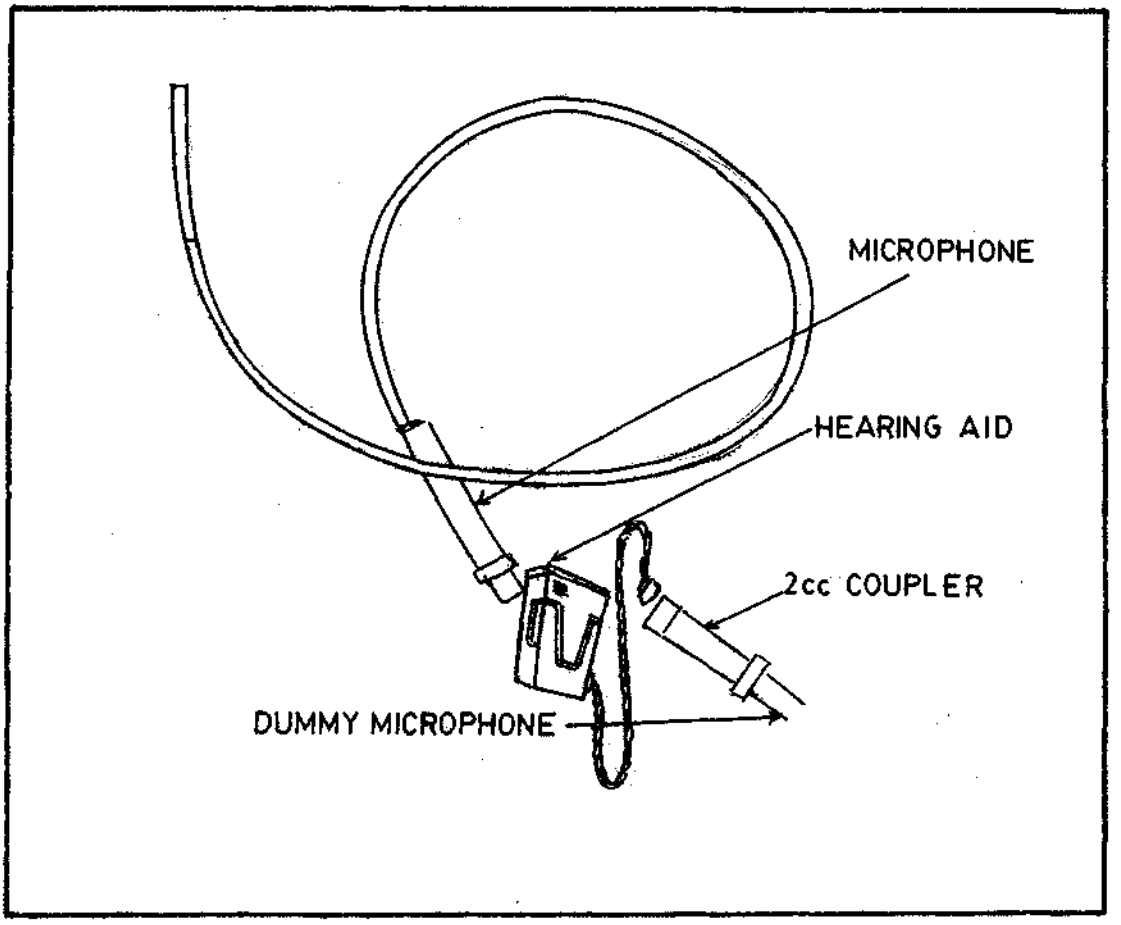
APPENDIX-A

Schematic representation of the connections made between the instruments ased for the study,



APPENDIX-B

Shows the position of dummy microphone, test microphone, hearing-aid and 2cc coupler inside the test box during calibration.



APPENDIX-C

Shows the position of dummy mic; test mic, hearing-aid and 2cc coupler inside the test box during testing situation.