VX Array™

Setup Manual

WAMM SET UP

NOTE: The WAMM full-range arrays are shipped without the mid-range modules or main crossovers mounted. This protects the structure of the full-range array and makes it easier to move. Do not mount the mid-range modules or main crossover until the full-range arrays are in their chosen initial locations in the room.

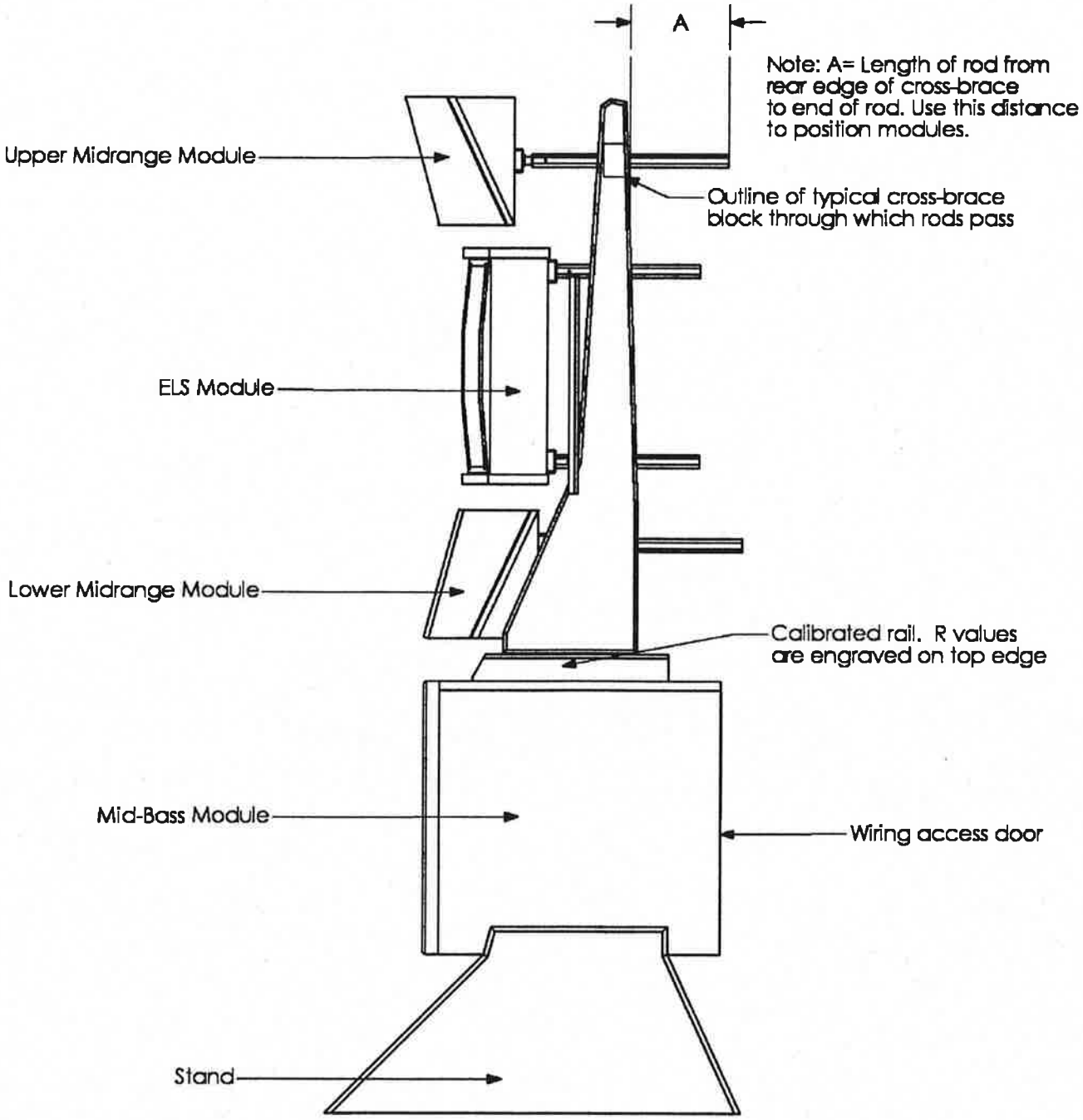
1.) Clear away a large area where the WAMMs will be placed. Temporarily, remove even amplifiers and cables from this area. The system requires a sizeable space around it to prevent damage to the equipment during the set up process.

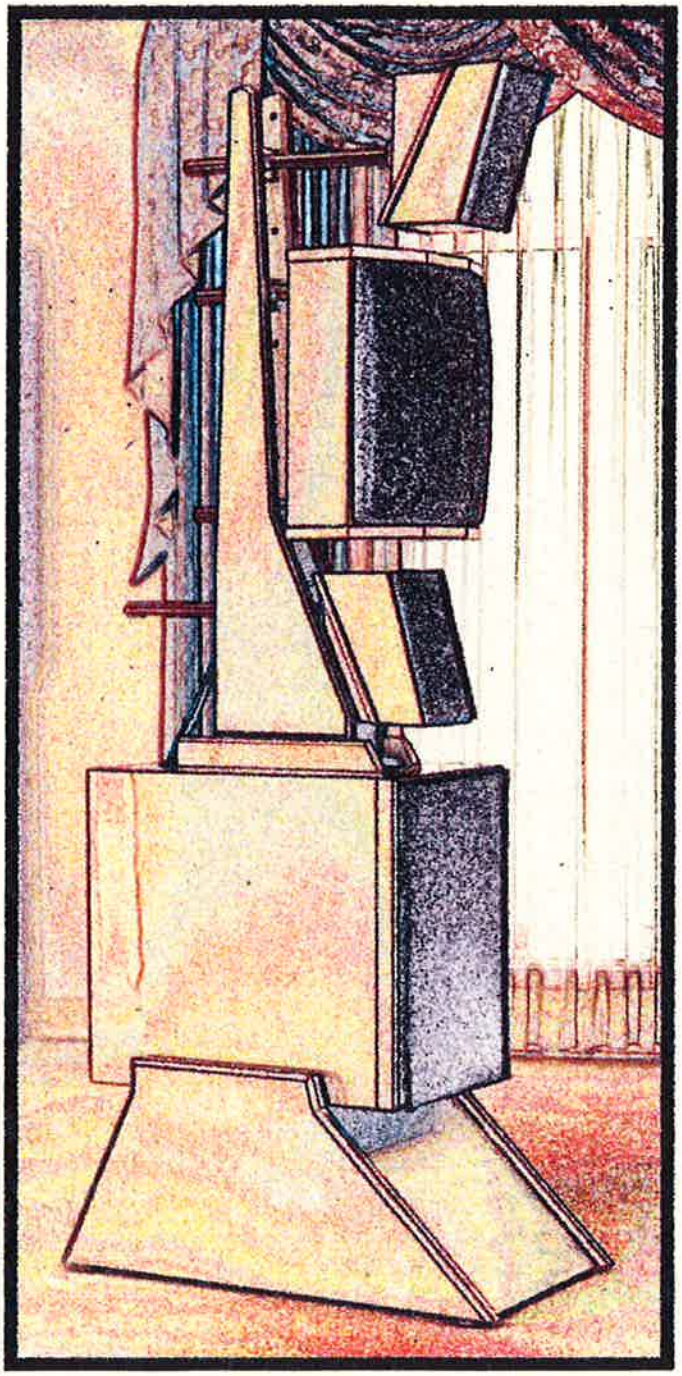
a.) The speaker system is composed of two (2) full-range arrays with adjustable group-delay geometry of modules, (see Figure 1) and, two (2) large subwoofer towers of approximately twelve (12) cubic feet of volume each. The vast majority of set up and calibration work involves the full-range arrays.

b.) It is recommended that odd numbered serial numbers be on the left channel, while even serial numbers be on the right channel.

c.) Referring to Figure 7, insure that all the elements of the system are available, and that cables are of the appropriate type and length.

Figure 1


A
Note: A= Length of rod from rear edge of cross-brace to end of rod. Use this distance to position modules.
Upper Midrange Module
Outline of typical cross-brace block through which rods pass
ELS Module
Lower Midrange Module
Calibrated rail. R values are engraved on top edge
Mid-Bass Module
Wiring access door
Stand



WILSON® AUDIO

WHERE TO POSITION THEM

NOTE: The room interaction conditions that favor low frequency reinforcement are contradictory to those that promote open soundstaging and maximum full-range transparency. Because of this, subwoofers are usually placed along a wall in, or near, a corner, while the full-range arrays are usually positioned out into the room away from walls and other boundaries.

2.) Position the subwoofers along the wall behind where the full-range arrays will be placed. The subwoofers are usually positioned symmetrically relative to the full-range arrays when viewed from the optimal listening position.

3.) If specific locations for placement are not provided by Wilson Audio, use the first two paragraphs of the WASP™ (Wilson Audio set up procedure) as described by Martin Colloms,[1] and quoted herein, in full, to locate a promising location for each of the full-range arrays. Generally, the full-range arrays will be between one or two meters from the side walls (more in very large listening rooms such as banquet halls or function rooms). The distance from the rear wall to the back edge of the full-range array stand is usually one and a half to two and a half meters (again, subject to the size of the room). Use of a paper or cloth based adhesive tape (i.e. masking tape), with moderately weak adhesive, will assist in marking these positions in a non-destructive way.

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1 Colloms, Martin; High Performance Loudspeaker 5th Edition; J. Wiley & Sons; © 1997; pg. 113

Wilson Placement Method

"Making the best of room acoustics can make a large contribution to sound quality. The American company, Wilson Audio, is a key exponent of a speaker placement technique that begins with a good listener making a subjective assessment of the room acoustics, especially the reflecting boundaries close to the proposed loudspeaker position. You begin by clearing the region between the loudspeakers and the nearby walls of any potential acoustic obstacles, including the proposed loudspeakers themselves. In one method pioneered by David Wilson, he reads aloud from a neutral text, employing a level monotone, while at the same time pacing over an imagined grid defined by the speaker and listening regions. The reader listens for changes in the character of his or her voice, in particular the early reflections. In most rooms it is found that neutral zones exist present as bands located about 1-2 m from side walls and running parallel to them. Depending on the absorption of the local wall and that opposite, these neutral regions may be between 0.3 and 0.8 m wide and are identified by the neutral sounding reverberation returning to the listener when he stands in these regions. The operator is looking for an absence of coloration, where the sound is neither boomy nor chesty, lacks roughness and the words sound most clearly articulated. The underlying principle is based on the interchangeability of source and observing listener. A second listener who would be located in a fairly neutral position, located centrally in the listening area, may beneficially guide the assessment. The quality of aural discrimination is improved with practice. To find the optimum listening position in a given room a first approximation is given by defining the initial speaker position, 1.5 m from the wall, where each speaker

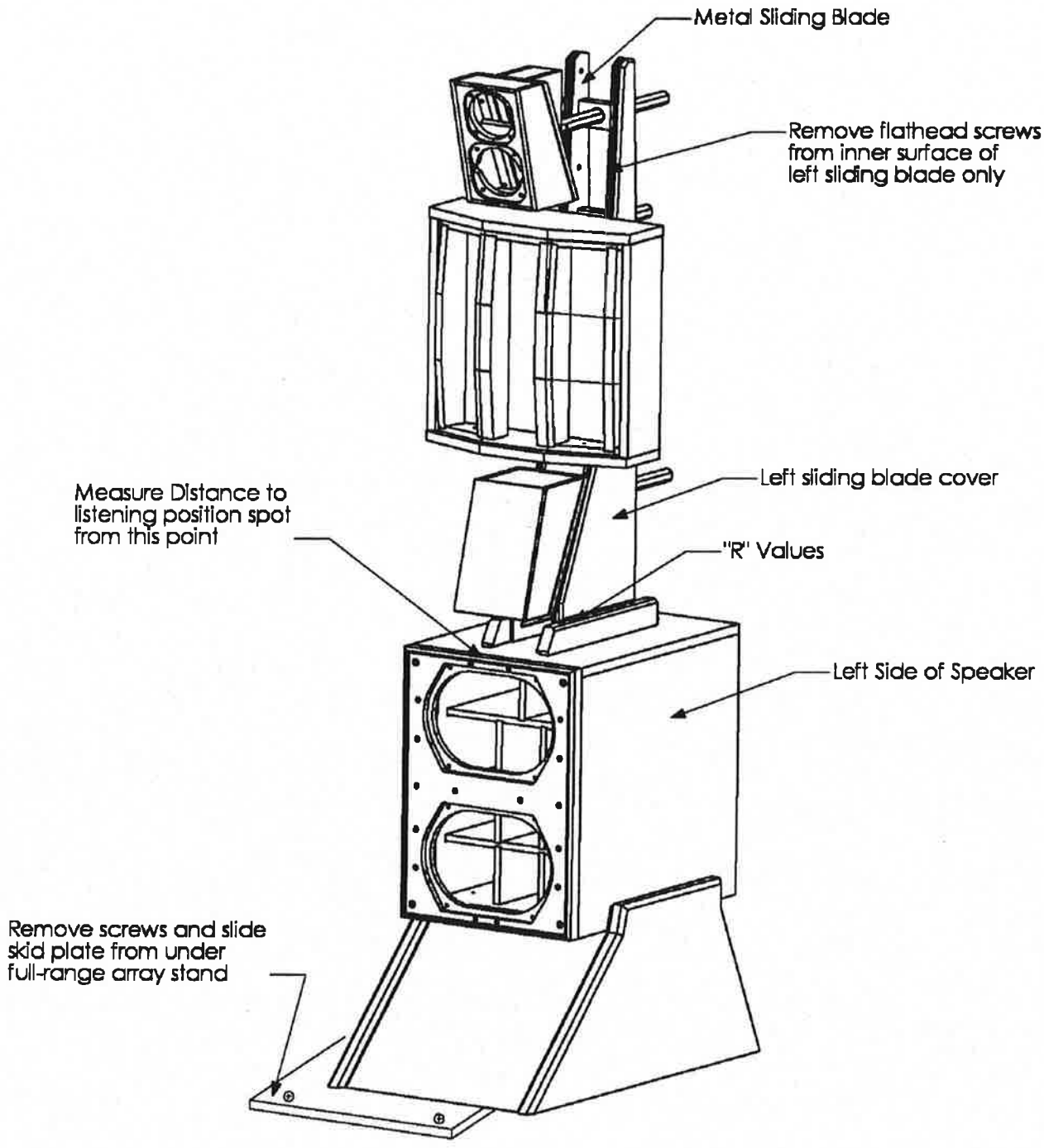
has a median axis placed centrally in it's neutral zone, so defining the space into the side wall."

"The next step is to triangulate from the speakers to a central point where the distance to each speaker is about 15% greater than the spacing between the speakers. Additional text may be read out at each nominated speaker position while assessing the listening position. This may be fine tuned nearer or further from the speakers, listening for the clearest and the most neutral speech sound."

"For the final stage of the Wilson procedure, the loudspeakers are installed but not locked or spiked. Trials are then conducted in stereo with a high quality wide range programme. The sound quality must be assessed quickly taking immediate notes before the ear/brain has a chance to acclimatize and make unwanted compensations. Those first opinions are the basis for adjusting placement of the speakers, forward and back, for the most even perceived frequency response. Trial and error will quickly show the surprisingly small adjustments which may be influential on perceived spectral balance."

"For critical applications there is a final test Wilson calls 'vowelling'. Here a piece of simple programme with a complex harmonic timbre may be used in single channel working for the listener, optimally seated, to assess subtle shades of mid-band clarity, this controlled by the critical adjustment of the speaker with respect to its nearest boundary. The use of calibrated masking tape temporarily fixed to the floor can aid this calibrated adjustment which is done for left and right channels individually. When correctly carried

Figure 2


Metal Sliding Blade
Remove flathead screws from inner surface of left sliding blade only
Left sliding blade cover
Measure Distance to listening position spot from this point
"R" Values
Left Side of Speaker
Remove screws and slide skid plate from under full-range array stand

out, the sound acquires a further dimension of precision focus and articulation in the stereo image."

4.) Carefully move the full-range arrays into the chosen initial positions. They should be equidistant from the listening position, as measured from the middle of the front edge of the mid-bass module (see figure 2). The spikes should not be attached, as you will want to move the speakers to optimize the sound. Do, however, remove the protective skid plates from the bottoms of the full-range array stands.

5.) Using a very short, or angled, Phillips-head screwdriver remove the screws which attach the covers to the left metal sliding blades only (See figure 2). It is not necessary to remove the cover from the right sides. Carefully remove the cover, which may be loosely adhered to the acoustical material on the surface of the sliding blade. Place the cover in a safe area.

6.) If the WAMM is covered with protective film, now would be a good time to remove it. If you wait until later, the mid-range modules will get in the way, and obstruct removal. Remove, also, any fiberboard protective covers from the module fronts.

7.) Carefully install the mid-range modules, according to Figures 3 & 4. Note that the upper mid-range module's mounting block is near the center of the back of the module.

Figure 3

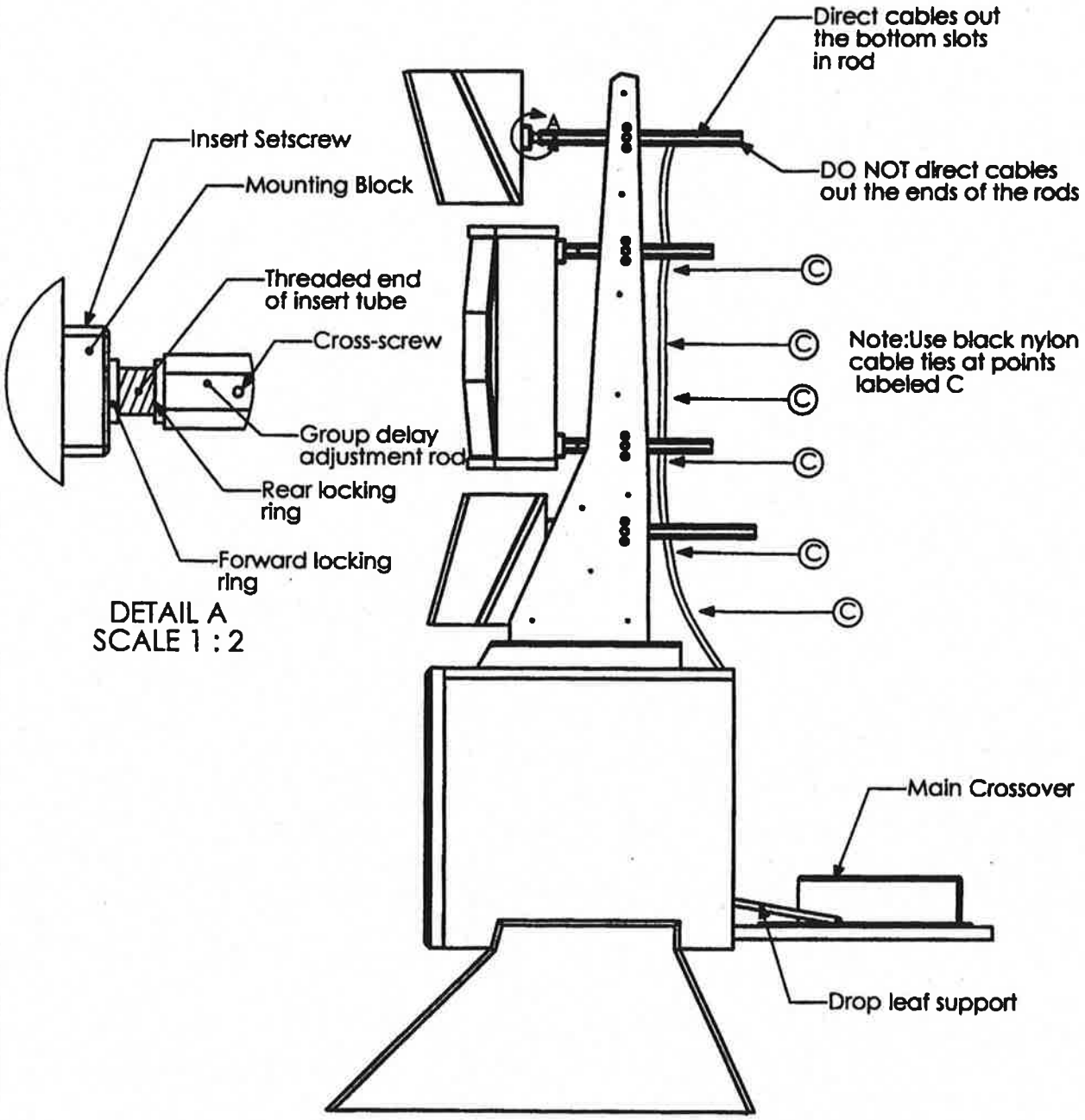
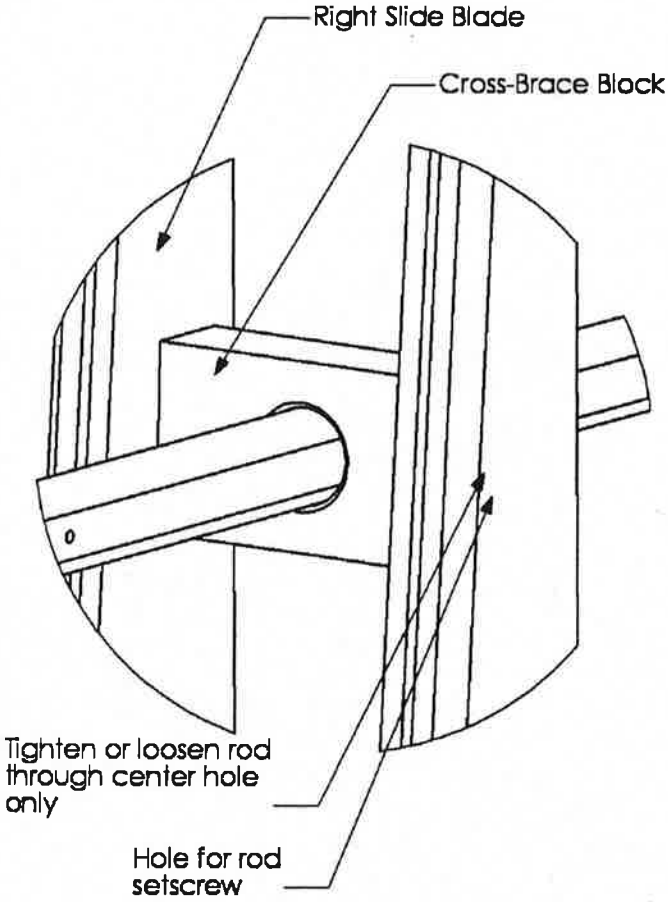
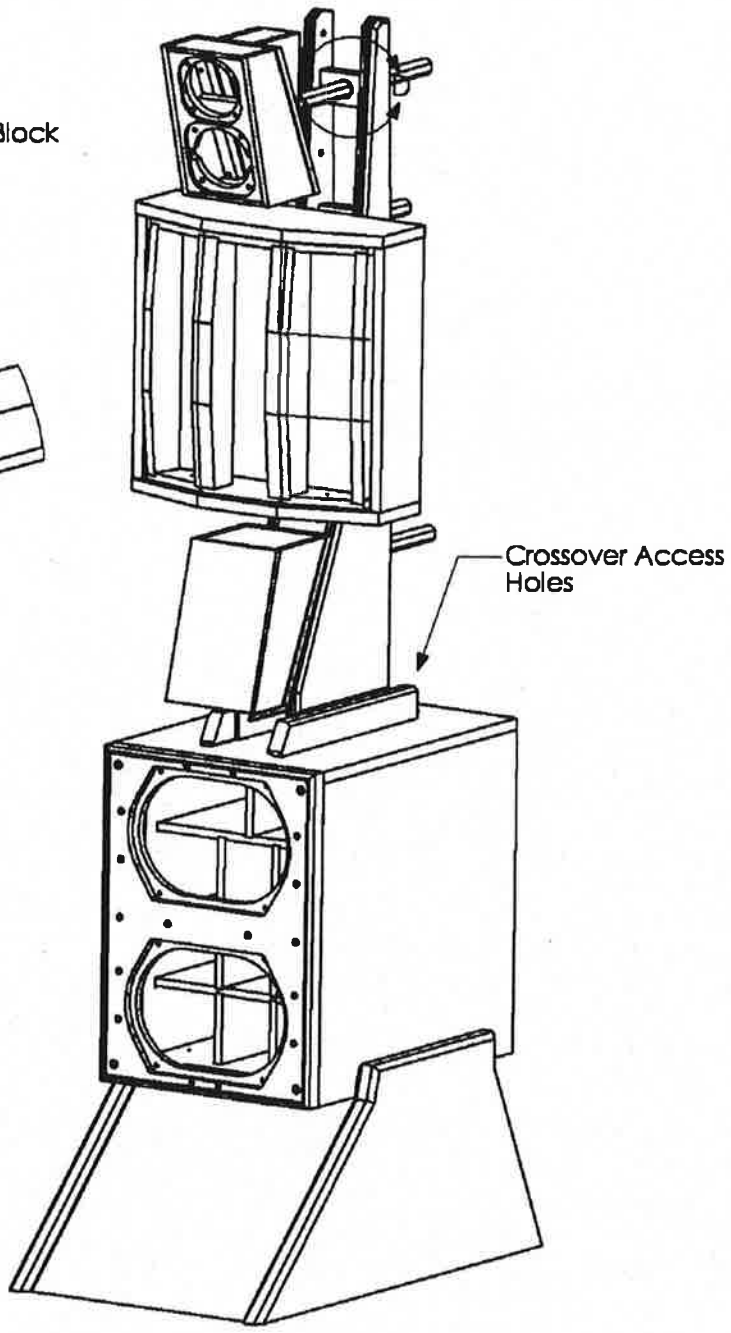

Direct cables out the bottom slots in rod
DO NOT direct cables out the ends of the rods
Insert Setscrew
Mounting Block
Threaded end of insert tube
Cross-screw
Group delay adjustment rod
Rear locking ring
Forward locking ring
DETAIL A
SCALE 1 : 2
C
Note:Use black nylon cable ties at points labeled C
Main Crossover
Drop leaf support

Figure 4



DETAIL D
SCALE 6 : 11



a.) Attach the threaded end of the small insert tube into the mounting block until it stops against the back of the module. Back off the tube a fraction of a turn until the threaded hole in the side of the tube points straight out from the left side of the module. Set the tube in this position by tightening the forward locking ring against the mounting block.

b.) Mount the upper mid-range modules into their group-delay adjustments rods. Someone should help you with this by standing behind the speakers and pulling the module's cable through the center of the rod, and out the slot on the bottom of the rod, as you hold and insert the module from the front. Adjust the rear-locking ring until the threaded hole in the side of the insert tube is centered with the cross screw hole in the side of the group delay adjustment rod. Secure with the short socket-head cross screw. Do not over tighten.

c.) Viewing from the front, straighten the module then tighten the rear-locking ring. As you tighten the ring, push up slightly on the bottom of the module. Make sure both rings are tight.

d.) Finally, tighten the insert tube set screw, which goes through the top of the mounting block.

8.) Repeat the above procedures as you install the lower mid-range modules. You will need to first extend the lower group-delay adjustment rods to gain access to their cross screw

holes. Do this by loosening their rod set screws (see Figure 4) through the left side of the left sliding blade.

9.) Dress the module wiring down the back of the sliding blades, along the right side of the group delay adjustment rods.

10.) Remove the two (2) upper screws that secure the door on the back of the mid-bass module. Open the door, and let it rest, open, approximately parallel with the floor. (See Figure 3).

11.) Remove the Phillips head wood screws which are partially screwed into the door. Carefully lay the main crossover module onto the door on the layer of bituminous pad. The barrier strip connectors should be closest to the back of the mid-bass enclosure. Secure the cross over module with the Phillips head wood screws. Do not over tighten.

12.) The main crossover modules are quite heavy. Therefore, to prevent damage to the door and its hinges, adjustable drop leaf supports are used (see Figure 5). These are mounted (two per channel) to the inside walls of the crossover compartment at the rear of the mid-bass module. The adjustment is made using the slotted setscrew on the rear edge of the slide brake block on the vertical rod. There are two of these brake blocks per enclosure.

a.) Using a screwdriver, turn the setscrews clockwise until they stop. At this position, no braking is available, and the door can move up or down freely.

b.) Turning the setscrews counter clockwise applies increasing braking action. Start by rotating each setscrew counter clockwise by 3 full turns.

c.) The brakes are correctly adjusted when the door, if released at the top of its arc, will slowly and safely descend to its full open position.

13.) Draw the cable from the upper mid-range module and the signal cable (twisted under heat shrink tubing) from the ELS module down through the crossover access hole closest to the right of the speakers (see Figures 4 & 5). Do not attach any connectors yet.

14.) Similarly, draw the cable from the lower mid-range module and the low voltage DC cable from the ELS module down through the crossover access hole closest to the speaker's left side.

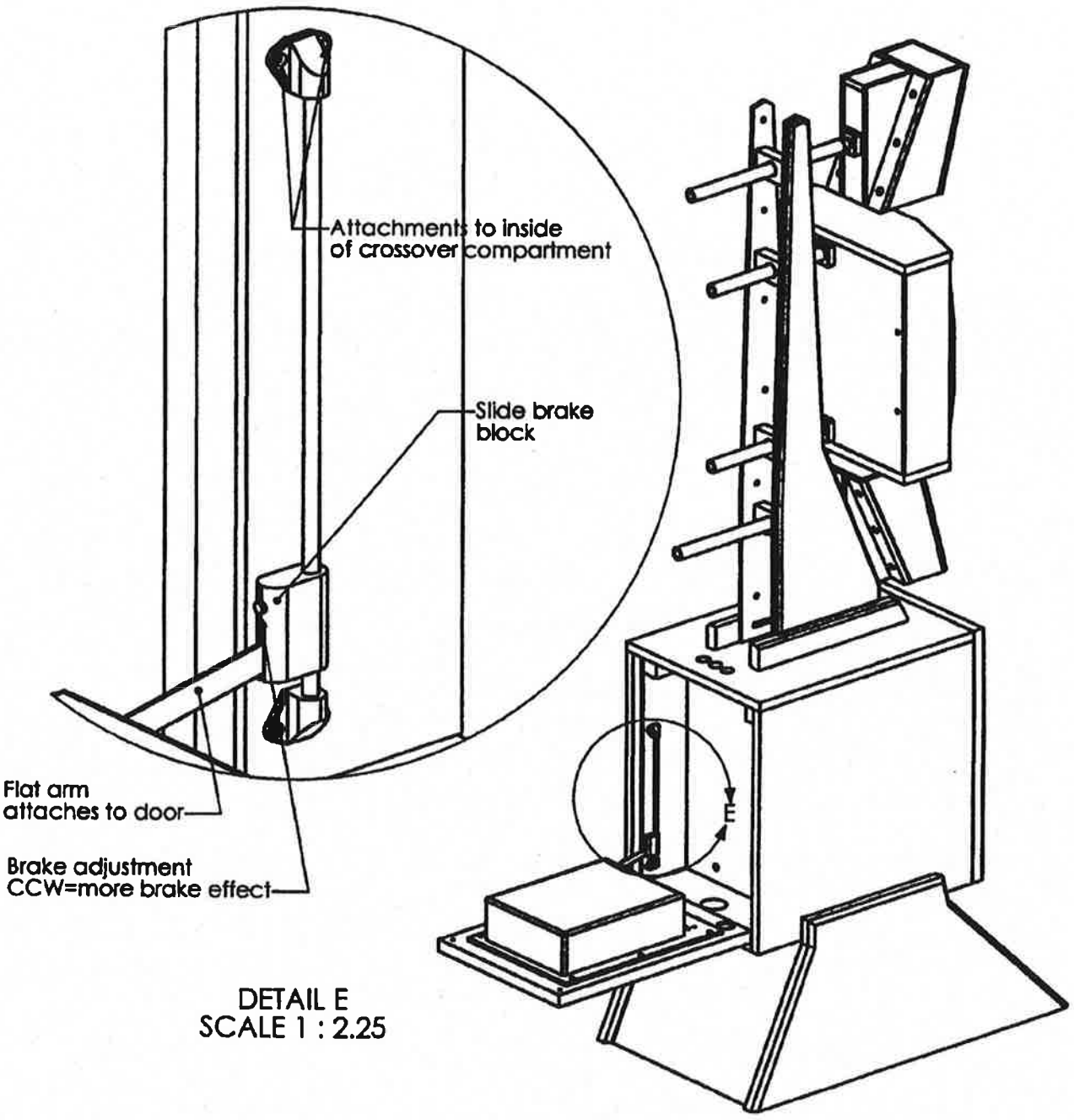
NOT CUT TO AFTER STEP

15.) At this time, carefully dresses the cable around the inner sides of the crossover compartment.

16.) Draw the low voltage DC cable down and out the large access hole on the floor of the crossover compartment.

17.) The AC step-down transformer is a small, wall plug-in type. Make certain that its primary voltage matches the mains voltage available in your room. With its output connector free, plug the transformer into the wall outlet and measure the low voltage AC across the

Figure 5



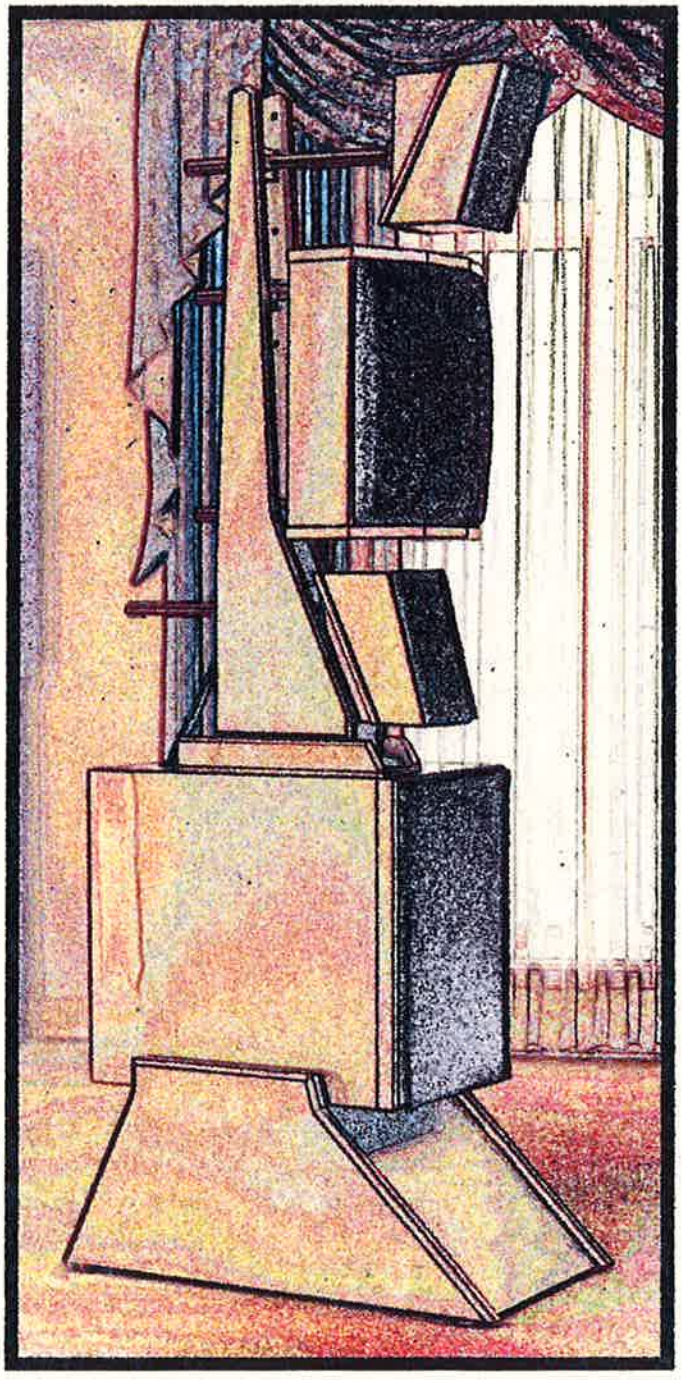
DETAIL E
SCALE 1 : 2.25

output connector. An acceptable range is from 11 to 16 VAC. Plug the output connector into the low voltage AC input of the rectifier circuit.

Note: Later series VII- A WAMMS have the rectifier circuitry built-in to the rear of the stand. Input and output connectors are labeled.

18.) Measure the DC voltage across the low voltage DC output connector of the rectifier. An acceptable value is between 14 and 20 VDC. As you can see, the voltage amplifier in the ELS module can operate successfully over a wide input voltage range.

19.) If the DC voltage is correct, connect the cable, which will carry the DC voltage to the ELS module to the low voltage DC output of the rectifier.



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ADJUSTING THE GROUP-DELAY CORRECTION FOR YOUR LISTENING ENVIRONMENT.

20.) While seated in your chair in the critical listening area, have an assistant measure the distance to your ear from the center of the top of the left channel's mid-bass module's baffle (see Figure 2). Repeat the process for the right channel. The distances for the two channels should be within one inch of each other. Note the distance.

21.) While seated in your chair, have an assistant measure the height of your ears off the floor. Note that ear height.

Correct adjustment of group delay is accomplished by moving the adjustable mechanical elements of the system so that their spatial relationship is appropriate for your specific listening distance and ear height.

The adjustable mid-range modules and ELS modules are part of the "upper array", which is also adjustable as a whole. The position of the upper array is indicated by aligning the front edge of the sliding blade to an "R" number on the top of the calibrated rail (See Figure 2.)

The individual modules however, are mounted at the ends of group-delay adjustment rods. The way that will be used in these instructions to determine the position of these rods will be to measure the distance from the rear edge of the cross-brace block to the end

of the group delay adjustment rod. This is shown as measurement "A" in Figure 1. The total range of these measurements could be from 1 to 10 inches.

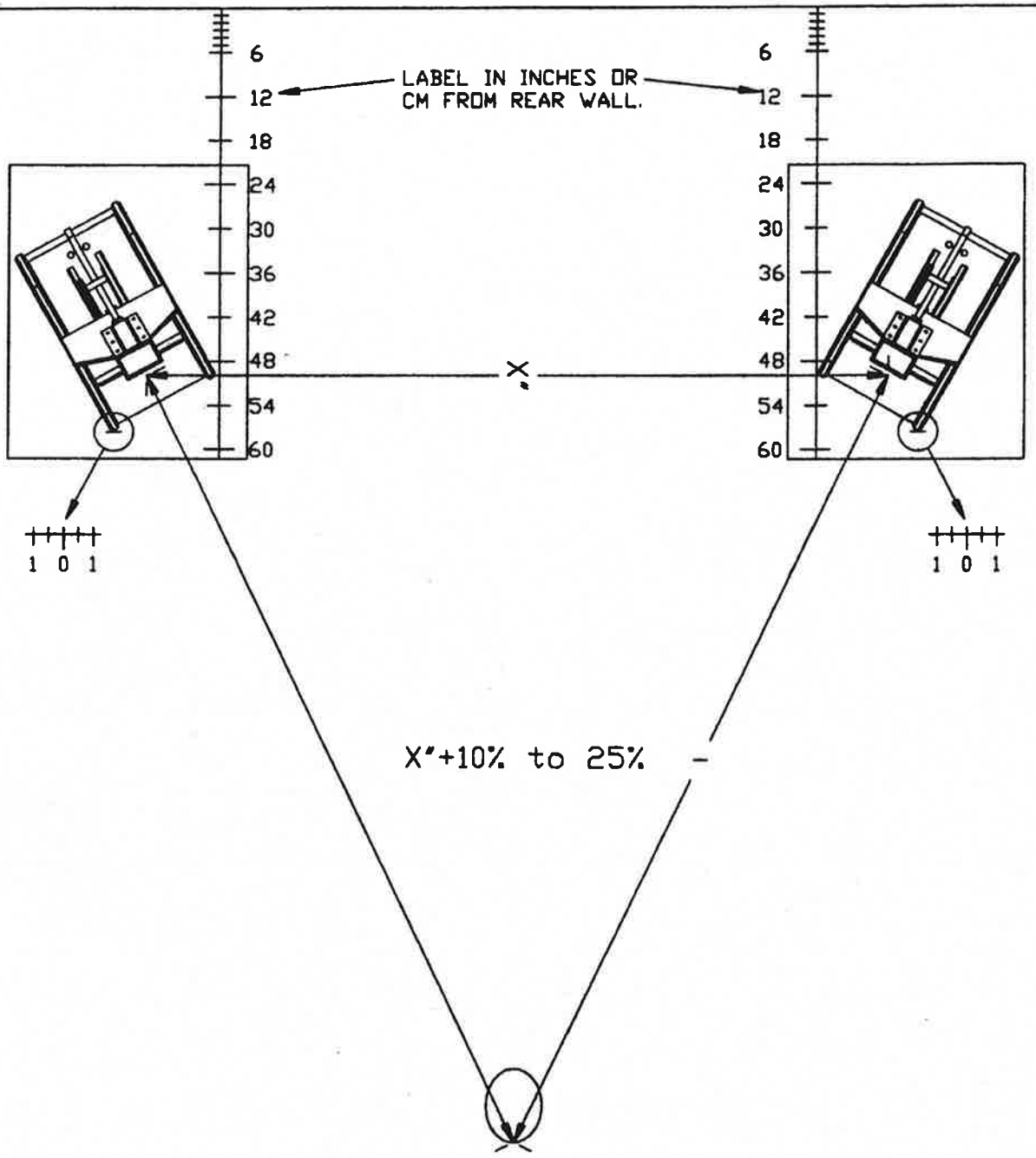
22.) In the tables (1-17), locate the distance you measured to your chair, under the left column "distance". Use the distance closest to the one you measured. Thus, if you measured 119", then you should use 120" from the tables.

23.) At the top of each sub-table there is an "Ear Height" measurement of from 39 to 51 inches. Select the sub-table whose ear height number is closest to your measured ear height.

24.) You will notice an "R=_____" number in the upper left-hand corner of the sub-table for your distance. Note that number. Loosen the four (4) large socket head screws, which secure the sliding blades to the calibrated rails. Adjust the position of the sliding blades so that their front edge aligns with that number on the rail. Tighten the 4 large screws.

25.) See Figure 4. Loosen the rod setscrews and move the modules in or out to result in the distance "A" specified in the tables for each module. Gently tighten the setscrew to hold the group delay adjustment rod in place. When the "R" and the "A" calibrations are set, the full-range array is now geometrically correct for your listening distance and ear height, since, during the course of fine tuning, you may need to re-position the full-range arrays to the extent that geometric re-calibration is required, do not replace the covers over the left metal sliding blades at this time. With

Rear Wall



DISTANCE FROM TWEETER TO LISTENERS' HEAD SHOULD BE APPROX. 1.1 TO 1.25 TIMES THE DISTANCE FROM TWEETER TO TWEETER.

Figure 6

Side Wall

Side Wall

Front Wall

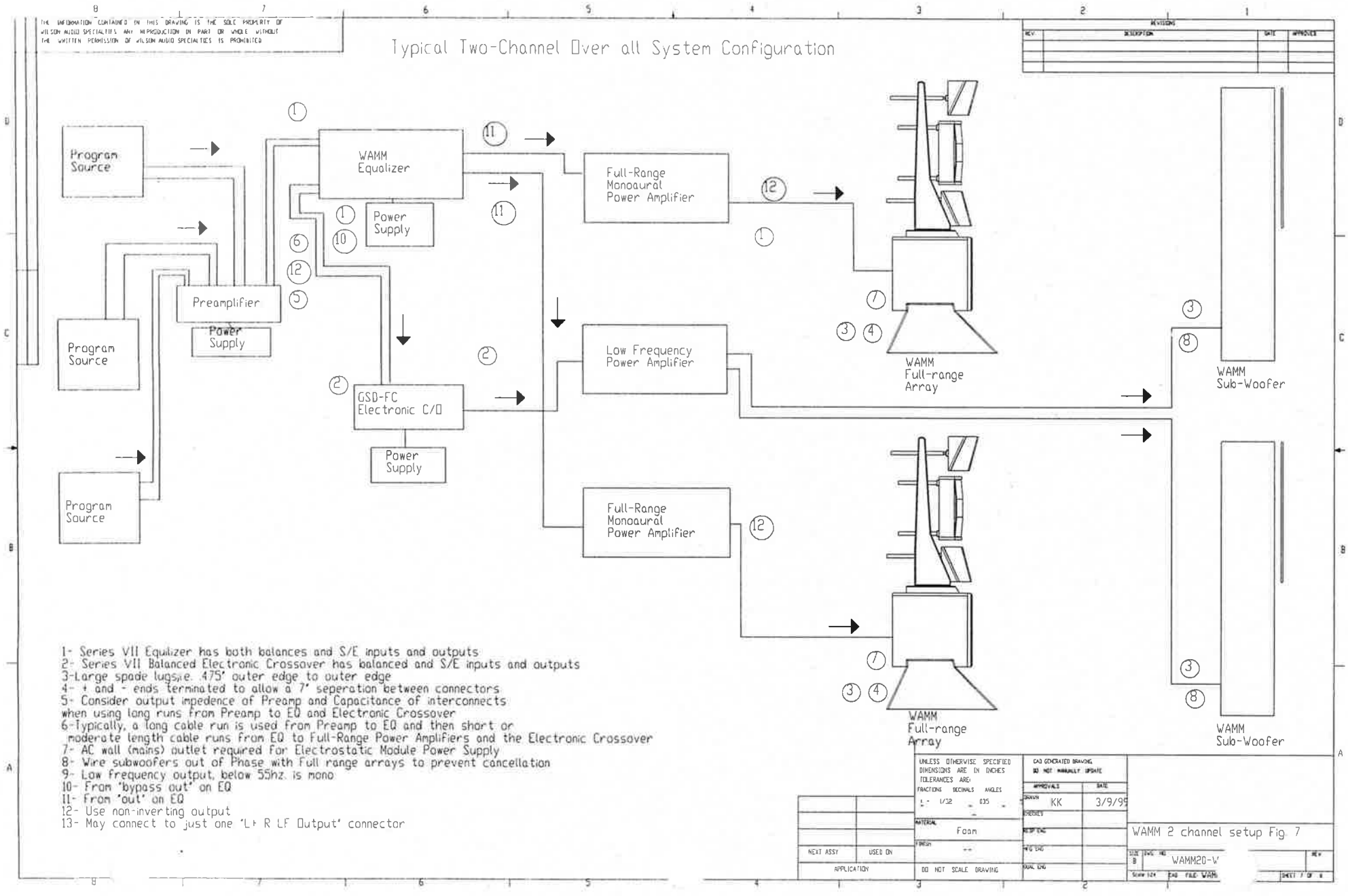
the modules positioned according to the tables, the cables to those modules may now be temporarily connected to the barrier strips on the main crossovers. It is not necessary, at this time, to dress the wires along the inner walls of the crossover compartment.

NOTE: An illustration of the equalizer's control setting needs to be created and it will constitute Figure 8.

26.) Now is also the time to electrically connect the WAMM to the rest of the system's electronics so that music can be played. See Figure 7

27.) After the system has been correctly electrically connected, the equalizer controls should be adjusted to their "default settings" see figure 8. The equalizer settings, plus the "A" and "R" geometric settings result in a system of high resolution potential. Full-range arrays of the WAMM system can now be fine-tuned to the room using musical material. Leave the sub-woofers off for this part of the calibration with the electronic crossover's output control fully counter clockwise. The system, even without sub woofers, extends below 40 Hz. The purpose of the equalizer in the WAMM system is not to adjust it's sound to the room. Rather, the equalizer fine-tunes the tonal balance and phase between the modules within each full-range array. The equalizer octave settings for all WAMM series VII and VII-A systems, in four continents, in a wide range of room sizes and using a wide variety of associated equipment, varies no more than $\pm$2dB from the default settings shown in Figure 8

Figure 7


Typical Two-Channel Over all System Configuration
Program Source
Program Source
Program Source
Preamplifier
Power Supply
WAMM Equalizer
Power Supply
GSD-FC Electronic C/O
Power Supply
Full-Range Monoaural Power Amplifier
Low Frequency Power Amplifier
Full-Range Monoaural Power Amplifier
WAMM Full-range Array
WAMM Full-range Array
WAMM Sub-Woofer
WAMM Sub-Woofer
1- Series VII Equilizer has both balances and S/E inputs and outputs
2- Series VII Balanced Electronic Crossover has balanced and S/E inputs and outputs
3-Large spade lugsize. .475" outer edge to outer edge
4- + and - ends terminated to allow a 7" seperation between connectors
5- Consider output impedence of Preamp and Capacitance of interconnects when using long runs from Preamp to EQ and Electronic Crossover
6-Typically, a long cable run is used from Preamp to EQ and then short or moderate length cable runs from EQ to Full-Range Power Amplifiers and the Electronic Crossover
7- AC wall (mains) outlet required for Electrostatic Module Power Supply
8- Wire subwoofers out of Phase with full range arrays to prevent cancellation
9- Low frequency output, below 55hz. is mono
10- From "bypass out" on EQ
11- From "out" on EQ
12- Use non-inverting output
13- May connect to just one "L+ R LF Output" connector
WAMM 2 channel setup Fig. 7
WAMM20-W

28.) The method of fine-tuning the system with music should be consistent with the procedure that Wilson Audio teaches its dealers and distributors. The speakers should be positioned "toed-in" toward the listener. It has been our experience that the correct amount of toe-in should allow a person sitting in the primary listening position to see through the small gap between the stand and the inner side of each mid-bass module. In large rooms, where the system is intended to provide music for numerous listeners throughout the room, a primary listening position should be established near the middle of the room. If, on the other hand, the room is large, but the system will be configured for one critical listener, the primary listening position should be at approximately 1/3 of the length of the room. Thus, the single critical listener would be closer to the speakers.

29.) Adjust the positioning of the full range arrays at the speaker area of the room until you achieve the best performance with no EQ change from default.

30.) Adjust all of the rotating "octave frequency adjust" controls to the "1 o'clock" position.

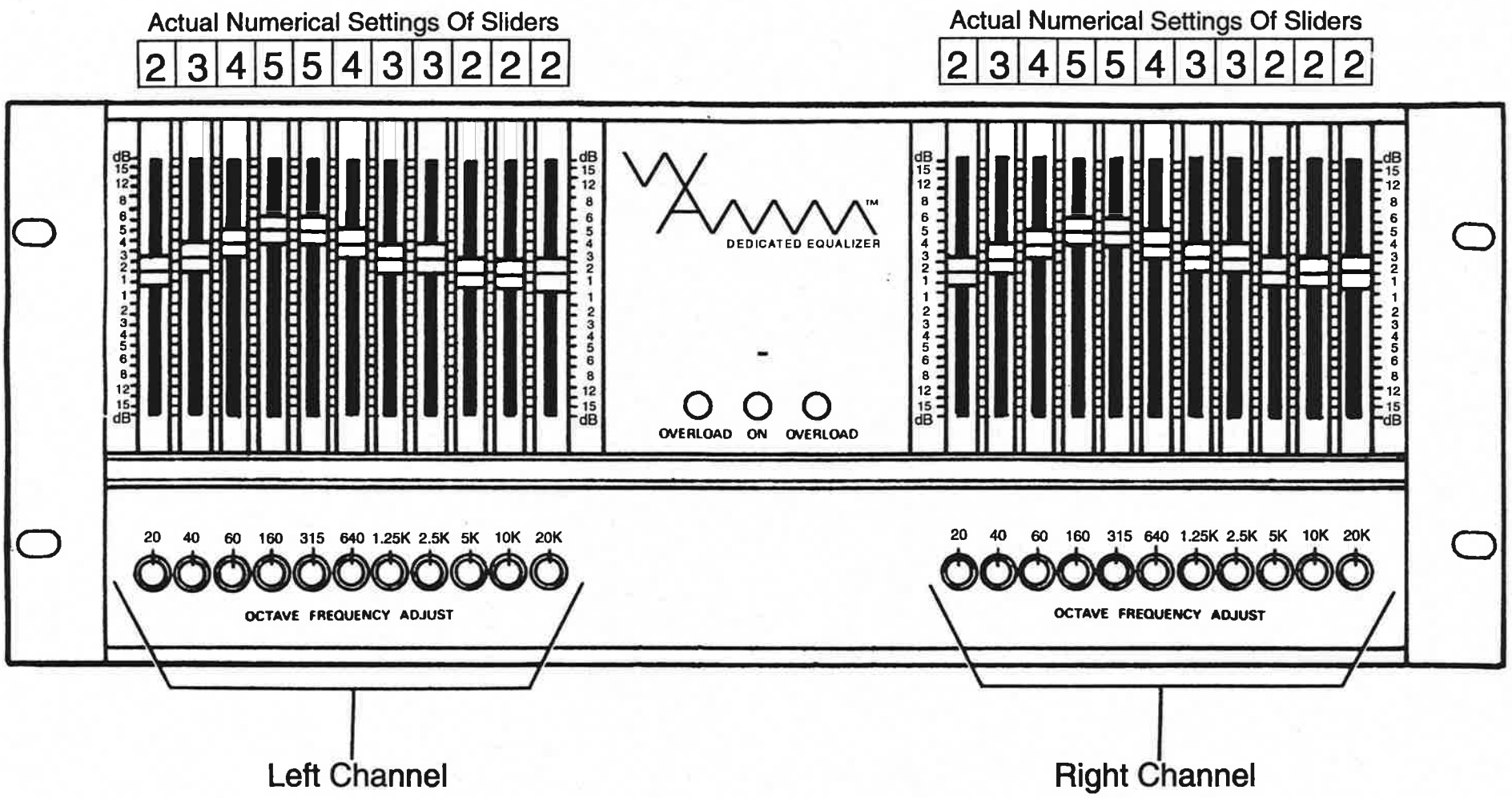
31.) Experiment with the sliding graphic EQ controls in order to understand their effect. Beware of any final settings that are more than one C/B above or below the default settings for the sliders.

Figure 8

WAMM VIIa

SETTINGS FOR SLIDER CONTROLS

(Both Channels Are Set The Same)



32.) If the amplifiers for the full-range arrays and the subwoofers have similar gain structures, you should set the electronic crossovers level control at the "one o'clock" position, and the phase switch to 180°. Note that while the full-range array's mid-bass module is a totally enclosed box. The sub-woofer is ported, thus their low frequency acoustic output is approximately 180° out of phase. Fine-tune the subwoofer level by first using a recording with low frequency transients (to establish phase), the sustaining low bass to establish level.

33.) Replace the left sliding blade covers, and secure them with their mounting screws. You may not be able to access the lower front screw hole, but that is acceptable.

34.) As the calibrations are complete, turn off the amplifiers and disconnect the lugs to the main crossover barrier strip. Gently pull the cables from the modules down and dress them neatly adjacent to the right side of the group delay adjustment rods, and close to the back of the cross brake blades. Secure them with black nylon ties at about 8 inch intervals.

35.) Carefully dress the cables around the inside walls of the main cross over compartments. For conventions sake, the upper mid-range module and ELS module signal cable run along the right wall as you face the compartment looking from the rear. Now connect the cables to the main crossover barrier strips. When dressed down properly, the cables will be out of the way of the crossover module, and the door will close completely. Close and secure the doors with the socket head screws.

36.) Using masking tape on the floor, mark the locations of the corners of the stand of the full range arrays.

37.) With the help of at least one assistant, tilt the full-range array slightly to the side to allow you to screw in the spiked feet. The supplied brass discs may be used to protect flooring if desired.

38.) Similarly attach the spikes to the bottom of the subwoofers.

39.) Gently attach the grill foams, being careful not the scratch them.

40.) The WAMM set up is complete.

R=7	Ear Height = 39		
Distance	Lower	ELS	Upper
96	8	2 1/4	1/2
100	7 7/8	2 1/4	3/4
104	7 7/8	2 3/8	1

R=7	Ear Height = 41		
Distance	Lower	ELS	Upper
96	8	2 5/8	1 1/4
100	8	2 5/8	1 1/2
104	8	2 3/4	1 3/4

R=7	Ear Height = 43		
Distance	Lower	ELS	Upper
96	8	3	2
100	8	3	2 1/4
104	8	3	2 3/8

R=7	Ear Height = 45		
Distance	Lower	ELS	Upper
96	8	3 1/4	2 5/8
100	8	3 3/8	2 7/8
104	8	3 3/8	3

R=7	Ear Height = 47		
Distance	Lower	ELS	Upper
96	7 7/8	3 5/8	3 1/4
100	7 7/8	3 5/8	3 1/2
104	7 7/8	3 5/8	3 5/8

Table 1

R=7	Ear Height = 49		
Distance	Lower	ELS	Upper
96	7 7/8	3 7/8	3 7/8
100	7 7/8	3 7/8	4
104	7 7/8	3 7/8	4 1/8

R=7	Ear Height = 51		
Distance	Lower	ELS	Upper
96	7 5/8	4	4 1/2
100	7 5/8	4	4 5/8
104	7 5/8	4	4 3/4

Table 2

R=6	Ear Height = 39		
Distance	Lower	ELS	Upper
108"	8 1/4	2 3/4	1 5/8
112	8 1/4	2 7/8	1 7/8
116	8 1/4	2 7/8	2 1/8
120	8 1/4	3	2 1/4
124	8 1/4	3	2 1/8
128	8 1/4	3 1/8	2 5/8
132	8 1/4	3 1/8	2 3/4
136	8 1/4	3 1/8	3
140	8 1/4	3 1/8	3 1/8

R=6	Ear Height = 41		
Distance	Lower	ELS	Upper
108	8 3/8	3 1/8	2 3/8
112	8 3/8	3 1/4	2 1/4
116	8 3/8	3 1/4	2 3/4
120	8 3/8	3 1/4	2 7/8
124	8 3/8	3 3/8	3
128	8 3/8	3 3/8	3 1/4
132	8 1/4	3 3/8	3 3/8
136	8 1/4	3 1/2	3 1/2
140	8 1/4	3 1/2	3 5/8

Table 3

R=6	Ear Height = 43		
Distance	Lower	ELS	Upper
108	8 3/8	3 1/8	2 3/8
112	8 3/8	3 1/2	3 1/8
116	8 3/8	3 1/2	3 3/8
120	8 3/8	3 5/8	3 1/2
124	8 3/8	3 5/8	3 5/8
128	8 3/8	3 5/8	3 3/4
132	8 3/8	3 5/8	3 7/8
136	8 3/8	3 3/4	4
140	8 1/4	3 3/4	4 1/8

R=6	Ear Height = 45		
Distance	Lower	ELS	Upper
108	8 3/8	3 3/4	3 5/8
112	8 3/8	3 3/4	3 3/4
116	8 3/8	3 7/8	3 7/8
120	8 3/8	3 7/8	4
124	8 3/8	3 7/8	4 1/8
128	8 1/4	3 7/8	4 1/4
132	8 1/4	3 7/8	4 3/8
136	8 1/4	3 7/8	4 1/2
140	8 1/4	4	4 5/8

Table 4

R=6	Ear Height = 47		
Distance	Lower	ELS	Upper
108	8 1/4	4	4 1/8
112	8 1/4	4	4 1/4
116	8 1/4	4 1/8	4 3/8
120	8 1/4	4 1/8	4 1/2
124	8 1/4	4 1/8	4 5/8
128	8 1/4	4 1/8	4 3/4
132	8 1/4	4 1/8	4 7/8
136	8 1/4	4 1/8	4 7/8
140	8 1/4	4 1/8	5

R=6	Ear Height = 49		
Distance	Lower	ELS	Upper
108	8 1/4	4 1/4	4 3/4
112	8 1/4	4 1/4	4 3/4
116	8 1/4	4 1/4	4 7/8
120	8 1/4	4 1/4	5
124	8 1/4	4 1/4	5 1/8
128	8 1/8	4 1/4	5 1/4
132	8 1/8	4 1/4	5 1/4
136	8 1/8	4 3/8	5 3/8
140	8 1/8	4 3/8	5 3/8

Table 5

R=6	Ear Height = 51		
Distance	Lower	ELS	Upper
108	8 1/8	4 1/2	5 1/8
112	8 1/8	4 1/2	5 1/4
116	8 1/8	4 1/2	5 3/8
120	8 1/8	4 1/2	5 1/2
124	8 1/8	4 1/2	5 1/2
128	8 1/8	4 1/2	5 1/2
132	8 1/8	4 1/2	5 5/8
136	8 1/8	4 1/2	5 3/4
140	8 1/8	4 1/2	5 7/8

Table 6

R=4	Ear Height = 39		
Distance	Lower	ELS	Upper
144	9	4	4
152	9	4 1/8	4 1/4
156	9	4 1/8	4 3/8
160	9	4 1/8	4 1/2
164	9	4 1/8	4 5/8
168	9	4 1/4	4 5/8
172	9	4 1/4	4 3/4
176	9	4 1/4	4 7/8

R=4	Ear Height = 41		
Distance	Lower	ELS	Upper
144	9 1/8	4 1/4	4 1/2
152	9 1/8	4 3/8	4 3/4
156	9	4 3/8	4 7/8
160	9	4 3/8	4 7/8
164	9	4 3/8	5
168	9	4 3/8	5 1/8
172	9	4 1/2	5 1/4
176	9	4 1/2	5 1/4

Table 7

R=4	Ear Height = 43		
Distance	Lower	ELS	Upper
144	9 1/8	4 1/2	5
152	9 1/8	4 5/8	5 1/4
156	9 1/8	4 5/8	5 1/4
160	9 1/8	4 5/8	5 3/8
164	9	4 5/8	5 1/2
168	9	4 5/8	5 1/2
172	9	4 5/8	5 5/8
176	9	4 5/8	5 5/8

R=4	Ear Height = 45		
Distance	Lower	ELS	Upper
144	9 1/8	4 3/4	5 1/2
152	9	4 3/4	5 5/8
156	9	4 3/4	5 3/4
160	9	4 3/4	5 3/4
164	9	4 7/8	5 7/8
168	9	4 7/8	5 7/8
172	9	4 7/8	6
176	9	4 7/8	6

Table 8

R=4	Ear Height = 47		
Distance	Lower	ELS	Upper
144	9	5	5 7/8
152	9	5	6
156	9	5	6 1/8
160	9	5	6 1/8
164	9	5	6 1/4
168	9	5	6 1/4
172	9	5	6 3/8
176	9	5	6 3/8

R=4	Ear Height = 49		
Distance	Lower	ELS	Upper
144	9	5 1/8	6 1/4
152	9	5 1/8	6 3/8
156	9	5 1/8	6 1/2
160	9	5 1/8	6 1/2
164	9	5 1/8	6 5/8
168	9	5 1/8	6 5/8
172	9	5 1/8	6 3/4
176	9	5 1/8	6 3/4

Table 9

R=4	Ear Height = 51		
Distance	Lower	ELS	Upper
144	8 7/8	5 1/4	6 5/8
152	8 7/8	5 1/4	6 3/4
156	8 7/8	5 1/4	6 7/8
160	8 7/8	5 1/4	6 7/8
164	8 7/8	5 1/4	6 7/8
168	8 7/8	5 1/4	7
172	8 7/8	5 1/4	7
176	8 7/8	5 1/4	7

Table 10

R=3	Ear Height = 39		
Distance	Lower	ELS	Upper
180	9 3/8	4 5/8	5 3/8
186	9 3/8	4 3/4	5 1/2
192	9 3/8	4 3/4	5 5/8
198	9 3/8	4 3/4	5 5/8
204	9 3/8	4 3/4	5 3/4
210	9 3/8	4 3/4	5 7/8
216	9 3/8	4 7/8	6
222	9 3/8	4 7/8	6
228	9 3/8	4 7/8	6 1/8
234	9 3/8	4 7/8	6 1/4
240	9 3/8	4 7/8	6 1/4
252	9 3/8	5	6 3/8
264	9 3/8	5	6 1/2
276	9 3/8	5	6 5/8
288	9 3/8	5	6 3/4
300	9 3/8	5 1/8	6 7/8

Table 11

R=3	Ear Height = 41		
Distance	Lower	ELS	Upper
180	9 3/8	4 7/8	5 3/4
186	9 3/8	4 7/8	5 7/8
192	9 3/8	4 7/8	6
198	9 3/8	5	6
204	9 3/8	5	6 1/8
210	9 3/8	5	6 1/4
216	9 3/8	5	6 3/8
222	9 3/8	5	6 3/8
228	9 3/8	5	6 1/2
234	9 3/8	5 1/8	6 1/2
240	9 3/8	5 1/8	6 5/8
252	9 3/8	5 1/8	6 3/4
264	9 3/8	5 1/8	6 7/8
276	9 3/8	5 1/8	7
288	9 3/8	5 1/4	7
300	9 3/8	5 1/4	7 1/8

Table 12

R=3	Ear Height = 43		
Distance	Lower	ELS	Upper
180	9 3/8	5 1/8	6 1/8
186	9 3/8	5 1/8	6 1/4
192	9 3/8	5 1/8	6 3/8
198	9 3/8	5 1/8	6 3/8
204	9 3/8	5 1/8	6 1/4
210	9 3/8	5 1/8	6 5/8
216	9 3/8	5 1/4	6 5/8
222	9 3/8	5 1/4	6 3/4
228	9 3/8	5 1/4	6 3/4
234	9 3/8	5 1/4	6 7/8
240	9 3/8	5 1/4	6 7/8
252	9 3/8	5 1/4	7
264	9 3/8	5 1/4	7 1/8
276	9 3/8	5 3/8	7 1/4
288	9 3/8	5 3/8	7 1/4
300	9 3/8	5 3/8	7 3/8

Table 13

R=3	Ear Height = 45		
Distance	Lower	ELS	Upper
180	9 3/8	5 1/4	6 1/2
186	9 3/8	5 1/4	6 5/8
192	9 3/8	5 1/4	6 5/8
198	9 3/8	5 1/4	6 3/4
204	9 3/8	5 3/8	6 7/8
210	9 3/8	5 3/8	6 7/8
216	9 3/8	5 3/8	7
222	9 3/8	5 3/8	7
228	9 3/8	5 3/8	7 1/8
234	9 3/8	5 3/8	7 1/8
240	9 3/8	5 3/8	7 1/8
252	9 3/8	5 3/8	7 1/4
264	9 3/8	5 3/8	7 3/8
276	9 3/8	5 3/8	7 1/2
288	9 3/8	5 1/2	7 1/2
300	9 3/8	5 1/2	7 5/8

Table 14

R=3	Ear Height = 47		
Distance	Lower	ELS	Upper
180	9 3/8	5 3/8	6 7/8
186	9 3/8	5 3/8	6 7/8
192	9 3/8	5 1/2	7
198	9 3/8	5 1/2	7
204	9 3/8	5 1/2	7 1/8
210	9 3/8	5 1/2	7 1/8
216	9 3/8	5 1/2	7 1/4
222	9 3/8	5 1/2	7 1/4
228	9 3/8	5 1/2	7 3/8
234	9 3/8	5 1/2	7 3/8
240	9 3/8	5 1/2	7 3/8
252	9 3/8	5 1/2	7 1/2
264	9 3/8	5 1/2	7 5/8
276	9 3/8	5 1/2	7 5/8
288	9 3/8	5 1/2	7 3/4
300	9 3/8	5 1/2	7 3/4

Table 15

R=3	Ear Height = 49		
Distance	Lower	ELS	Upper
180	9 3/8	5 1/2	7 1/8
186	9 3/8	5 1/2	7 1/4
192	9 3/8	5 5/8	7 1/4
198	9 3/8	5 5/8	7 3/8
204	9 3/8	5 5/8	7 3/8
210	9 3/8	5 5/8	7 1/2
216	9 3/8	5 5/8	7 1/2
222	9 3/8	5 5/8	7 1/2
228	9 3/8	5 5/8	7 5/8
234	9 3/8	5 5/8	7 5/8
240	9 3/8	5 5/8	7 5/8
252	9 3/8	5 5/8	7 3/4
264	9 1/4	5 5/8	7 7/8
276	9 1/4	5 5/8	7 7/8
288	9 1/4	5 5/8	7 7/8
300	9 1/4	5 5/8	8

Table 16

R=3	Ear Height = 51		
Distance	Lower	ELS	Upper
180	9 1/4	5 5/8	7 1/2
186	9 1/4	5 5/8	7 1/2
192	9 1/4	5 5/8	7 5/8
198	9 1/4	5 5/8	7 5/8
204	9 1/4	5 5/8	7 5/8
210	9 1/4	5 5/8	7 3/4
216	9 1/4	5 5/8	7 3/4
222	9 1/4	5 3/4	7 3/4
228	9 1/4	5 3/4	7 7/8
234	9 1/4	5 3/4	7 7/8
240	9 1/4	5 3/4	7 7/8
252	9 1/4	5 3/4	8
264	9 1/4	5 3/4	8
276	9 1/4	5 3/4	8 1/8
288	9 1/4	5 3/4	8 1/8
300	9 1/4	5 3/4	8 1/8

Table 17