The Graham-Holliman Velocity-Coupled Infra-Bass Speaker

Published by VAN KAREN PUBLISHING 5 SWAN STREET WIMSLOW CHESHIRE

A do-it-yourself version of the "sensational" new
GRAHAM HOLLIMAN VELOCITY-COUPLED INFRA-BASS SPEAKER

Scaled for 15",12", and 10" drive units

Note: These speakers employ a completely new method of bass loudspeaker loading. Invented by Mr. Graham Holliman, which claims to enable a loudspeaker of acceptable size to reproduce frequencies considerably lower than those, which have been obtainable using conventional techniques in a normal sized domestic listening room, and to do this with a high degree of efficiency and fidelity.

It has been established that much of the quality of realism produced by a given sound system depends not so much on the volume of bass frequencies, which we can hear, but rather on the volume and purity of those infra-bass frequencies, which it is ***normally*** assumed we couldn't hear. (The term purity is here used in the subjective sense, to denote that any distortion produced by the system should be substantially inaudible to the trained and experienced ear.) This system is intended to compliment the normal 'full range' speakers already being used in a domestic Hi-Fi installation, to provide a musically satisfying and realistic sound, very closely approximating live music set in its ***original*** acoustic environment, rather than to measure accurately in terms of such parameters as harmonic distortion, delayed resonance, phase and transient response, when located in a controlled environment such as an anechoic chamber. This latter approach is likely to give very different results when the speaker is transferred to a domestic listening room. However, if the system is measured, alongside the best of the (conventional) competition, ***in the correct acoustic environment***, i.e. a domestic lounge of the recommended size, it is likely that the difference will be just as obvious by measurement as it appears when listening tests are carried out in such and environment.

The drawings show all the component parts, which need to be made, plus cross sections showing how they are to be assembled, and overall front and side elevations. There are also a number of drawings giving details for the constructions and assembly. Panels have been given identification letters, and a table has been drawn up which gives the corresponding dimensions to be used when building cabinets for 15", 12", and 10" drive units.

To obtain satisfactory results, it is essential to use the correct drive units, and matching crossover networks. The units and crossovers have been specially designed for these speakers, and will be sold together. The drive units and the crossover networks to be used with them have characteristics, which compliment each other, and the cabinets with which they are intended to work. The drive unit/crossover combined packages will be sold in matched pairs.

One small word of warning – Those of you who are sufficiently interested in good bass response to consider building a pair of these enclosures, are probably already familiar with the effects of acoustic feedback – the very loud, uncontrolled hum, rumble or scream, which sometimes occurs when the equipment is being used at high volume levels, due to sound from the loudspeakers vibrating the turntable and being amplified by the system again and again, until everything else is obliterated. With infra-bass speakers wired in circuit, this form of feedback may well occur at infra-bass frequencies, and will therefore be inaudible (if the speakers are worth their salt, i.e. if they are free from distortion!). The presence of infra bass frequencies can often be detected by ones sense of feeling, however, and also by the fact that loose objects in the listening room are liable to shake about! ***Excessively*** high-powered, ***uncontrolled*** and ***continuous*** sound energy at frequencies around 7Hz have been proved to be dangerous to both property and health, so if and when such and effect occurs, ***don't*** ignore it because it isn't very loud in the conventional sense – turn the volume right down to remove the immediate danger, and then investigate the cause, and ***remedy it***.

Because of the inaudibility of these very low frequencies, and LED indicator is being developed, which will illuminate whenever the infra bass is being radiated by the loudspeakers in significant quantities. Under normal operating conditions this light should remain off for most of the time, occasionally flashing 'on' when and infra bass signal is present. If the light remains on continuously, one should immediately take steps to remedy the situation.

Of course there will be times when the light will remain on for longer periods then usual, due to information actually recorded on the record, and one will need to get used to these and to ignore them, as they will not produce any ill effects. Such pieces as the organ introduction in 'Also spracht Zarathustra' (also known as the theme music from the film 2001) and similar, are likely to produce extended periods when the indicator LED will remain 'on', but provided that there are significant 'off' periods in the music, there is not cause for alarm.

As I have stated elsewhere, these speakers succeeded, where other more conventional 'Bass Bins' fail, because they are able to produce large amounts of energy within the nominal range of 5Hz to 25Hz, at high relative efficiency and with ***very low*** audible distortion, and furthermore, they will do this with ease in the small rooms commonly encountered in the domestic environment. Conventional speakers not only begin to cut off steeply below about 30-35Hz, even in the best available systems, but also, in general, their efficiency is orders lower than the 'infra-bass' design in the range below 50Hz, and furthermore their coloration and harmonic distortion are audibly much higher when used in the normal sized domestic lounge.

There are three more points to be considered before deciding to build a pair of these infra-bass cabinets is finally taken.

1. If the amplifier used cannot produce infra-bass frequencies (down to about 10Hz or below) then there is little point in adding infra-bass speakers to the system, as there will not be any infra-bass present to be reproduced!

2. If the turntable to be used produces excessive rumble, it must be borne in mind that this will be reproduced at full volume along with the required signal, and that, in bad cases, this by itself may well be enough to keep the infra-bass indicator light 'on' permanently!
3. It may be necessary to add extra weight to the pickup head and counter balance assembly in order to increase the arm inertia and thus allow more infra-bass to be extracted from the record. If required, this is best performed in the following way. First, balance the arm and cartridge to zero playing weight. Then add weight to the head shell, equal to about the weight of a 10p piece, and a suitable weight to the counter balance assembly to make the arm balance again, taking care at all times to protect the stylus from any damage it might otherwise sustain in the process. Suitable weights are often available from arm manufacturers, to enable cartridges of greater than normal mass to be used in an arm which otherwise could not accommodate them. When this has been achieved, add the required tracking force as before (or very slightly more, say 1.25gms for the high inertia arm if 1gm was used previously).

This arm inertia conversion is a tricky operation to carry out in some cases, because to much weight can cause arm sticking and record warp problems, whereas too little has to noticeable effect. Also to further complicate matters, some amplifiers object to a lot of deep bass applied to their pickup inputs. Trial and error is the best method to use.

Cabinet Construction

Unless you are a very good carpenter, it is advisable to have the various panels etc. cut for you by an expert. In this way you can be sure that they are all cut accurately to size, and that all sides are straight and square, or cut accurately to the specified angles. This is very important, as any slight leak will completely spoil the sound, which this type of cabinet can give. All joints made must be completely, 100 per cent airtight, and by this I mean pressure tight. Imagine that the joints are in a completely enclosed cabinet. Such a cabinet would be so airtight that it could be pumped up to quite a high pressure without leakage. The reason for this is fairly obvious- at high frequencies, only a little air has to be moved about, but at very low frequencies a vase amount ahs to be shifted. This is even more so at frequencies below the listening room cut off. Here the whole room has to be raised and lowered in overall pressure, as no actual sound wave can be produced (due to the fact that its wavelength would be too long to fit into the room). A considerable column of air is therefore required to be pumped into and out of the room on order to raise and lower its overall pressure, and the only place from which this air can be removed, and to which it can be returned, is the inside of the infra-bass cabinet. Hence it follows that, unless this is built with the characteristics of a pressure chamber, the design will obviously not work! Because of this requirement, it is essential to accurately chamfer those pieces, which require it, to the correct angle as shown in the diagrams. This can either be performed using a power tool with and angle plate attachment, such as a circular saw, or manually using a small saw and finishing off with a plane and surform file. Again,

it is advisable to obtain professional help unless you are supremely competent, as the 'pressure tight joints rule' must not be broken anywhere, come what may.

The holes in panels A, B and C must be cut to size using a keyhole saw. This first requires a pilot hole to be drilled to insert the saw blade. Make sure to drill this pilot hole well inside the perimeter of the final hole required and use the saw to approach the latter slowly. In this way one can ensure that the final hole is truly circular. A more accurately circular hole can be cut with a fly-cutter, and again a pilot hole must be drilled, this time accurately in the center of the piece to be removed, using the drill size specified on the cutter. Slow drilling speeds are necessary when using a fly-cutter on plywood in order not to damage the surface, and it is often advantageous to only cut through the sheet half way initially, finishing off the cut from the opposite side, for similar reasons. Fly-cutting is however only really suitable for use in a carpenters shop where special tools, such as bench mounted pillar drilling machines are available.

The chamfering of hole C poses particularly difficult problems, which are most easily overcome using a quarter round wood rasp, and finishing off with course and fine sandpaper, after firstly cutting the inner circumference with the keyhole saw. Follow the diagrams precisely when rounding off corners and edges, and making pieces smooth, are concerned. When all the pieces have been accurately made and finished, glue panels A and B together, using an overall thick covering of a rubbery type of glue, such as Bostik Black or Bostik Clear, etc, ***keeping the smooth side of panel B outwards, away from panel A***. Panels A and B when stuck together should not rattle, hence the glue contact must make contact ***all*** over. If any rattles do materialize, they cannot be remedied later, so make sure this part is done properly!
Panels A and B together should be as thick as panels C,D,E,F,G etc. and panel B should be as thin as possible consistent with its having a high degree of rigidity. One-eighth inch Formica, or dural sheet would be ideal. Hardboard sheeting should only be used at a pinch, if the other alternatives are not available, (unless it is of a ***specially*** rigid grade).

It is very important to make the inside surfaces of each tapered port smooth along the whole of its length, with no sharp edges or rapid changes in cross-sectional area anywhere. The holes should also be finished smoothly, and in particular the hole in B should be given rounded edges and the hole in C should be smoothly chamfered as shown.

The inserts L may possibly be obtainable as standard stock sections, from wood supply yards, but otherwise this section must be accurately made, and fitted to keep the port cross-section area smoothly increasing round the bend. These might be the most difficult parts to make satisfactorily, if they are not available 'off the shelf'.

Panels A/B, C, D, E's, F's and K's should now be placed in position on one of the panels G and their edge outlines marked on this panel using a soft pencil, or other

marking device which can be removed later, of necessary (for reasons of cabinet finishing). Use the interior cross sectional diagram as a guide.

All these panels can now be removed again, and screw holes marked out and drilled in the penal G at intervals of about 6" along the centerlines of the marked panel positions. If the screws are to be visible in the finished product, care can be taken as this stage to position the holes where they give an aesthetically pleasing result in the final cabinet, i.e. don't for example, put 3 screws on one side and only 2 on the other side, for matching panel positions! One tip when drilling panel holes to avoid splintering the surface, is to drill straight through into another piece of wood, kept especially for the purpose, a fresh part of the surface being used for each hole drilled. If this is kept in close contact, surface to surface, the normal splintering cannot occur.

Assuming that all the holes have been correctly drilled in the first panel G, of a suitable size for the screws to be used (say 2¼" no. 8's) this panel can then be used as a template to drill out the holes in the second panel G, after which both sets of holes can be countersunk as required.

Similar holes have now to be marked out and drilled, at suitable intervals, in panels A/B, C, and D, to allow them to be screwed to each pair of panels E, F, and K. These holes also have to be countersunk. It is advisable to drill the holes in panels C and D at an angle corresponding to that of the panels into which the screws will be anchored, for reasons, which will become clearer later.

The battens to be used between panels A/B and C must now be cut and finished to shape (see detail diagram), and drilled as shown in the diagram, ready to screw them to panel C, at about 6" intervals as before. Pieces H can be similarly drilled and countersunk, and then temporarily screwed to the pieces J to form the feet of the unit.

Temporary Assembly

Panels A/B, C, D, E's, F's, K's can now be temporarily screwed into position on one of the panels G, using, say, 2 screws per panel and NO glue at this stage. When all are together, with C and D also screwed to E's, F's and K's where appropriate, for rigidity, the second panel G can be screwed to the assembly, the alignment being frequently checked as the assembly proceeds. Panel A/B can now be unscrewed again, and the battens can be temporarily screwed, in similar fashion, to panel C.

The actual positions of the battens can now be measured, and their corresponding positions marked on panel A/B, ready for drilling, again every 6" or so, taking care not to drill panel A/B screw-holes in line with the screws already to be used for fitting the battens to panel C!

The box should now be turned upside down, and the feet assembly placed in position, symmetrically, on the bottom panel. Again the pencil should be used to mark out the positions of the pieces, forming the feet, on the bottom panel of the box, and further

screw positions should then be marked out for drilling on their center lines. The box can now be disassembled, and panels A/B and D drilled where marked. All the holes in panel A/B should now be countersunk (on the A side!), and also those which require it in panel D – but remember that these latter holes should be countersunk on the ***inside*** of the box, as the feet screw onto the outside!
Note that it might prove difficult to screw both the feet panels J and the box panels F to panel D – the trick is to angle the screw holes inwards at about the same angles as the panels themselves, so that each screw head comes clear of the opposing panel. Note too that screws of 2¼" length cannot be used in all positions along pieces H, as the center section is too narrow. It is not essential to screw the thin part at all, however provided that it is glued to prevent rattles. If these screws ***are*** to be omitted, be sure not to drill holes for them, as any unused holes might prevent the cabinet from being made pressure tight!

With all the cabinet in pieces, it is a good idea to mark with the pencil each piece, making it clear which piece fits where, and which way round. This is particularly important with pieces E,F and K, as although nominally identical pairs have been made, in actual fact where are almost certain to be small differences which might affect the 'fit'.

Now that all the component parts have been finished, one can, if desired, assemble the whole cabinet without glue for preliminary testing, but of course the bass will not be as pronounced at this stage due to the fact that the cabinet is not pressure tight. It would however allow the 'ultra-keen' enthusiast to experiment with damping materials etc. in order to attempt an even closer compensation for the particular room in which the cabinets are to be used. However, those with less technical prowess will no doubt be quite content at this stage to press forward with the final assembly, using both screws and glue.

Final Assembly

Use rubbery, thick glue, such as Bostik Clear, or Bostik Black. Wipe off excess inside the ports, to leave a smooth surface. Any excess inside the main box will act as added sealant, and need not be removed. Leave any excess glue on the outside of the cabinet until thoroughly dry, then, remove it with a razor blade or very sharp knife.

1. Glue and screw panels F to panel D – leave the screws about 1/8 turn loose.
2. Glue and screw panels F, D to one of the panels G.
   Tighten panel D/G screws first, then panels F/D screws, leaving panels F/G screws 1/8 turn loose.
   Make sure that these joints and all subsequent ones employ enough adhesive to make them pressure tight!
3. Fit panel C with glue and screws to panels G and F. Checking that the top of panel C is at the correct spacing to allow the later fitting of the battens and panel A/B, and that its ends lie equi-distant from the ends of panel G, firmly tighten screws C/G. If the positioning of the other panels is satisfactory, tighten screws C/F. Otherwise very slightly slacken screws D/G before tightening screws C/F, and re-

tighten them afterwards. (It is assumed that the glue will still be slightly malleable at this stage.) Finally fully tighten screws F/G. Take particular care to ensure that there are no sharp edges or corners protruding at the joins C/F.

4. Assemble pieces H and pieces J with screws and glue, making sure that the top edges are all at the same level, and then glue and screw the assembly to panel D. (Remember the warnings already given concerning screw lengths and possible air leakage)
5. Glue and screw panel K to C and G.
6. Glue and screw panels E to G.
7. Fit the concave fillets L with glue and panel pins to G and panels E, making sure that their alignment will match that of the top of the battens, when fitted, and that no rough or uneven/discontinuous surfaces remain to impede airflow.
8. Glue and screw the second panel G to the rest of the assembly, making sure that enough glue is used to form a good seal ***everywhere***. Fully tighten all of these screws.
9. Fit the battens with much glue and screws, to panel C and both panels G, taking care to get the alignment just right.
10. Temporarily fit panel A/B, with screws only, and ***briefly*** test with the drive unit temporarily installed in place.
11. If satisfactory, remove panel A/B, and refit with much glue and screws to make the final airtight joints. The working part of the cabinet is now completed.

ALLOW PLENTY OF TIME FOR THE GLUE TO FULLY SET BEFORE FITTING THE DRIVE UNIT IN PLACE FOR LONGER THAN A FEW MINUTES, AS GLUE VAPOURS, IF PRESENT FOR LONG PERIODS, CAN SERIOUSLY DAMAGE THE MATERIALS USED IN DRIVE UNIT CONSTRUCTION!

Making a suitable cover, Cosmetic finishing's, etc

If there is no objection, the screws can be left visible and the cabinet stained, and polished with button polish, trench (or French – vague on hardcopy) polish, or even polyurethane varnish. This is in fact quite attractive if the screws are of polished brass. Otherwise the box can be covered in veneer or other decorative laminate, or even wallpaper etc. to taste. The feet will look attractive in either matching stained wood, or matt black paint.

A suitable cover can be made in a number of different ways, but in all these the outline shown in the diagram should be maintained, in order to give an attractive proportion to the finished cabinet. The front of the cover may be curved or bent, as shown in the sketches, if so desired.

Materials used for the cover must be transparent to sound, and must be able to be secured in order that rattles do not materialize. Decorative laminates of the Hardboard variety are possible contenders, as also would be expanded aluminum sheet, covered grille cloth, on a wooden framework. If it is intended to fit middle and treble units beside the bass unit, under the grille, it must be designed to be particularly transparent to these higher frequencies in order to avoid both H.F cut-off and standing waves inside the cover itself.

The use of damping materials might help in the latter case, but further discussion on these lines is beyond the scope of this particular publication.

It will be found especially useful to paint everything inside the cover matt black, as this will prevent the interior being seen in strong light.

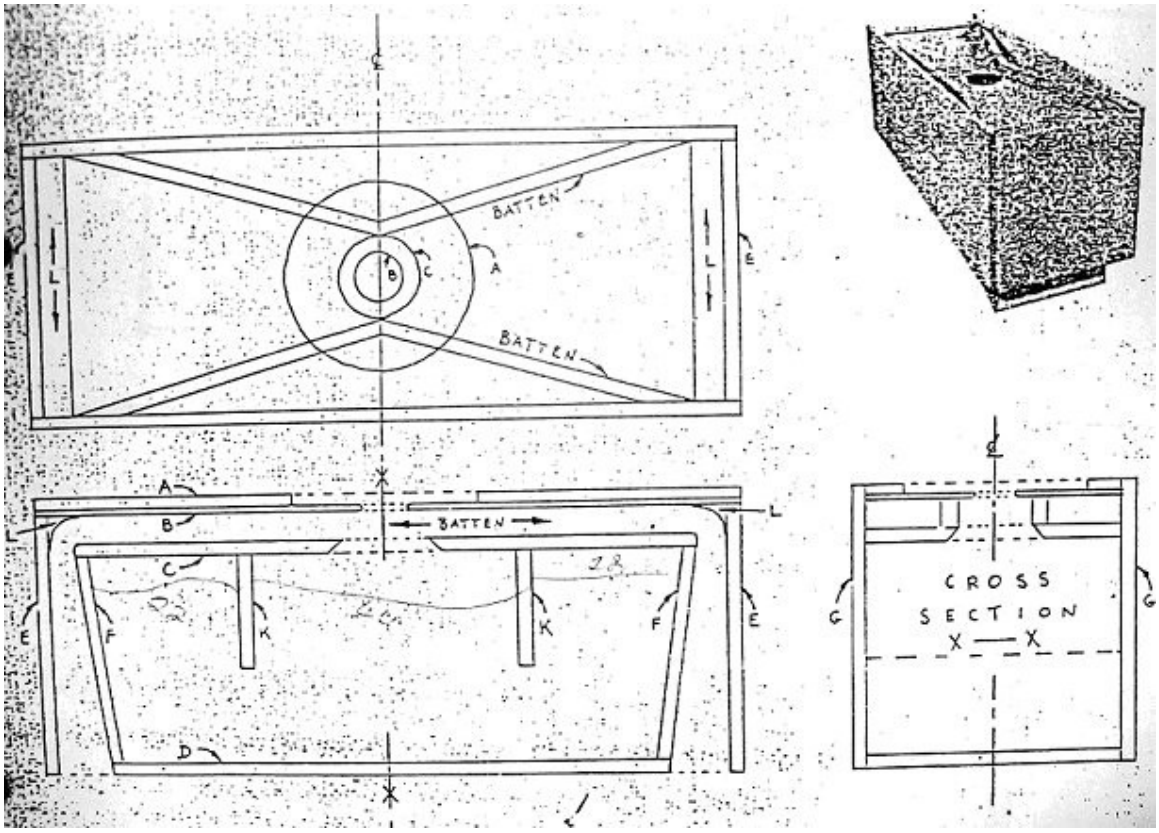
The indicator LED, which lights up when significant levels of infra-bass are being radiated, can conveniently be placed on the front of the cover where it will be easily visible.

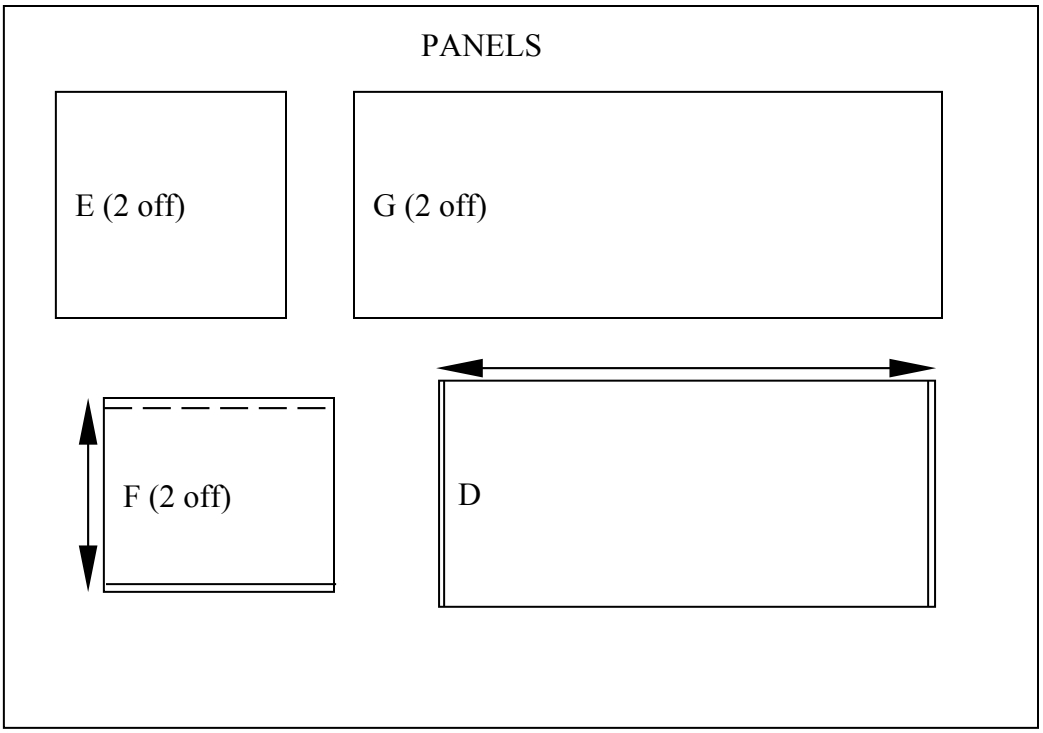
The drive units, crossover networks etc. for the Holliman Infra-Bass design are obtainable exclusively from:

WILMSLOW AUDIO LTD
SWAN WORKS
BANK SQUARE
WILMSLOW CHESHIRE

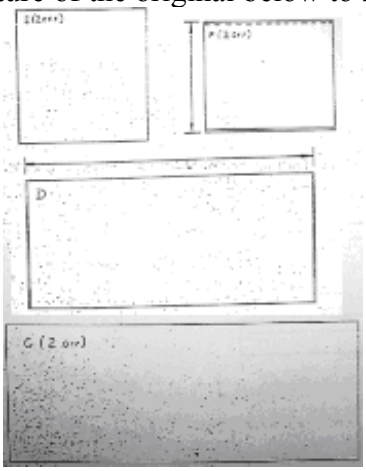
Cabinet Sizes and Dimensions

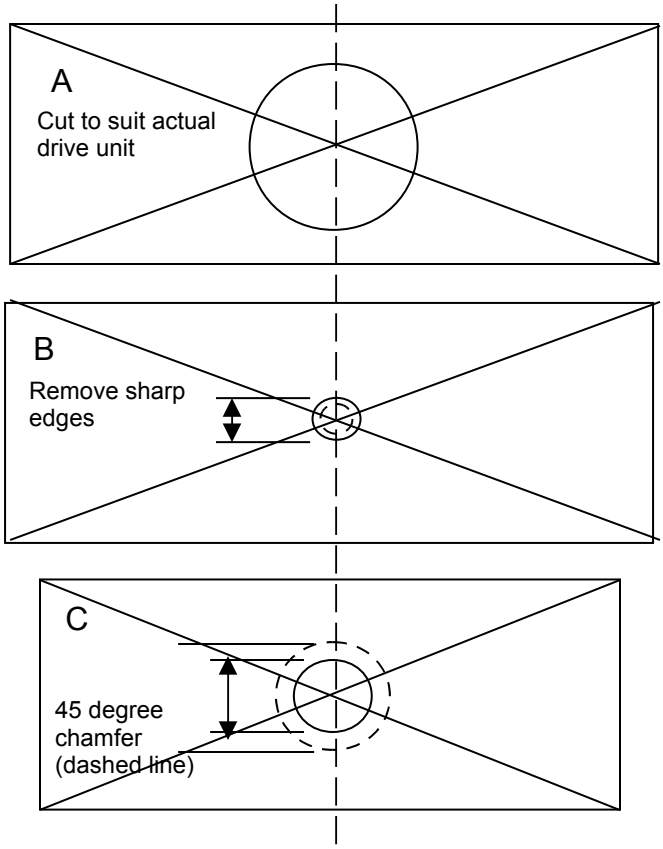
Item	15" DRIVER SYSTEM (1" Marine Plywood)	12" DRIVER SYSTEM (4/5" Marine Plywood)	10" DRIVER SYSTEM (2/3" Marine Plywood)
Panel - A	52" X 18.8"	41" X 15"	34.7" X 12.6"
Panel - B	52" X 18.8"	41" X 15"	34.7" X 12.6"
Panel - C	46" X 18.8"	36.8" X 15"	30.7" X 12.6"
Panel - D	41.8" X 18.8"	33.5" X 15"	27.9" X 12.6"
Panel - E	19.8" X 18.8"	15.8" X 15"	13.2" X 12.6"
Panel - F	16.3" X 18.8"	13" X 15"	16.2" X 12.6"
Panel - G	52" X 20.8"	41.6" X 16.7"	34.7" X 13.9"
Feet - H	45.4"(V) 5.3"(W) 1.9"(X) 1"(Y)	36.3"(V) 4.25"(W) 1.52"(X) 0.8"(Y)	30.3"(V) 3.53"(W) 1.27"(X) 0.7"(Y)
Feet - J	5.9" X 15"	4.72" X 12"	3.93" X 10"
Standing Wave Control Insert - K	8.4" X 18.8"	6.7" X 15"	5.6" X 12.6"
Batten Material Cross-Section	1.75" X 1.25"	1.4" X 1"	1.17" X 0.83"
Curved Fillet - L	2" X 2" X 18.8"	1.6" X 1.6" X 15"	1.3" X 1.3" X 12.6"
Cover Grille Height - M	6.5"	5.2"	4.34"
Hole Sizes - A	To suite unit	To suite unit	To suite unit
Hole Sizes - B	3"	2.4"	2"
Hole Sizes - C	6" (45 degree angle)	4.8" (45 degree angle)	4" (45 degree angle)

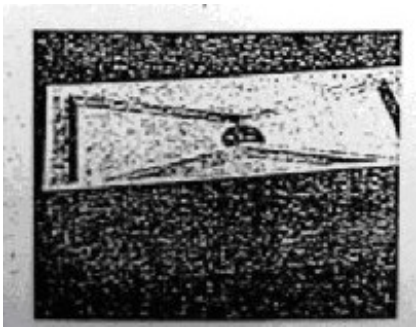

BATTEN
BATTEN
A
B
C
L
E
BATTEN
F
K
K
F
D
CROSS
SECTION
X — X
G



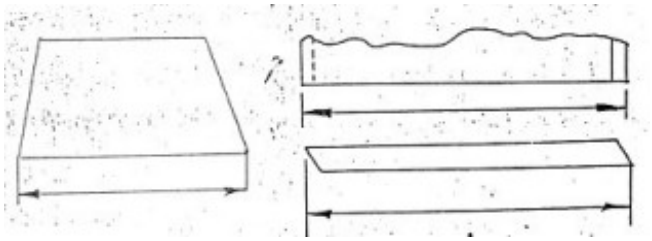
Small capture of the original below to save space



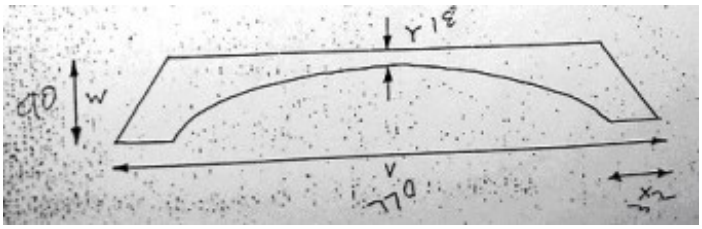

A
Cut to suit actual drive unit
B
Remove sharp edges
C
45 degree chamfer (dashed line)



The measurements given in the table are for overall dimensions of component parts. In the case of tapered or chamfered pieces, the distances are to be measured thus:-

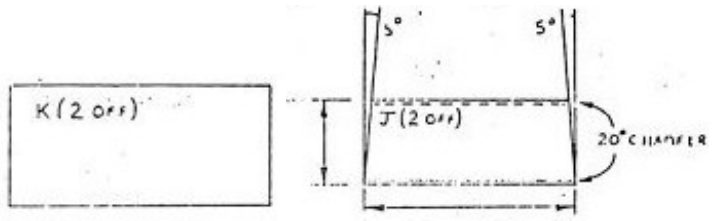


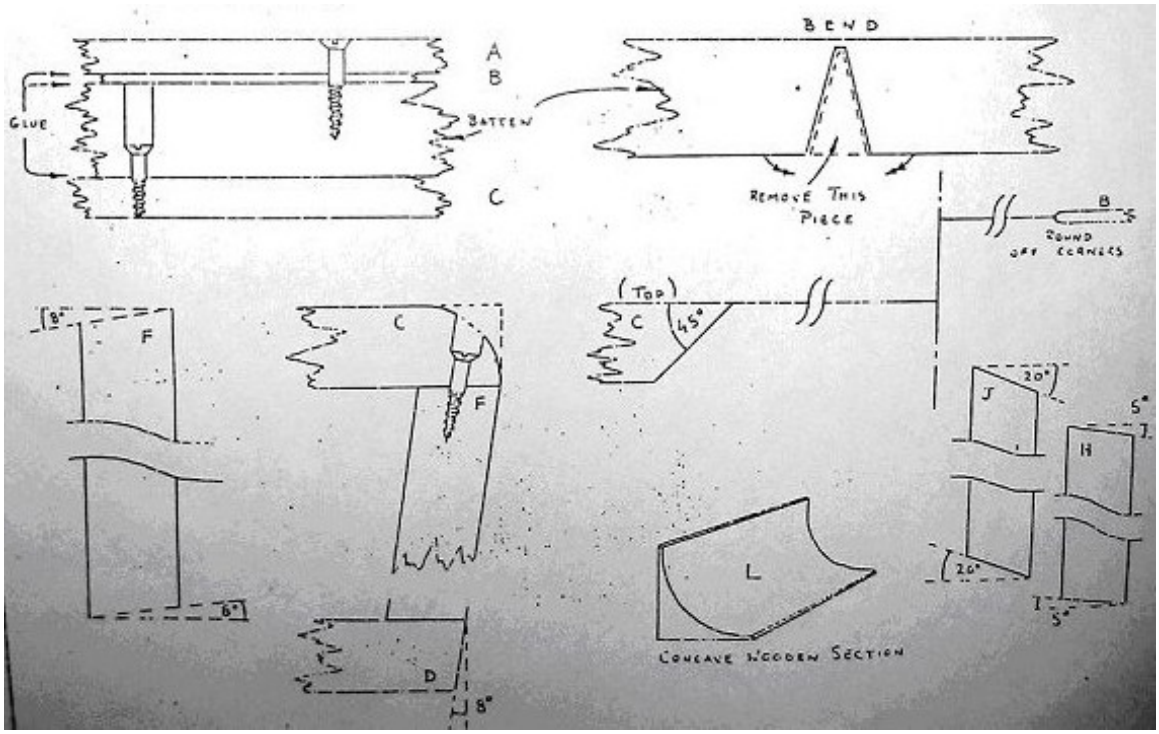
The letters given with the measurements with pieces H refer to the following;



(Also marked as such on the plan sheet)


70°
70°
Y
W
11(2 off)
5° CHAMFER
V
X


K (2 off)
5°
5°
J (2 off)
20° CHAMFER


A
B
C
GLUE
BATTEN
BEND
REMOVE THIS PIECE
B
ROUND OFF CORNERS
(TOP)
C
45°
8°
F
6°
C
F
D
8°
20°
J
5°
H
20°
5°
L
CONCAVE WOODEN SECTION

APPENDIX A - Builders experience

by Ryan Reynolds (oiltanker@webmail.co.za)
South Africa

Size: The 10" Design
Built : June 1994

Why and how: As an engineering student in South Africa, in 3rd year, a few of my classmates and I thought of ourselves as Hi-Fi fanatics. We collectively owned NAD, Acoustic Research, Music Fidelity, B&W components, and were constantly on the prowl for knowledge and the holy grail of great sound on a student's budget.
One of my classmates gave me the Graham Holliman plans, and some months later decided to build one. I had no one else's experience to go on, and so continued to see if this monster worked.
It took me three months, 98 screws, lots of glue, a failed subject (due to my not studying) and lots of scrambled brains as to why it initially wouldn't work.

Assembly Advice

1. I'm an engineer, and it took a lot of head scratching to understand fully how all the parts fitted together. So I strongly recommend you build a scaled down model of it out of cardboard so you have a perfect idea of what you need to do, and how the thing pieces together. If you glue the wrong piece in the wrong order…there's no going back. Its permanent!
2. I'm pretty handy with my hands, so I was ok, but I strongly recommend getting the edges cut nicely from someone with the skills….its not that simple.
3. I know you are going to ask about where the 'Standing Wave Control Inserts' are supposed to go. This was a guess for me too, as it is not stated in the plans. However measuring from the diagram on the paper, I figured it was divided up

into quarters. So the control inserts were placed ¼ from each end. I wasn't totally convinced that the diagram was to scale, so I reasoned from my engineering that holes on a microwave grill on the door, stop those harmful waves getting out even though you can see inside. Those microwave holes are ¼ of the wavelength of the waves inside, and thus attenuates those waves, protecting you from being fried. Since sound is just another wave, and to stop it you would have to have a mechanism for blocking ¼ of the wavelength to block the entire wave (1/4 wavelength is at 90 degrees or the peak of a sine wave), it stands to reason that the inserts are placed ¼ from each end. I was happy with my assumption, and it works fine.

4. Assemble the box with only the screws (no glue) the first time. This aids in knowing what to glue first, and what to glue last. I also tested it at low settings at this stage. Sounded promising so far, but nowhere near what it sounds like with glue as well.

Materials Used

I used ordinary 16mm chipboard (making 1mm adjustments in dimensions where necessary). In hindsight I feel this type of wood isn't dense enough, and marine plywood isn't easy to come by around here, and would have been expensive if I had found some anyway. If I had to rebuild a cabinet, I would definitely use supa-wood. Its very dense compacted chipboard essentially. So fine are the chips, they are hardly discernable. It's a lot heavier than chipboard, and is the better choice.

Initial trials

In my tiny listening space…3,5mX2.5m it wasn't that great…but I still had lots to learn. I was mortified the first month I had it, that I had wasted my time, effort, and money on something that actually gave me less bass when connected with my current system, than without the blasted box. I was so disappointed I gave up for 2 weeks till I went home to my parent's house.

Alive

At my parent's house, my brother assisted listening to the box while I switched it on and off. He confirmed my disbelief that WITH the box, the overall bass was LESS!!!! Eventually, after much frustration I mindlessly (more out of despair) connected the terminals ass about face (That's wrong way around)…while the music was softly playing. What instantly seemed like thunder…the whole room suddenly shook ever so deeply and gently, as if there had been a nuclear explosion some 200km away. The room came alive. In the first 5 seconds, I raced out the room to fetch my brother (who had given up out of boredom). He had a far away look in his eyes when he heard and felt the deep low foundations rumbling away. By this I don't mean everything was shaking about, it's hard to explain, it's not loud at all, simply bloody powerful!!!

What happened?

So I figured out, that the reason for less bass with my current system was that the infra bass enclosure emitted the bass 180 degrees out of phase with my normal floor standing speakers….cancellation occurs, and wham….no bass at all! Upon swapping

the terminals…constructive interference, and there you have it…all of it in all its glory.

Amazingly efficient

Consider this! It's generally accepted that the lower the fr's you try to produce, the more power you need. Bass, and even lower bass normally require masses of power. I was running this bass bin directly plugged into one of my amp outputs, in parallel with one of my floor standing speakers believe it or not. Ok, ok, impedance matching all messed up and all but so what. My amp…if not modest…a NAD 3020PE, with only 30W odd of RMS power. What I still have to tell you is that I was also using a 10" driver unit (Vifa to be exact) and it was a tiny 80W rms driver unit, the magnet not much bigger than about 8cm's. (I should be on Ripley's-as I write this it sounds ridiculous).

I was playing a pipe organ piece at about a quarter volume, and the roof of the house felt like it was going to cave in. The wave is just that powerful, even at low volumes. But there is a secret to this that I later discovered.

The ROOM, THE ROOM, THE ROOM

So my parents spare lounge where I listened to my hi-fi was about 5mX4.5m and had a high roof (about 4m at the apex slanting down to the sides. It had 2 French bay windows, and French sliding doors into another lounge. What I think made the speaker work so well……the fact that I could close all the windows, and the doors, so that the speaker cabinet can pressurize and depressurize the room sufficiently to create the low bass I was after. Remember the lowest bass fr a room can deliver or sustain is fr = 560/L where L is the longest length of the room in feet. Which means you need a room 28 feet long to fit a wave producing a fr of 20Hz. That's a big room. Any lower, you need some special stuff…like this box.

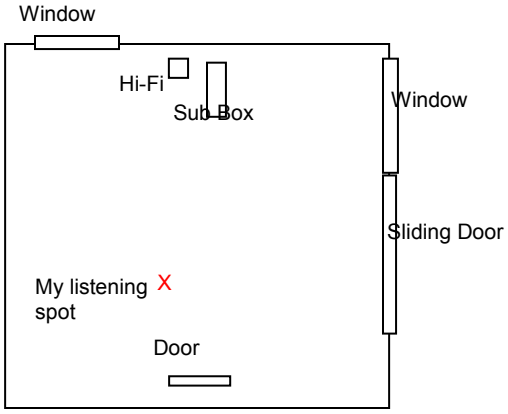
Ill re-iterate this point that you need a closed room for this box to work properly. Compare it to a car tire. If it has a gaping hole in it, you wont be able to pump it up at all. Same here. For some reason, you need to close the windows, and especially the door to get the desired effect.

It might be my lack of amplification, or the wimpy speaker I was using, but the base I got out of it was fantastic. Any open plan room I've tried it in was just a total flop.

Further trials

In a friend's student flat, which was about 7mx7m, cement roof, and usual cement floor, sliding door, and 3 windows, door closed of course. Attached in the same cheap student fashion as described above, but to a mini all in one Hi-Fi…Kenwood no less. It must have cost the owner about $100 for the entire system. However, listening to my usual recording, I heard bass fr's I have never heard ever again since that day. Not by any equipment, in any hi-fi show, nor in any hi-fi shop. Many have demonstrated their best subs, and yes, they are tight, tight, tight, and stunning to say the least, but I have yet to hear one that goes as low as my budget home made box. The air around me felt like liquid it was so thick with bass (I stress again, its not loud at all, and the volume again on this system was about 40% of max. Even at 20% it was still powerful. That's how efficient this box is. I yean to hear my box do that again!

See below for how it was arranged for best listening according to me. (Just my personal opinion.)



Where is my box now: In the garage, under a plastic sheet. I have an open plan house, and use a conventional home made sub woofer, that seems to be happy where it is. The only sealed rooms I have are my bedroom, and the babies room, and my wife won't allow the box in either. I tried in vain to get the box to work in every corner nook and cranny of the house to no avail. You really need to have a nice closed off space, else it just booms a little and sounds like a dying goat farting its way into the grave.

A question you WILL ask!!!
HOW DID YOU MOUNT THE SPEAKER ON THE BOX?
The mutha of all questions I think! Actually, I don't know at all. The above configurations I actually mounted the unit directly on the box, with a little press-stick to seal any air leaks. That worked very well, however, we always try get more out of something don't we, so I tried some spacers using thick cardboard to mount the driver about 2cm higher, however, I'm not really sure here. I don't have fancy equipment to test results. So that's your job out there to try this, and perhaps provide the rest of us some feedback as to what the best way is to mount the driver on to the box besides a little silicon and 4 screws.

My attempt at a scientific reason
The problem I see is the following: There is such a small air space between the cone of the speaker and the flat board surrounding the tiny hole where all the air has to escape through. So, if you really apply too much power to the driver unit, there are massive forces of vacuums and pressures working on the cone. When the speaker pushes down, almost instant pressure buildup pushes it back up, and HAS to distort the cone to unspeakable units of measurement. Likewise for when the speaker goes up. A huge vacuum will pull it down. And when played like this (considering my non existent budget on anything of quality) the speaker just flutters and makes no other sound. It's when you play it softly that it really comes alive. With as little cone excursion as possible. (***This is an important point to take note of***) (Consider how loud and low a drum sounds when you press the pedal with your foot. The large drums diaphragm moves minimally, but is low and loud. Thus you have much less distortion.)

I therefore believe that a stiff cone (as bass speakers were designed way back in the old days) , low excursion type driver would best suite this box, as well as a powerful amp for less distortion. I do believe my amp is under powered, and perhaps why it wont work at louder volume levels, however, to whoever out there tries this, I would love to hear some report back on what you used, how you did it, and of course, how it sounded. I really look forward to hearing from anyone out there with any revelations that could improve what this box already does.

A Note on Safety
I have seen many people pointing out how dangerous infra-bass can be. In fact, it can cause nausea, dizziness, and listener fatigue all at the same time. I have experienced this first hand, and had to give up my listening tests for 2 days to recover.
Considering I was running it on such an underpowered system, I would imagine it could get far worse if on a higher, powered system.
BUT I was doing tests and running the same section of a song over and over, so it was no wonder that I was feeling queezy. If you run it as you should with infra-bass every now and then, one word comes to mind – stunning!

No-one can preach about how no-one can withstand 10Hz at 120db sound pressure level, using a signal from a sinewave generator. Firstly there are no harmonics and no richness in the sound….no musicality. A pipe organ can sound much more pleasing to the ear, and you wouldn't have to "endure" it so to speak.
By the same token, try see how long anyone could withstand, lets say for arguments sake…3kHz at 120db spl. I'm willing to bet that you'll suffer permanent hearing loss and extreme pain if you hold out for 5 minutes. Besides that's a torture endurance test. Everything in moderation – including infra-bass.
Too much of anything is bad, so go easy until you have understood what its all about, and what level adds to your listening experience, and what levels of infra-bass is too much.

A final note: Good luck!

APPENDIX B - FAQ

Q. Why is it so room fussy though? Is it simply because of having to pressurize the space enough to produce these frequencies?

A: You will see in the plans why you need a SUITABLE listening environment. He explains, but not explicitly says that the box raises and lowers the overall pressure of the listening environment. It stands to reason then that if you leave the door open,

how do you pressurize the room. Eg. If you have a hole in your car tire, how will you pump the wheel up to its correct pressure?

Q: Why do you say that if you turn it up the worse it sounds?

A: Good question. Remember I was on a tight students budget. I only had an 80W rms 10" speaker, and a 30Watt rms NAD amp.
Of course if you turn it up too much, massive distortion is going to take place. I don't have a huge amp, and powerful speaker to test it to the limit. Besides, I didn't want to kill thy neighbor. I would love someone to try this box with the more powerful equipment. Remember the distortion is also less the softer you play the speaker (within reason) and I found that the less the cone moved, the deeper, and purer the sound was. I don't believe my amp could drive it.

Q: any ideas on how to work out the required chamber volume and port sizes for any given driver?

A: This design doesn't have round ports as in some designs, however, don't worry about that. The plans include 3 designs. All dimensions are included to build a 10", 12", and 15" design. My 10" blew me away. 15" I think would stop your heart.