

Index

The Tractrix Horn Project by Alf Lepp

I have always been interested in horn loudspeaker designs, indeed one of my earliest constructional projects was a Gately superhorn powered by an 8 Watt valve amplifier (Push Pull 6BM8's) circa 1956.

At that time however there was very little information on the matching of drive units to horns with the result that the sonic result was less than optimum.

Recently my interest in horns was rekindled by articles on mid-range bass horns in Speaker Builder by Dr Bruce Edgar [\[1\]](#), so I decided to "Have a Go".

Most of the bass horn designs available were too large to be domestically acceptable. However I remembered a mini horn design by J. Dinsdale, in a series of articles on horn design in Wireless World during 1974 [\[2\]](#). It had a cut off frequency of 70Hz, had a Tractrix contour and used a 6 Inch (15 cm) drive unit. The rear of the cone driving the bass horn, and the front loaded with a mid-range horn.



Latest version with treble cone and large phase plug.

It should be noted that this is a 1/8 scale horn designed to be placed in the corners of a room however as my realisation of this design fires downward and exhausts at the front and both sides at floor level, I reasoned it would also give a satisfactory bass performance when placed along a rear wall away from the corners. This later proved to be correct.

The next problem was to find a suitable drive unit for the two way loaded horn. The requirement was for a 6 to 7 Inch unit with f_s approximately 50Hz, QES preferably less than 0.2 and high efficiency. Zalytron were advertising a Focal 7V513 unit which seemed to have possibilities - f_s 46 Hz, QES 0.25, SPL 93 dB. I therefore obtained a pair of these units, however as these are not full range units a separate tweeter was required.

I chose a Focal T120 Ti02 foam surround unit. This unit has a SPL of 94 dB so I decided to also load this unit with a Tractrix horn to better match the efficiency of the bass/mid range. Additional magnets were also added this did not increase efficiency as expected, but improved the decay characteristics as demonstrated by waterfall plots taken with an IMP measuring system.

The mid-range horn has a Tractrix contour with a 300 Hz cut off frequency as used in the Edgar mid range horn, it has a square mouth and a circular throat the square mouth was used in preference to Dr Edgar's 2/1 ratio to minimise cabinet width. The horn is solid chipboard, laminated from 11 pieces, 12 mm thick.

Testing of the mid-range horn with the Focal 7V513 indicated that efficiency fell off above 2 kHz. A rather low 2kHz crossover was therefore required for the tweeter (12 dB/Octave Linkwitz Reilly).

The efficiency of the complete system has not been measured but I estimate it to be between 95dB and 97dB/W/Meter.

It is a fact of life that nothing stays the same very long with a DIY project, there is always another tweak to be tried - So read on

Just when I was getting used to the wonderful, natural sound of these horn speakers, along with came an article from Sound Practices [\[3\]](#) giving a history of Lowther loudspeakers - Those world renowned UK manufactured full range units, much sought after for horn loudspeakers. I was intrigued by the simple treble (whizzer) cone and pear shaped phase plug used to horn load the treble cone and I wondered how my 7 Inch Focal units would sound with the treble cone setup.

I used a thin cartridge paper to make a 73 mm diameter cone with a 73 degree included angle. This was attached to the main cone with a multi bond adhesive taking great care not to run adhesive into the voice coil gap.

As the Focal unit already uses a phase plug I fitted a larger pear shaped phase plug (turned from pine timber) over the existing one.

This modification worked very well. The frequency response now extended out to 14/15 kHz but the upper mid-range / treble level was somewhat low.

A notch filter was then introduced centred on 1 kHz to reduce the peak between 500 Hz and 1500 Hz. The formula for the filter were obtained from Vance Dickersons Loudspeaker cookbook.

The system now sounded much better balanced although a few dB's of efficiency were lost in the process. The tweeter is now only required above 15 kHz and is rolled off using a 6dB / Octave filter.

The system now sounds great, it has all those wonderful attributes you expect from horn loudspeakers.

I may later try different drive units - perhaps Fostex FE168E but for the moment I am content. I have included drawings and sketches to show the construction of the horns. Although I built them in two sections to make them easier to transport, they could be built as single units.

The horns were finished with an iron on, real wood veneer (Queensland Walnut) sealed with a flat urethane and finished with Danish oil.

The amplification used is home built - a Nelson Pass 20 Watt single ended class A solid state power amplifier and a Mu follower valve line level pre-amplifier built from a local kit (Contan Audio). I used a high quality components Holco resistors, Solen and MIT caps and solid silver wiring - They sound great.

At the moment the system only has a CD front end, using a Rotel RCD965BX player, but I am building a valve phono pre-amplifier - the first stage of the four valve pre-amplifier from Alan Wright's pre-amplifier cookbook built on copper ground planes plated gold over silver.

I hope the above will inspire some of you DIYers out there to "Have a Go", the rewards are well worth the effort.

DIY forever

Alf Lepp

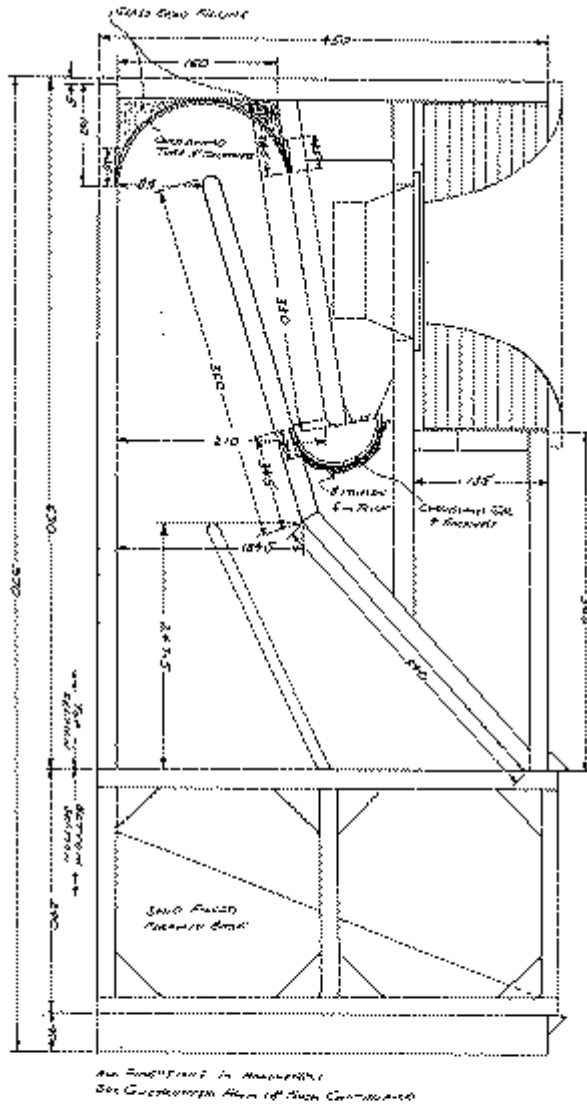
References

- [1] Speaker Builder 2/83 - A 70 Hz mini horn by Bruce Edgar.
Speaker Builder 1/86 - Edgar's mid range horn
Speaker Builder 2/90 - The show horn by Bruce Edgar
Speaker Builder 1/86 - The monolith horn by Bruce Edgar
- [2] Wireless World March, May and June 1974 - Horn loudspeaker design by J. Dinsdale MA Msc.
- [3] The Lowther Voight legacy Sound Practices Winter 94/95

Pictures

1. Cross Sectional drawings of horn



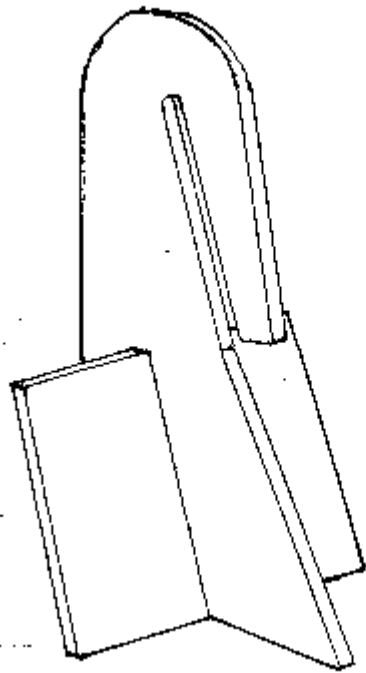


TRACTRIX HORN
BY ALE LEOP
CABINET DIMENSIONS (EXT)
370W X 450D X 370H

2. Sketches of internal partition

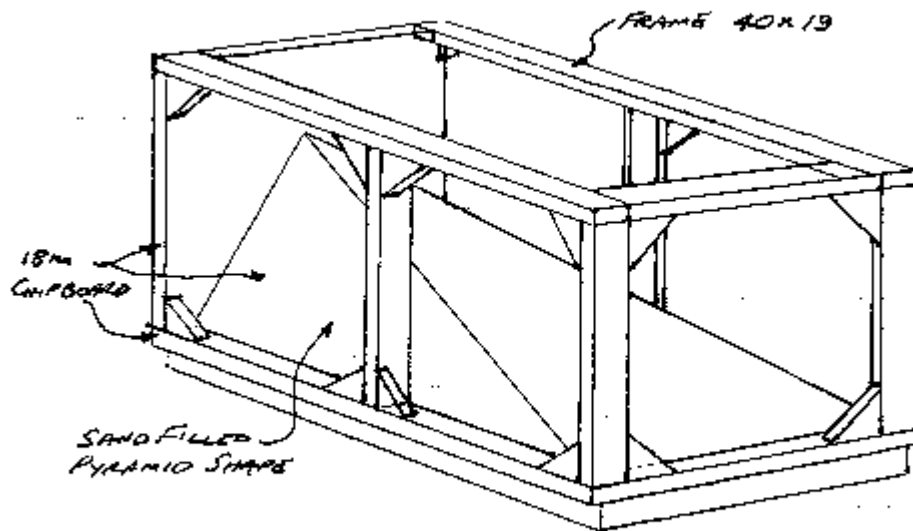


TRACTRIX HORN
BY ALF LEPP



INTERNAL PARTITION
12mm CHIPBOARD

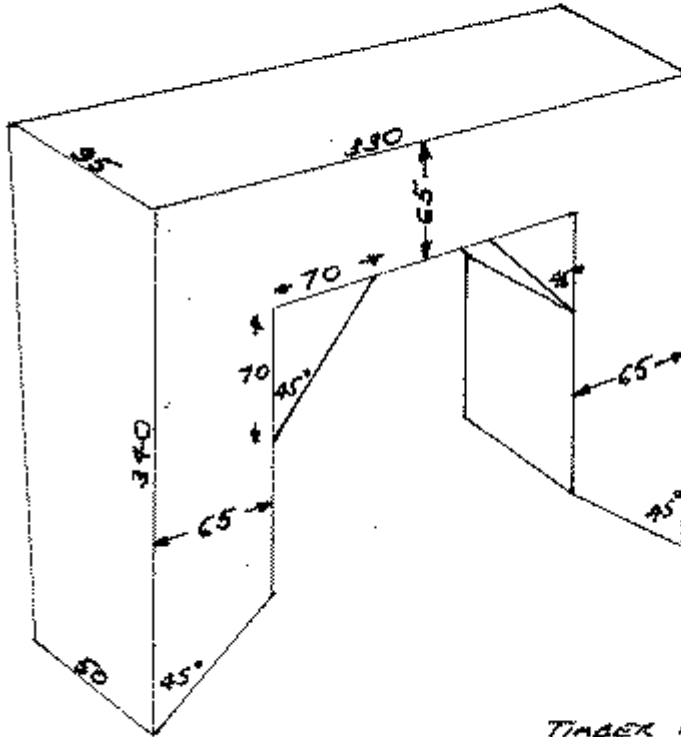
NOT TO SCALE



GENERAL CONSTRUCTION
OF BASE
NOT TO SCALE

3. Base and insert for drive unit cavity

TRACTRIX HORN
By ALF LEPP



TIMBER INSERT FOR
CAVITY BEHIND DRIVE UNIT

NOT TO SCALE

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