

CABINET CONSTRUCTION SHEET

(Oct. 1965) — ISSUE 11

INTRODUCTION

The following diagrams show the essential features of enclosures to give optimum results—in relation to size—with the Wharfedale range of speakers.

Although large enclosures still give the best bass, there is an ever-growing interest in compact models for small rooms and stereo, and remarkable progress has been made in LF performance with roll surround units in comparatively small cabinets during the last few years.

We have also carried out much experimental work recently with vent openings, distributed ports (i.e. slotted backs), absorbent materials, polystyrene diaphragms, tweeter boxes, crossover networks, etc., and this leaflet embodies the latest designs based on our findings.

For a complete account of the principles involved and how to construct and finish a wide range of cabinets, the new *CABINET HANDBOOK* by G. A. Briggs, published in April 1962 at 7/6 (8/6 post free) is recommended as a good buy.

Cone Surrounds

One problem with enclosure design has been the effect of cone surrounds on the performance. There are now four types of suspension in common use and these may be detailed as follows:

CE—corrugated edge	FS—foam surround
CS—cloth surround	RS—roll surround

One of the main objectives has been to simplify the problem by designing cabinets, where possible, to suit all the four types. This means discarding the Acoustic Filter in all cabinet models, WHERE IT SUITS ONLY FS AND CS TYPES, but it is retained in columns and pipes, where it cuts down harmonic resonance.

Wide Range Units

Now that 8", 10" and 12" units are available with double diaphragms (DD) and roll surrounds (RS) special care has been given to the production of optimum results on a cost/size basis.

Minimum Size

For reasonable bass, the minimum size is still 1 cu.ft. and our criterion of performance is that the speaker, when connected to a good FM set or tape recorder, should give much better reproduction than the internal speaker(s) which have to work in a confined space.

DISTRIBUTED PORT

This is the main design novelty in the leaflet and takes the form of a slotted back. It is adopted in Figs. R1, R3 and R5. The main advantages are that enclosure tuning is not necessary and any type of cone surround can be used. The ventilated back reduces resonance and improves the reproduction of speech, and the cabinet can be placed within an inch of the wall without upsetting the performance. The actual number of slots is not critical, but reducing them

raises the frequency and the Q of the main cone resonance.

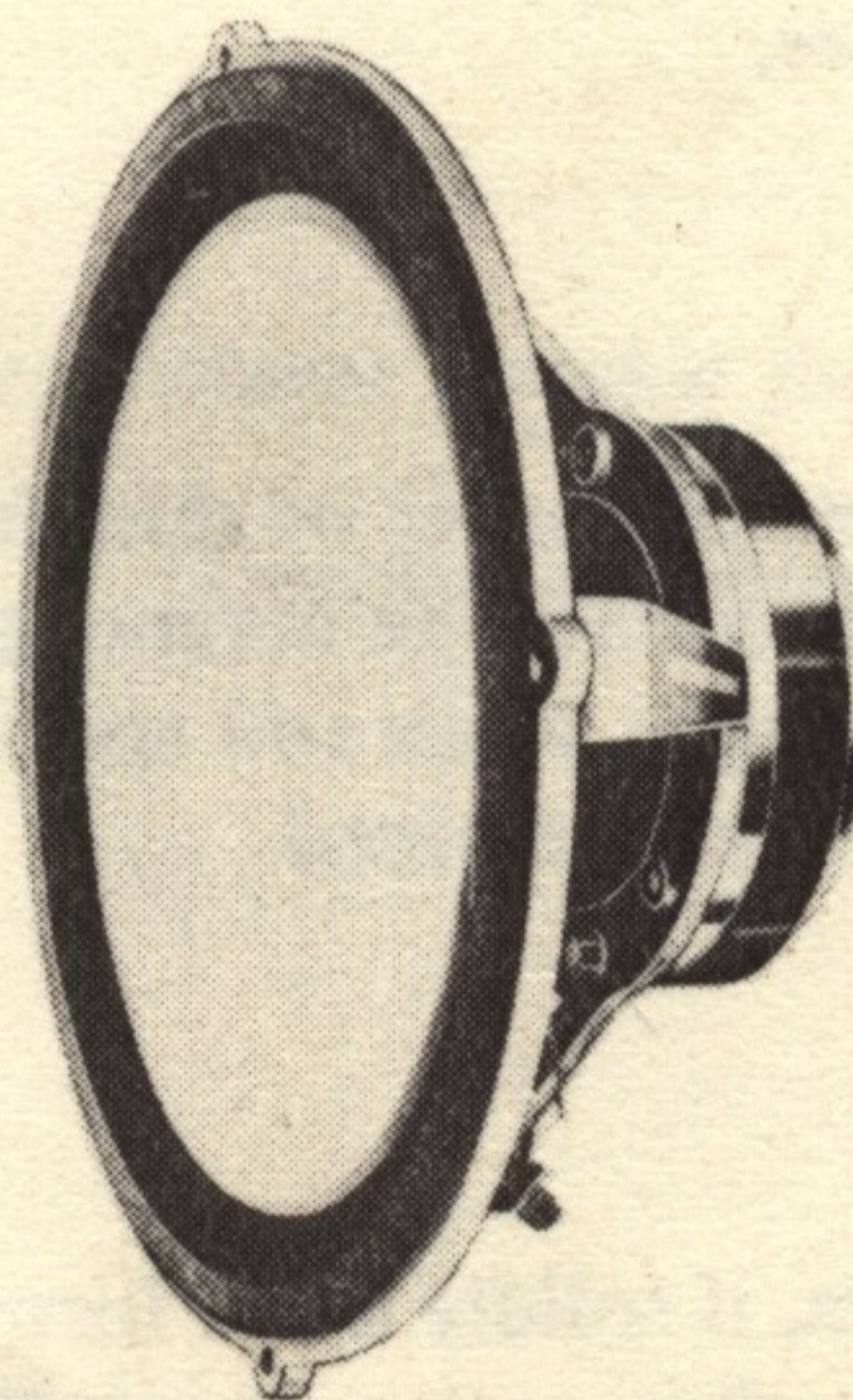
The slots can be replaced by rows of holes which are easily drilled in plywood.

The distributed port has been used with success in our W4 and Airedale speakers, and also in Line Source models.

POLYSTYRENE DIAPHRAGM

This represents another important development. It is found that 12" units are more difficult to house satisfactorily in small enclosures than 8" or 10" sizes, because the internal resonances are heard mainly through the cone. These resonances can be masked by fitting a polystyrene diaphragm to the 12" cone as shown in the W12/RS/PST illustrated here, and now available for general use.

W12/RS/PST



12" loudspeaker with 1½" thick polystyrene diaphragm added to absorb enclosure resonances.

N.B. In production units, the polystyrene is sprayed black to avoid showing through mesh of cabinets.

Patent applied for No. 46738/61.

This unit is recommended in a 2 cu.ft. enclosure in preference to an ordinary 12" cone speaker. The response is well maintained up to 4,000 c/s; a crossover and treble unit are necessary additions.

GENERAL HINTS

on CABINET DESIGN, CONSTRUCTION and USE

Size

The larger enclosures always give more output at low frequencies, but the smaller designs described give a satisfactory response consistent with their size. Outside dimensions are given, together with constructional specifications and recommended materials. Plywood thinner than that specified should not be used unless lined with Celotex or building board securely glued to the plywood.

The shape of any model may be changed slightly without affecting the low frequency performance, provided the total volume does not vary by more than 10 per cent.

It is usually an advantage to mount a speaker in an enclosure designed for a larger unit. It is, however, quite wrong to reverse the procedure and fit, say, a 10" unit in one designed for an 8" model.

Lining

Where absorbent lining is specified this should consist of bonded acetate fibre, cellulose wadding, fibre glass, cotton wool or cheap carpet felt, up to about 1" thick.

Cotton wool makes a very good absorbent and is freely available in all chemists' shops. B.P.C. quality costs about 7/6 per lb. and this works out at 10½d. per sq.ft. and is very satisfactory and economical. Where maximum absorption is necessary, a super quality under the name Verisan is sold by Timothy Whites at 9/- per lb.

Generally speaking, a 12" unit in a given compact enclosure will require more absorbent treatment than a smaller unit.

Although cotton wool is highly satisfactory as an absorbent, it requires rather more support than sheet B.A.F.=bonded acetate fibre.

Dust Exclusion

It is important that no foreign matter or dust from fibre glass should be allowed to enter the magnet gap; the cotton bags fitted to the open voice coil speakers should therefore be permanently retained.

Walls

The corner walls of a room, if solidly built, form an ideal backing for a corner reflex enclosure, and are superior to any cabinet. The front and top panels should make an airtight fit to the walls; gaps are easily filled up by glueing layers of cloth or felt to the edge of panels. Wall mounting is also an excellent acoustic device and is still worthy of consideration.

Sand-filling

Next to concrete or bricks, a sand-filled panel gives the least resonance. Two sheets of plywood are spaced $\frac{1}{2}$ " or 1" apart—the larger the area the wider the spacing—and the cavity is filled with dry sand, which adds weight and absorbs vibration. Ordinary builder's sand is satisfactory.

Openings

Loudspeaker and port apertures can be covered with an open mesh. The placing of such openings is not critical. Avoid loose cloth which may vibrate.

Tweeters

Treble units should not be placed in the bass enclosure without being surrounded by absorbent material and carefully boxed in, because they are fitted with open chassis and the cones would be affected by the LF sound waves, thus offsetting one of the benefits of the crossover network.

Stereo

Carefully matched speakers are not essential because room acoustics often vary from side to side and pickups have been known to do likewise. The main thing is to have similar treble dispersion on both channels; it is wrong to use a very directional speaker on one side and a non-directional type on the other.

Mesh

A layer of thin black cloth glued to plywood before fitting mesh will hide speaker and vent openings and will prevent vibration when expanded aluminium is used.

Electric Guitars

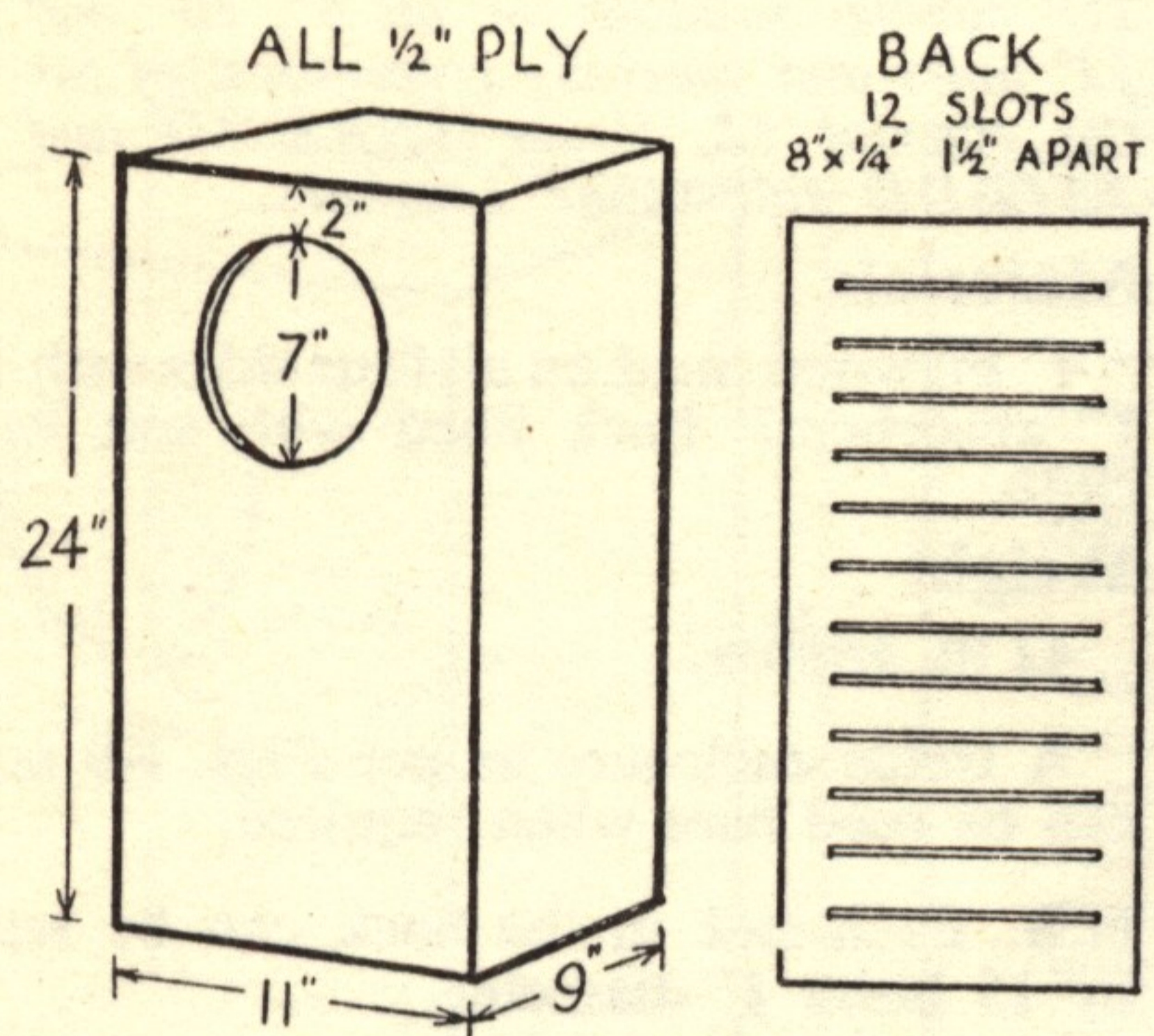
Ordinary 12" and 15" speakers should *not* be used with electric guitars, as the high voltage generated by the microphone placed on the instrument can result in severe overloading of amplifiers and speakers, followed by serious damage and possible breakdown.

The speaker units should be specially constructed for the work, and the cabinets must be even more rigidly assembled than is normally necessary if resonances and vibrations are to be avoided.

Details of suitable DP and tuned enclosures are given in the *Cabinet Handbook* already referred to.

Special guitar leaflet available on request.

FIG. R1—1 cu.ft.



DP cabinet suitable for all types of 8" unit.

Materials

$\frac{1}{2}$ " plywood lined on all four sides with about 1" absorbent. Back lined soft cloth.

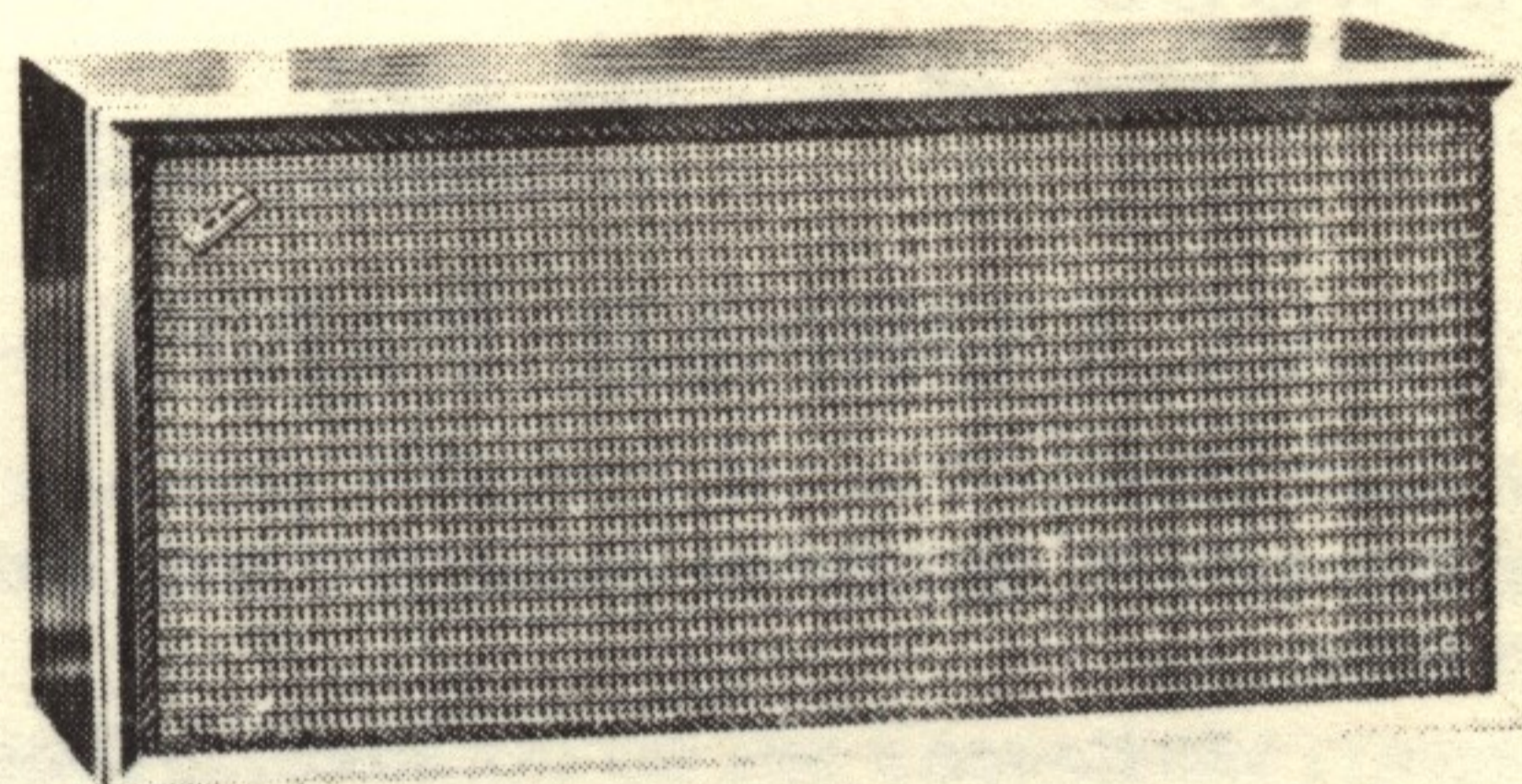
Weight

14 lb. approx.

Alternative tuning

Vent 9" x 1" in front panel, with solid back.

Finished appearance with solid wood frame and Tygan mesh.



ASSEMBLY OF BACK

For the home constructor, the slotted back is not so easy to make as a simple vent opening. One plan is to use strips of plywood of the required width and fix them firmly $\frac{1}{4}$ " apart to side battens or plywood frame. In all cases the slots should be covered by soft cloth such as grey flannel or black melton

securely glued to the inside of the panel.

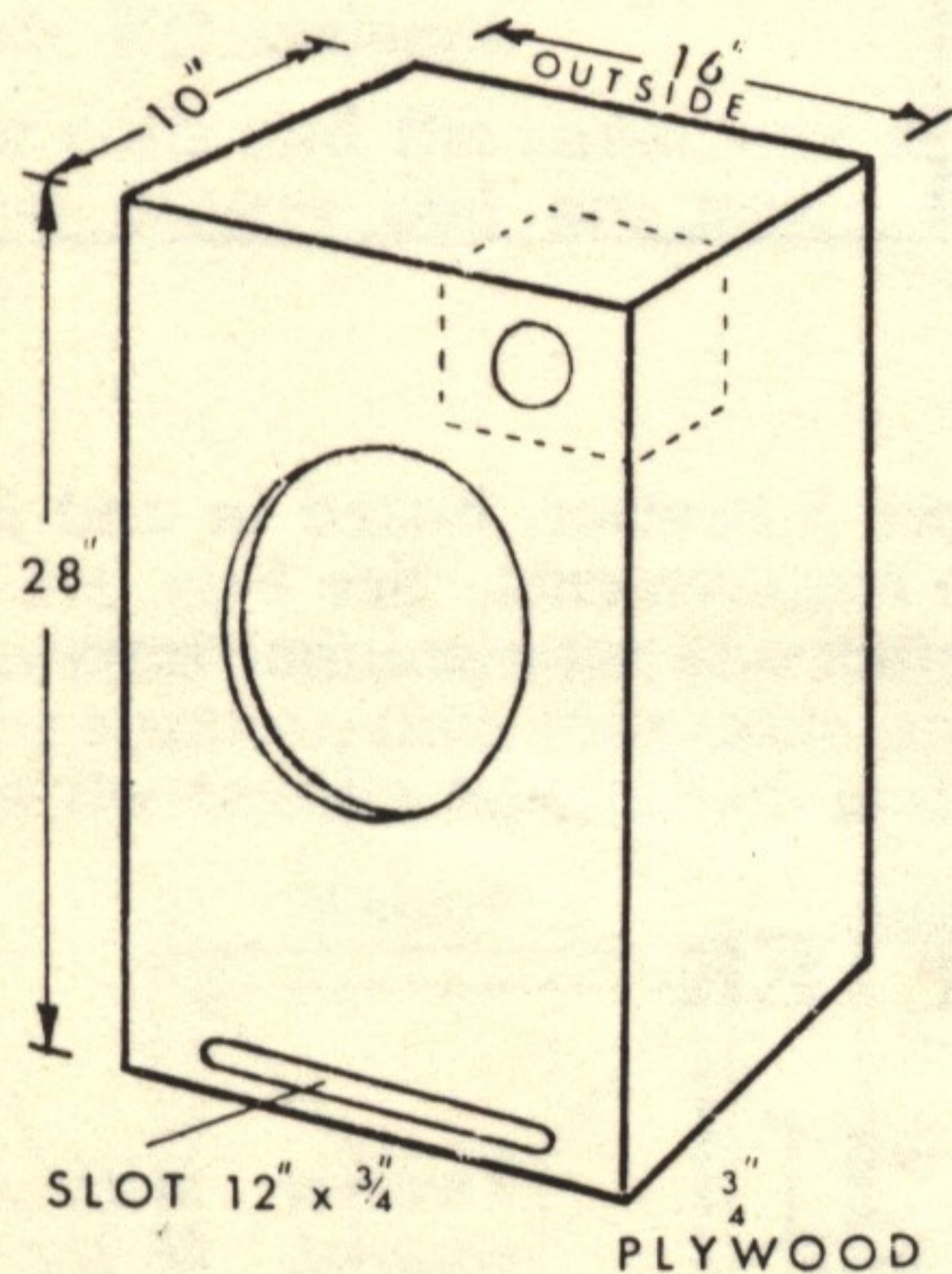
An easier method is to replace the narrow slots by a number of small holes drilled in the back panel. A row of 10 holes each $\frac{1}{2}$ " diameter would give about the same area as one slot $8" \times \frac{1}{4}"$ and would of course have to be covered by soft cloth.

FIG. R2—2 cu.ft.

With this size of enclosure the tuned reflex still gives the best LF performance, and the narrow vent $12" \times \frac{3}{4}"$ is suitable for 8", 10" and 12" speakers.

A low resonance 12" RS unit will give clean bass

in the R2 down to 25 c/s at low input level. For optimum results, a 12" RS unit with polystyrene diaphragm and separate tweeter is recommended.



Reflex cabinet suitable for 8", 10" and 12" units.

Tweeter box optional.

Materials

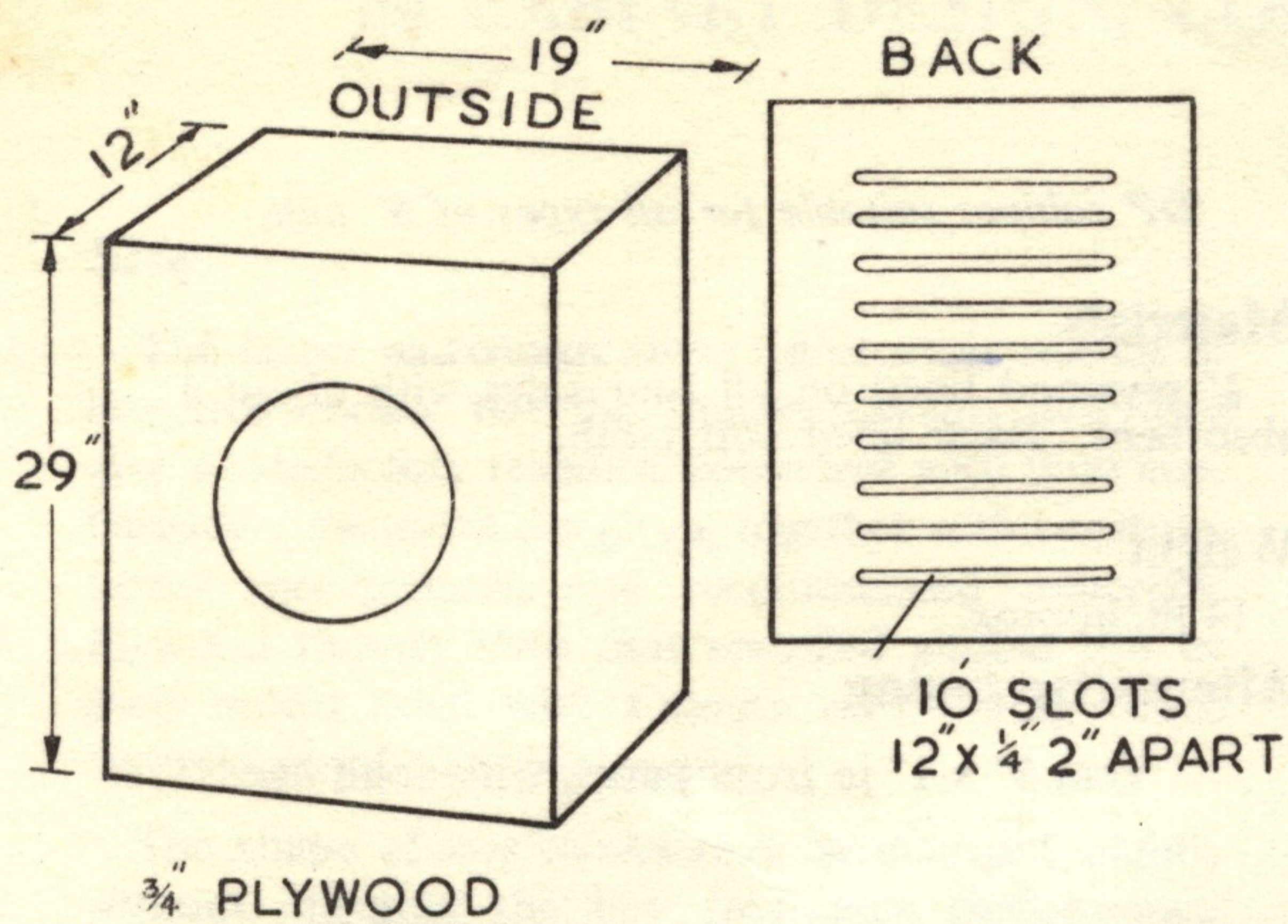
$\frac{3}{4}$ " plywood completely lined with 1" absorbent. If a wide range 12" unit is used, the enclosure should be well filled with absorbent.

Weight

35 lb. approx.

This cabinet is easily finished on the lines of the R1.

FIG. R3—3 cu.ft.



DP cabinet suitable for all 8", 10" and 12" units and specially recommended for the coaxial 12, Super 12/RS/DD and RS12/DD full range speakers.

Materials

3/4" plywood lined on all four sides with about 1" absorbent. Back lined with soft woollen cloth.

Weight

42 lb. approx.

A treble enclosure as per Figs. R6 and R7 can be used here when required.

N.B. Each slot in the back can be replaced by 15 holes 1/2" diameter.

Alternative tuning

Vent 12" x 1" in front panel, with solid back.

FIG. R4—4, 5 and 6 cu.ft.

FLAT CORNER PANEL—SAND-FILLED—WITH TOP

These enclosures are simple to construct and give very good results.

Height inside in.	Width inside in.	Distance along wall inside in.	Approx. Volume cu.ft.	Sand Thickness in.	Total Port Area sq.in.
31	30	21 1/4	4	3/4	10
38 1/2	30	21 1/4	5	3/4	14
40	32 1/4	22 3/4	6	1	20

Materials

Solid wood frame of thickness to give required sand-filling, faced both sides with 3/8" plywood. Top in 3/4" plywood. For maximum bass response an airtight fit to walls should be ensured by fitting strips of felt or Bostik white sealing strip.

The panel could also be made of marble, slate or metal with excellent results in the acoustic sense.

Absorbents not usually required here.

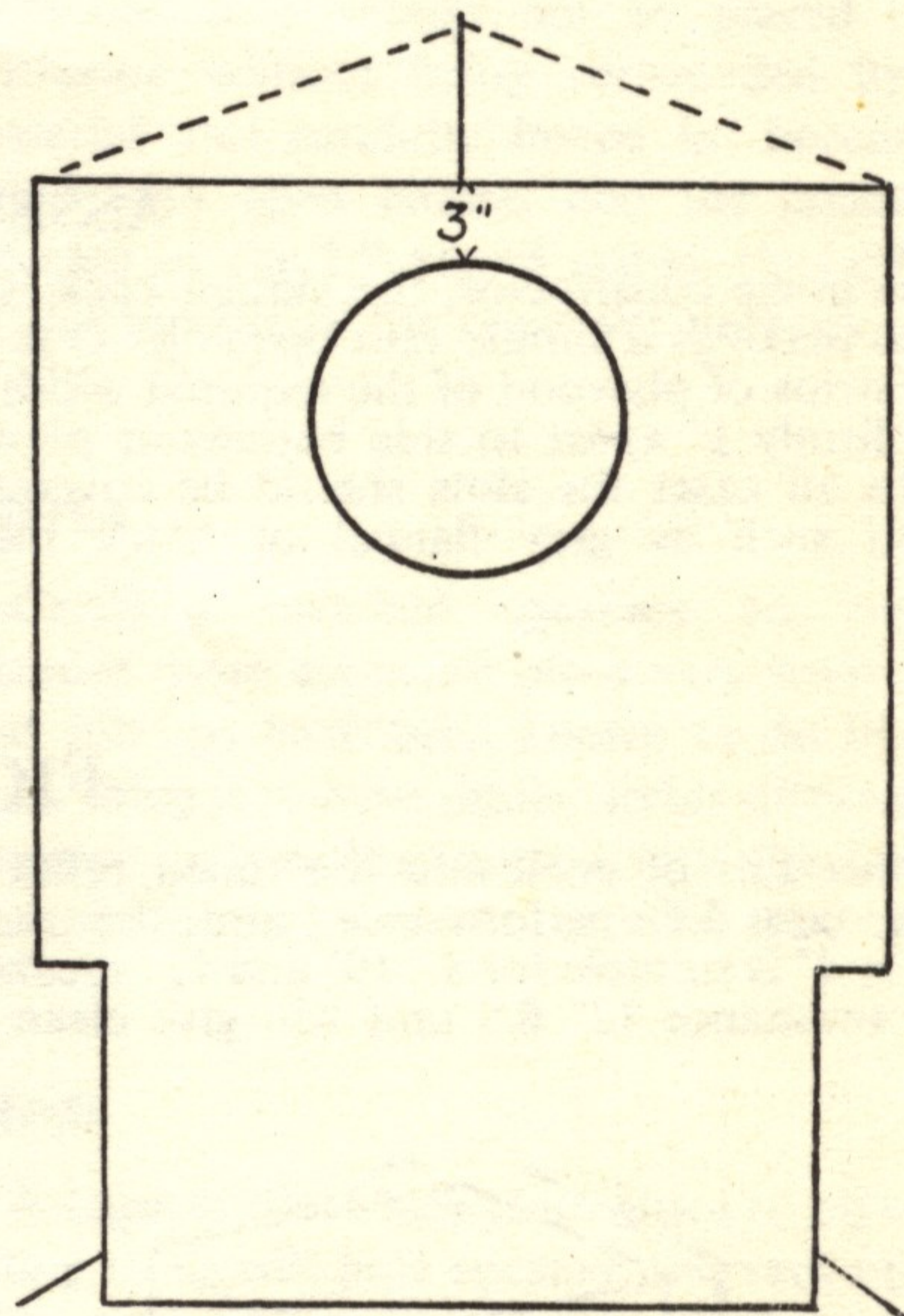
The following units can be used:

4 cu.ft. size: Any 8" or 10" speaker. Also the RS 12" units.

5 cu.ft. size: As above, plus FS 12" and RS 15" units.

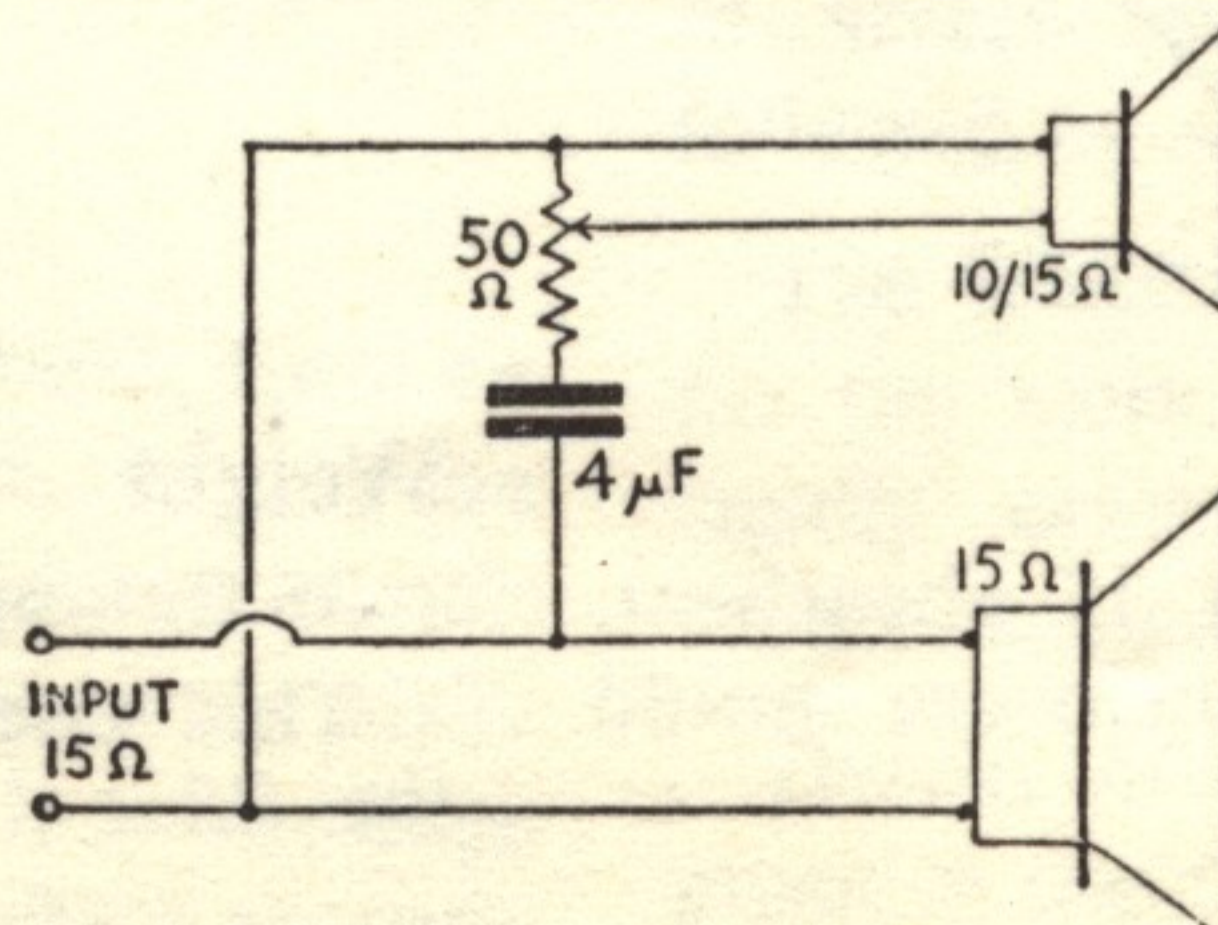
6 cu.ft. size: All models including FS 15" units.

These corner enclosures are big enough to accommodate a Super 3 tweeter, boxed in and lined with soft absorbent, facing forwards or upwards according to taste or stereo requirements. See Figs. R6 and R7. This little box must be acoustically sealed from the bass sound waves, otherwise very peculiar buzzing or vibration effects may be heard.



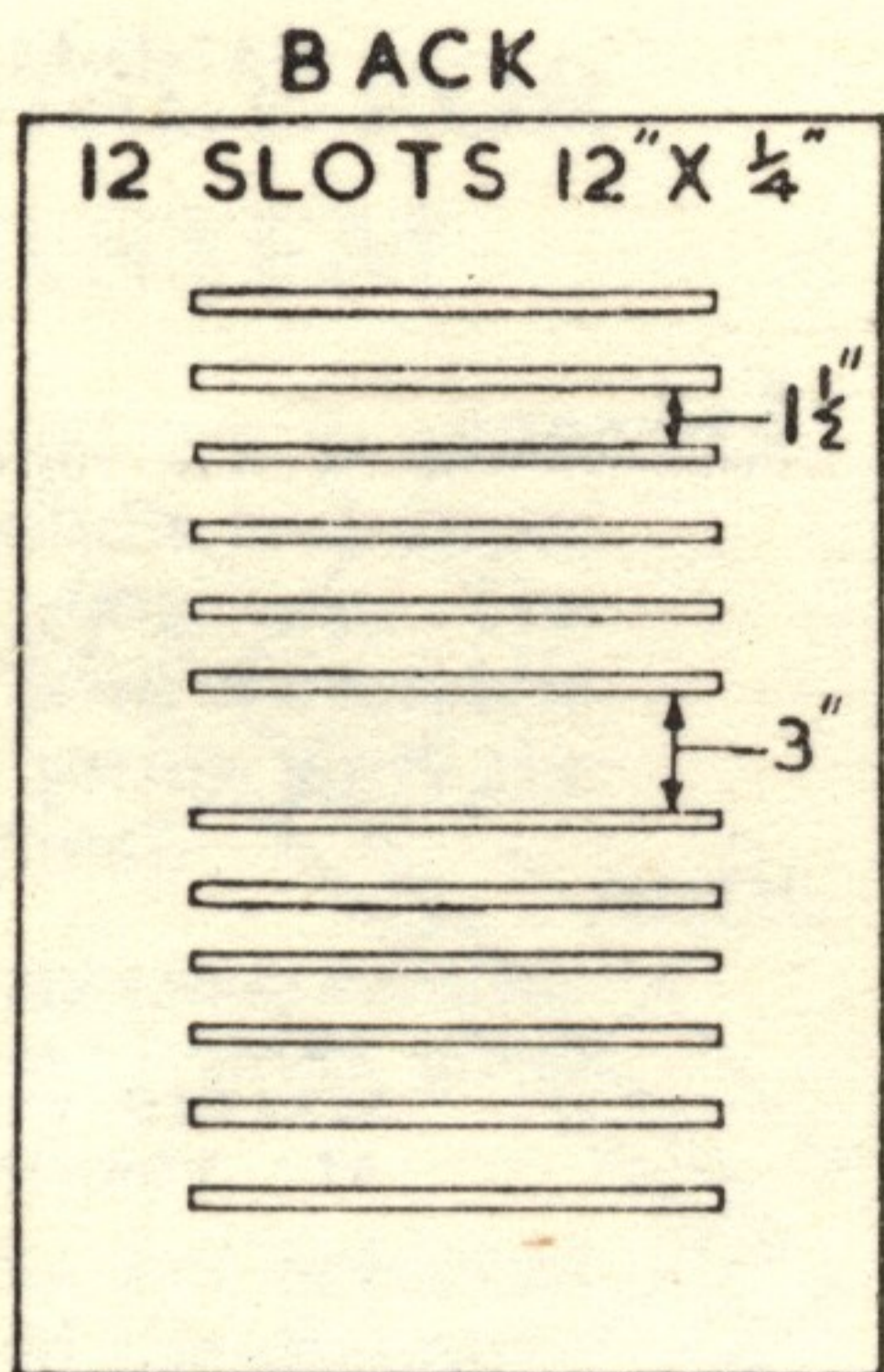
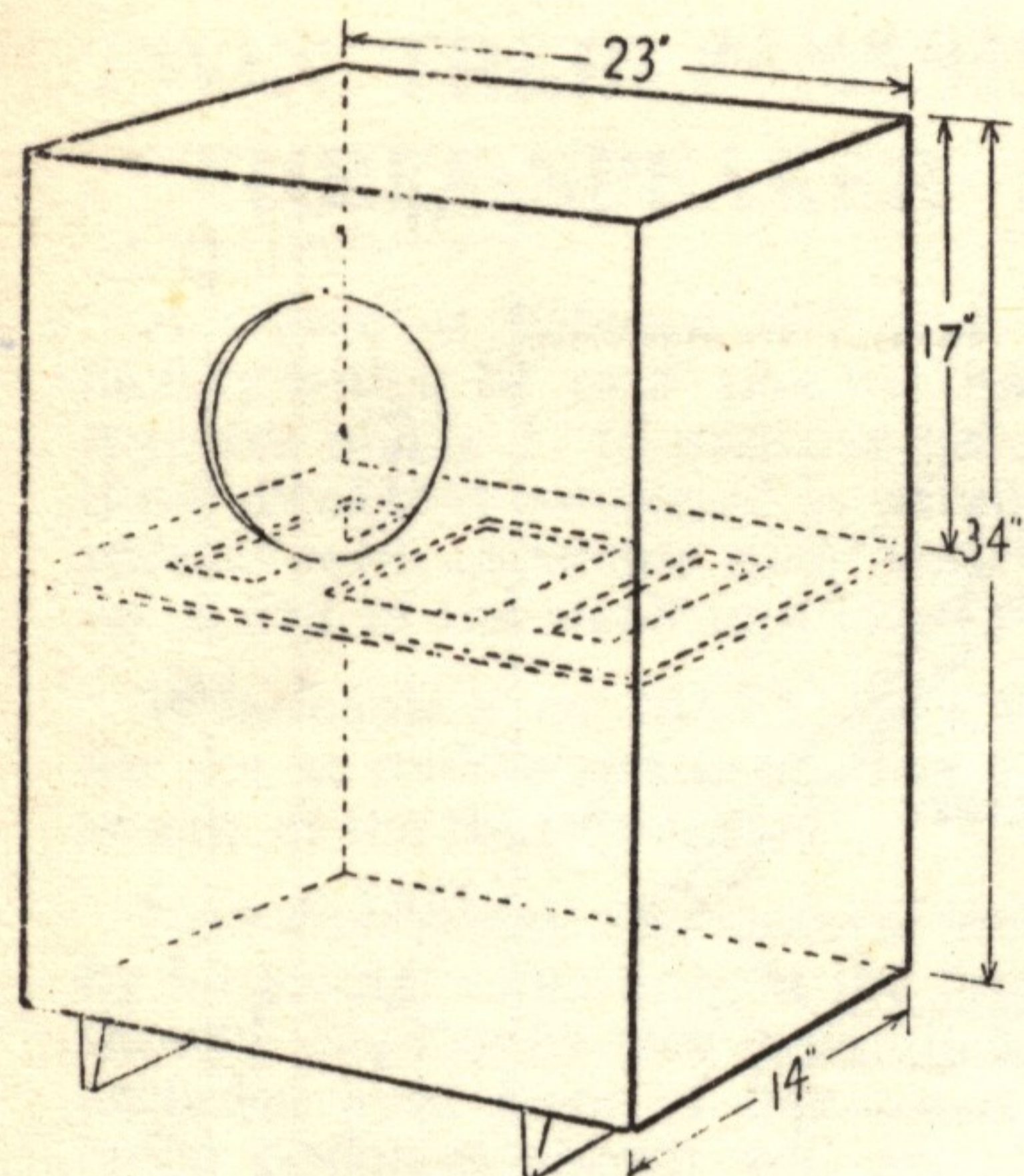
ADDING A TWEETER

When it is desired merely to improve the HF response, without rolling off the main speaker, this simple circuit can be used, and in fact often reduces audible mid-range coloration.



Tweeter with volume control. If the impedance of the main loudspeaker is 2/3 ohms, the filter capacitor and VC should then be 12 Mfd and 20 ohms respectively.

FIG. R5—5 cu.ft.



DP cabinet suitable for all speakers, CS, FS and RS types, up to and including 15" units.

Materials

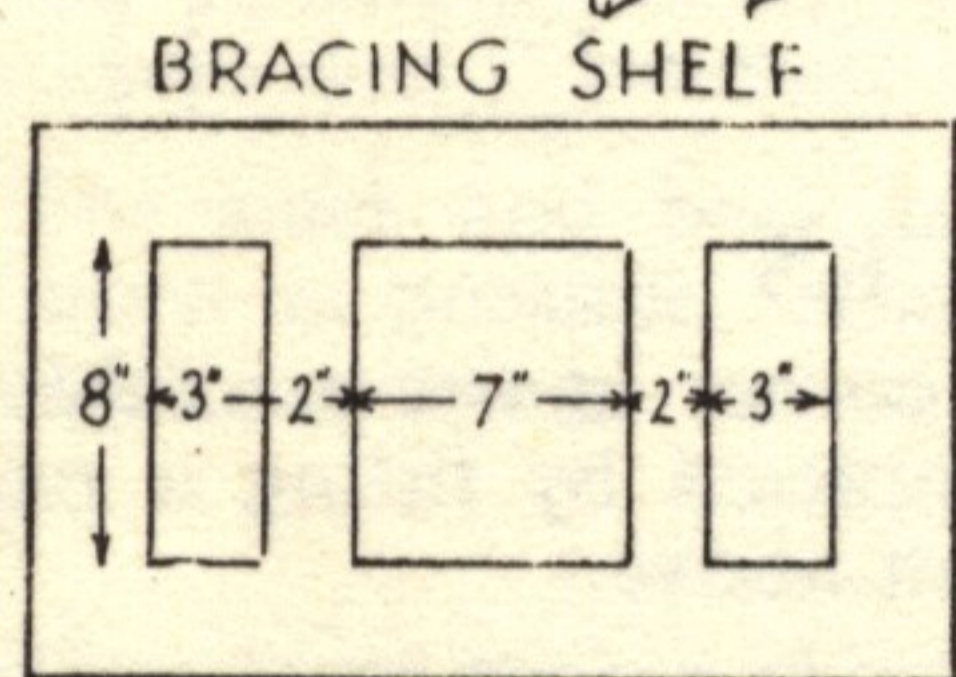
$\frac{3}{4}$ " plywood, lined on all four sides with $\frac{1}{2}$ " Celotex or $\frac{1}{4}$ " building board. Back lined with soft cloth.

The bracing shelf must be secured around all four sides to cut down panel resonance.

Weight

54 lb. approx.

Each slot can be replaced by 15 holes $\frac{1}{2}$ " diameter.



Absorbents

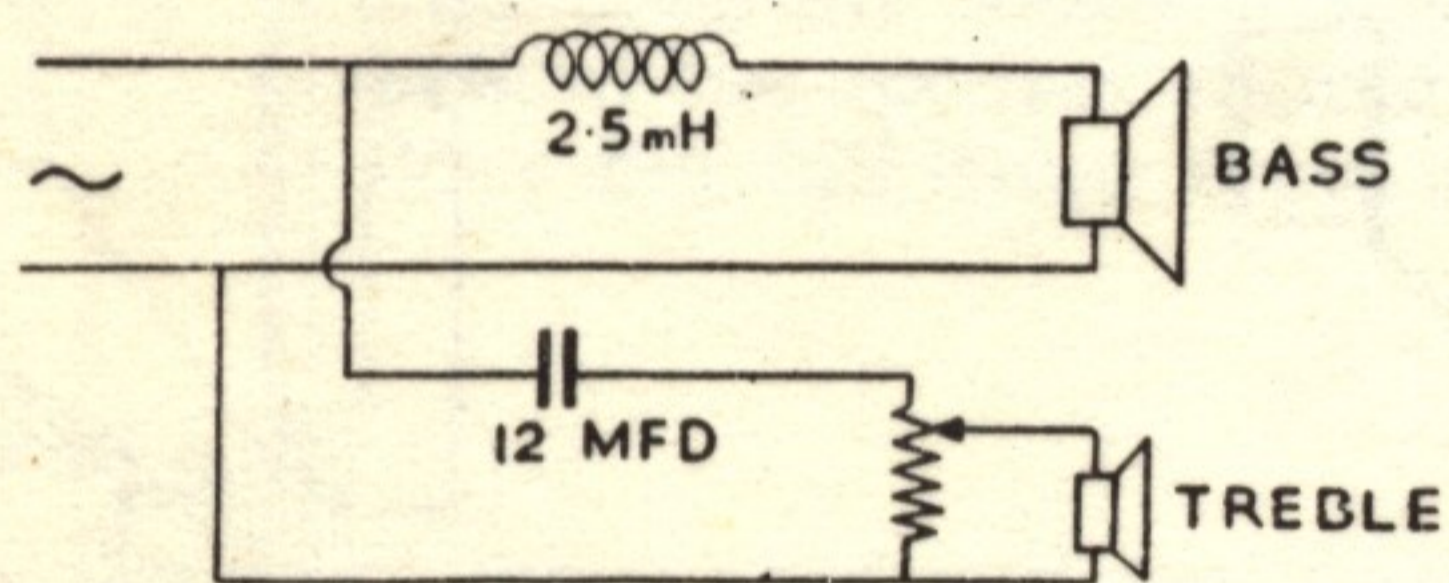
One loop of absorbent wadding 7 ft. x 1 ft. x 1" thick, fixed to top of cabinet and passing through the two small openings of the bracing shelf.

A tweeter box, or external treble unit(s) on the lines of the corner speaker system can easily be added.

TREBLE ENCLOSURES

When a 12" unit is used in a small enclosure it tends to expose the internal resonances and honking may result. The best remedy is to add a tweeter with a crossover, as follows:

CROSSOVER



Simple system for control of two speakers in compact enclosure.

Treble VC optional.

The inductance coils and the capacitors are available through hi-fi dealers and are easily fitted in a bass enclosure.

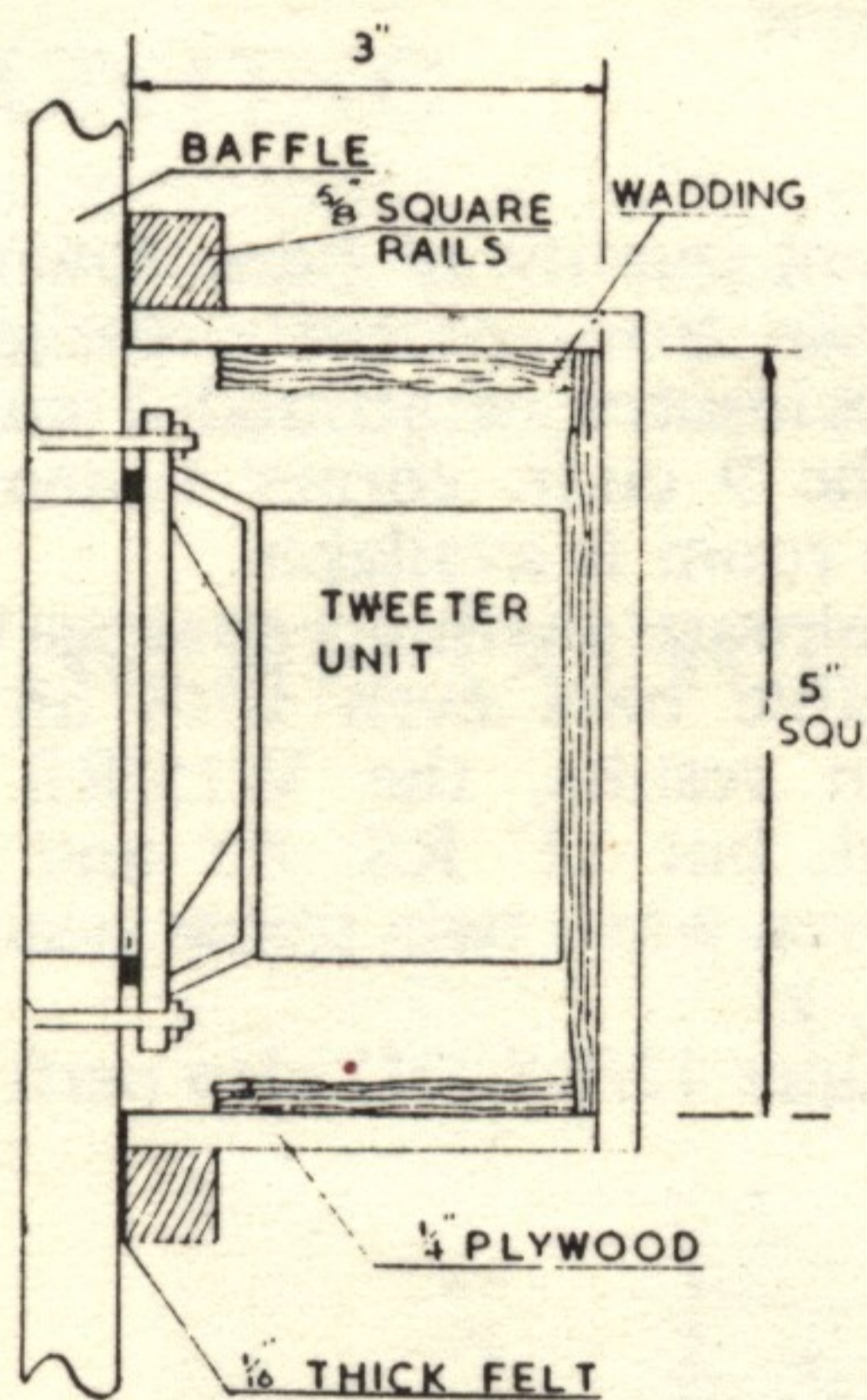


FIG. R6

Assembly details for airtight-enclosure for 3" unit with large magnet. The speaker leads are brought out through a hole which should be sealed off with adhesive tape to make it airtight.

For more omni-directional results, the design of Fig. R7 can be adopted. The centre hole is made to suit the diameter of the speaker, then four extra openings about $\frac{1}{2}$ " wide are made so that sound waves are reflected from the inside of the tweeter box, which is designed with sloping sides for this purpose.

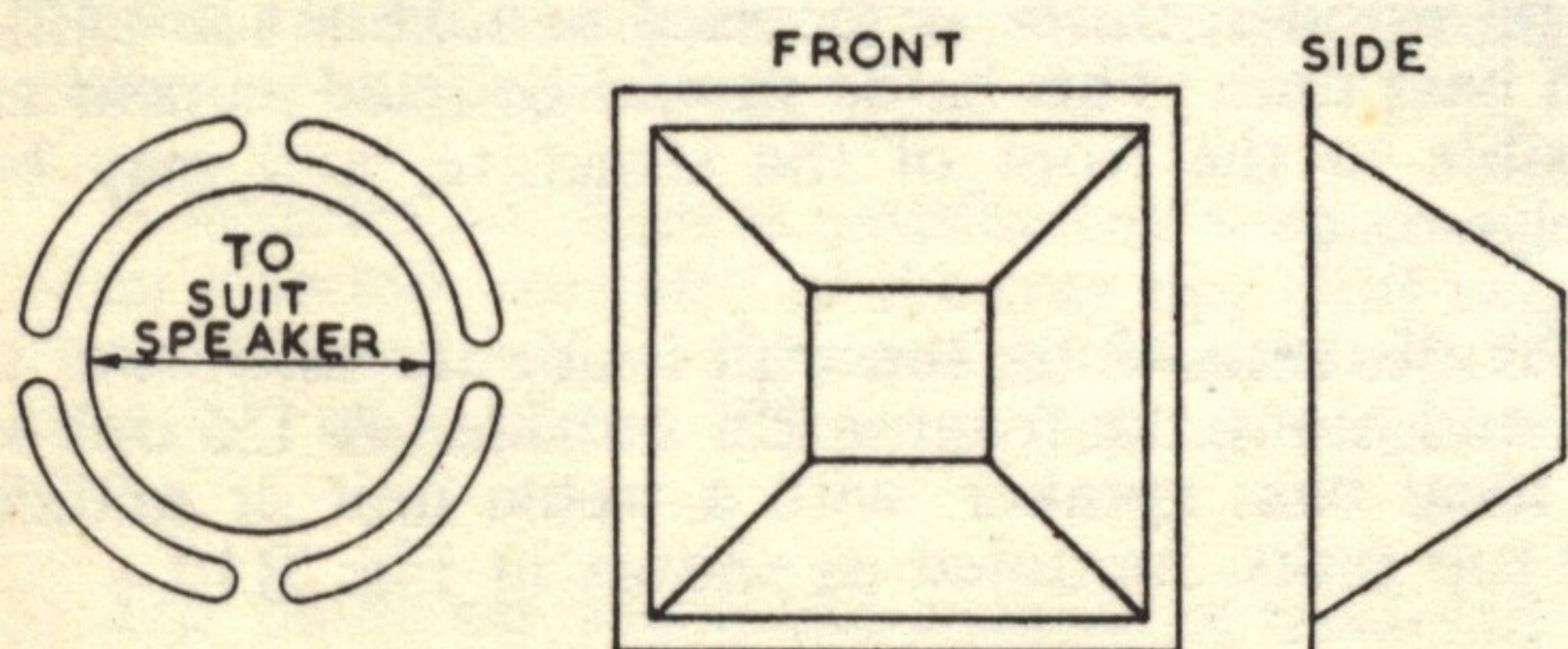
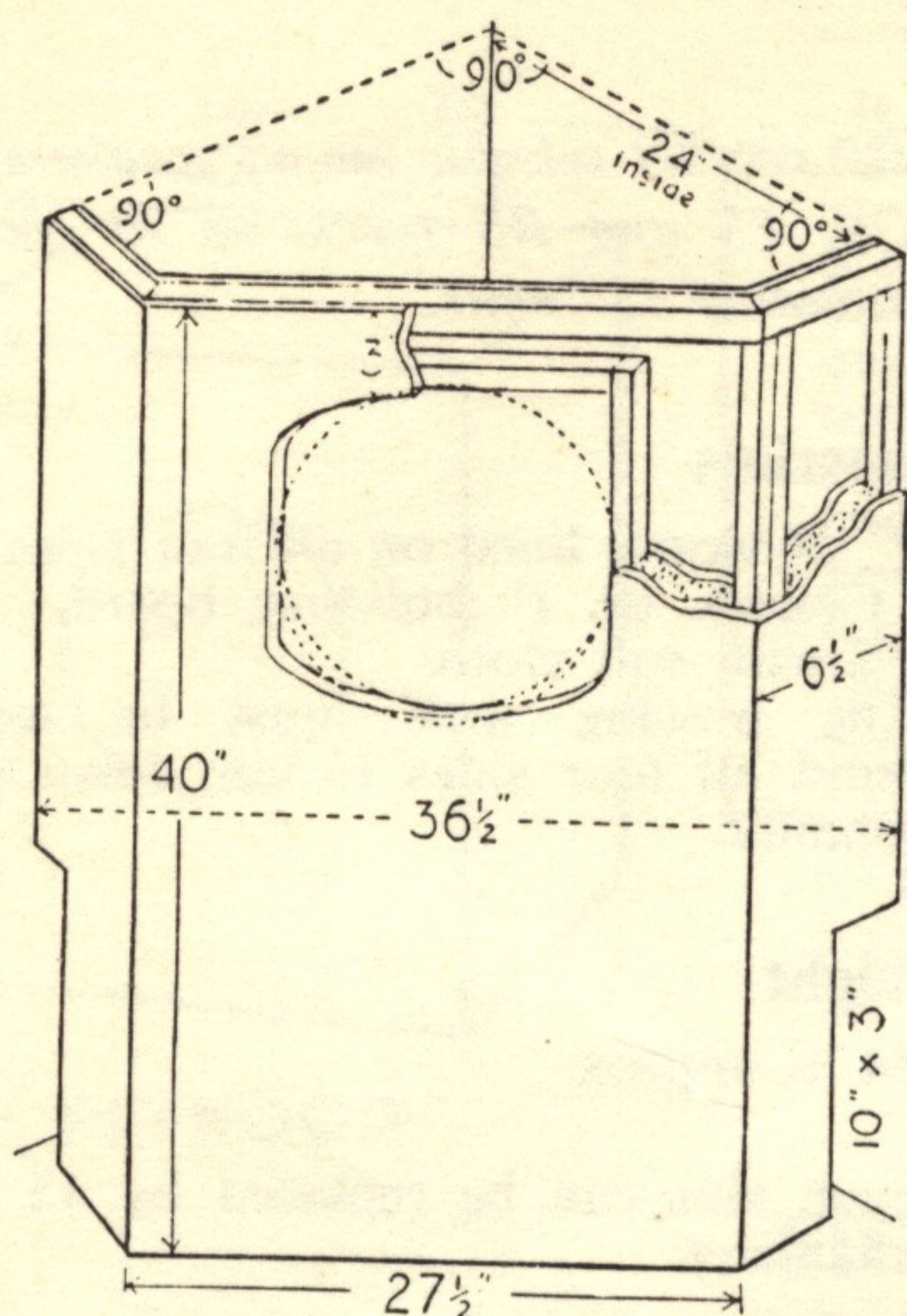


FIG. R7

Tweeter box with sloping sides to reflect sound through openings around the speaker. Line with thin layer of absorbent.

This box or cover can be made by hand in strong cardboard, secured inside and outside by adhesive tape to ensure airtight joints. A layer of soft cloth or felt should be glued to the front rim before fixing the box in position—again to avoid any air leaks.

FIG. R8—9 cu.ft. SAND-FILLED CORNER PANEL



Distance along wall from corner to front of lid is $26\frac{1}{2}$ ". Weight of front panel 124 lb.

Materials

Solid wood frame 1" thick, faced on both sides with sheets of $\frac{1}{2}$ " plywood. Space between plywood filled with tightly-packed dry sand. Top in 1" plywood or blockboard. For maximum bass response an airtight fit to walls must be ensured.

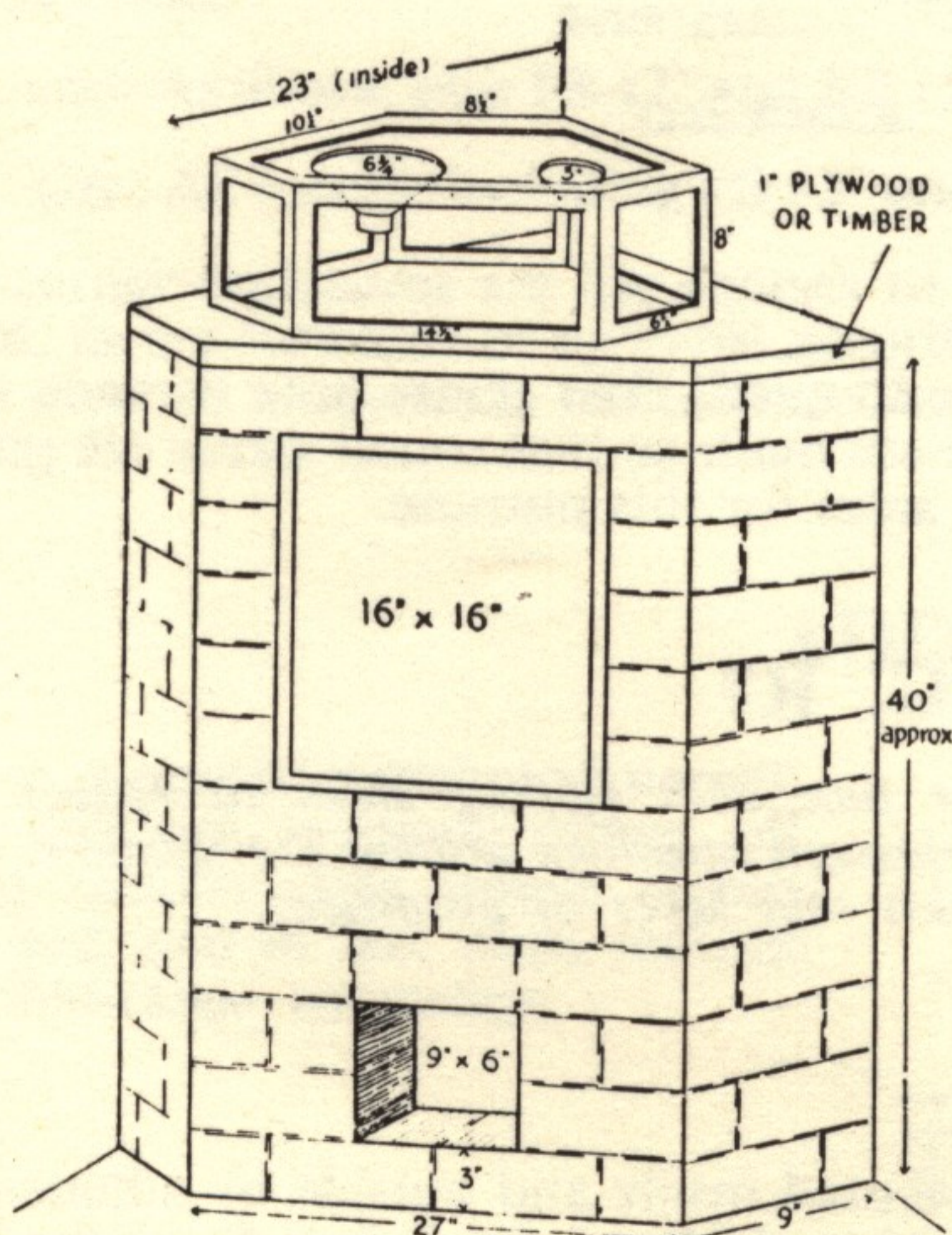
Sub-baffle about 16" x 16" in $\frac{3}{8}$ " plywood should be fitted up to the rear side of the front plywood panel, inside the frame shown in drawings, to avoid a cavity in front of the cone.

Units

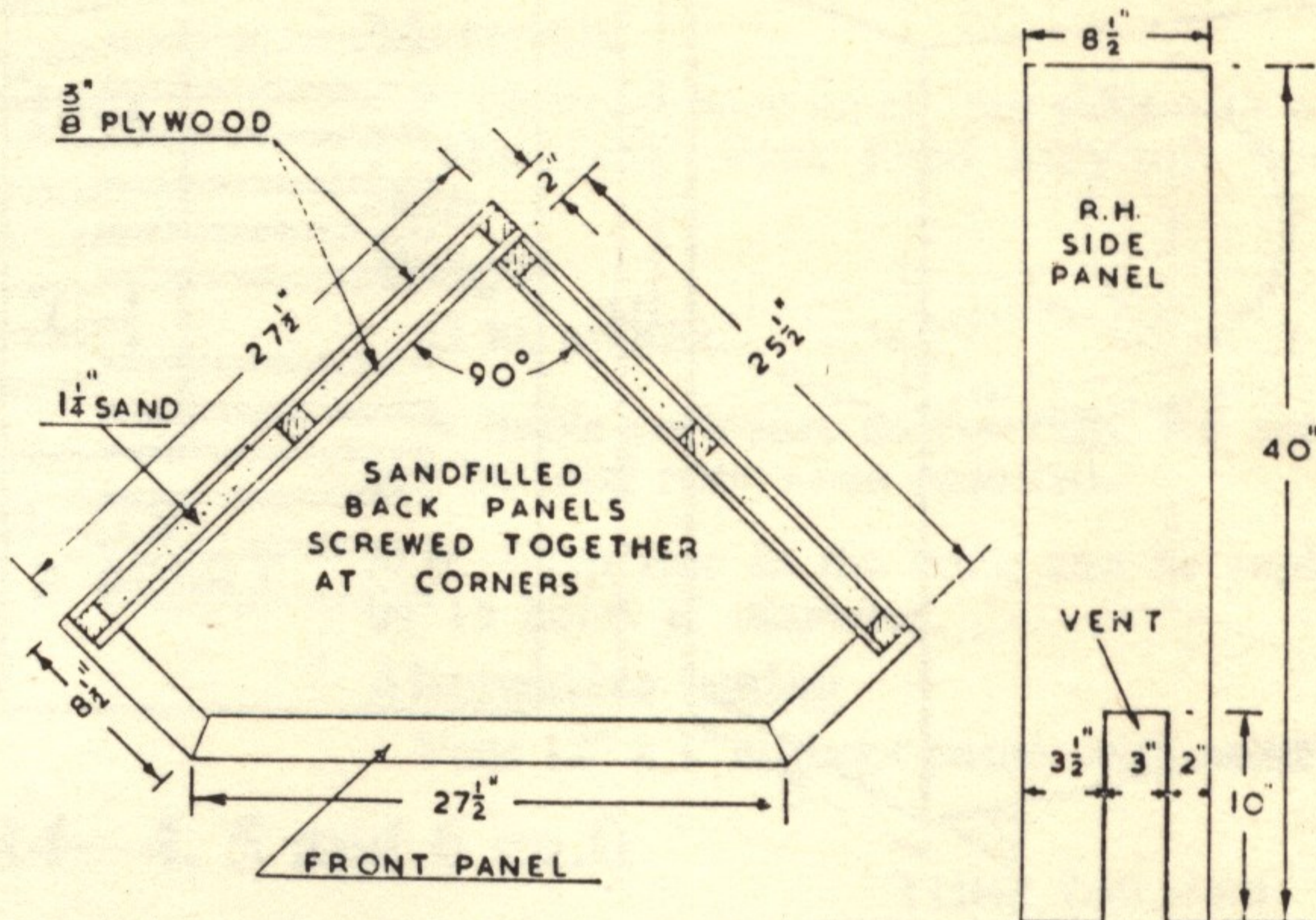
In spite of the excellent quality of bass down to 30 cycles now obtainable from properly designed 12" units in compact enclosures of around 2 cu.ft., the fact remains that the 9 cu.ft. corner system is still worth having where room is available.

As to suitable units, almost anything goes as this enclosure gives remarkable bass even with an 8" speaker. For optimum results, the W15/RS or W15/FS should be used, but 12" RS, FS and CS models are satisfactory even when twin treble systems are added.

The Coaxial 12 and Super 12/RS/DD also perform well in this enclosure.



SAND-FILLED BACKS



SAND-FILLED BACKS

Where a solidly built corner is not available, the enclosure should be completed by fitting a pair of sand-filled backs as shown above.

The width of the two side panels is increased to $8\frac{1}{2}$ " to cover the edges of the back panels, the vents being cut out as indicated in the drawing.

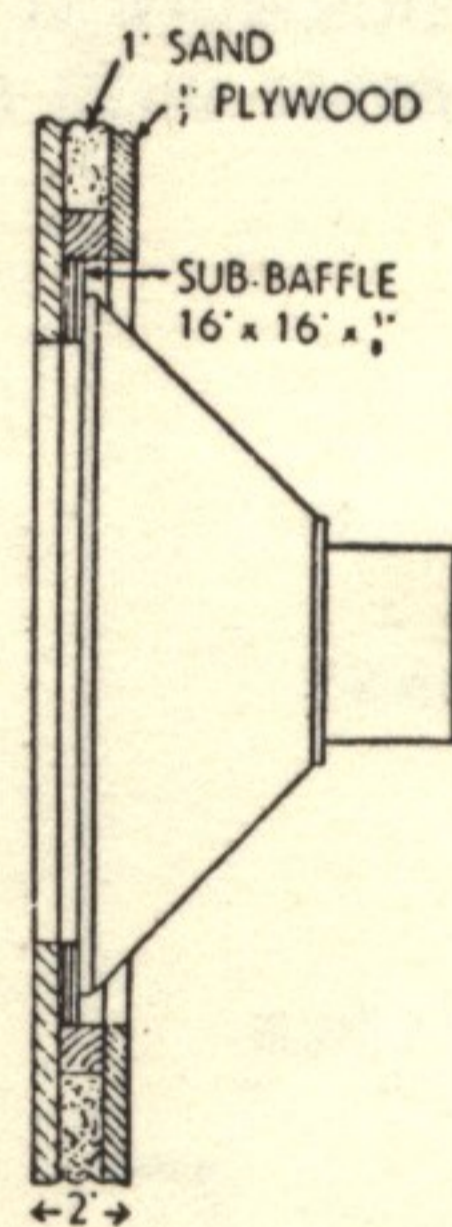
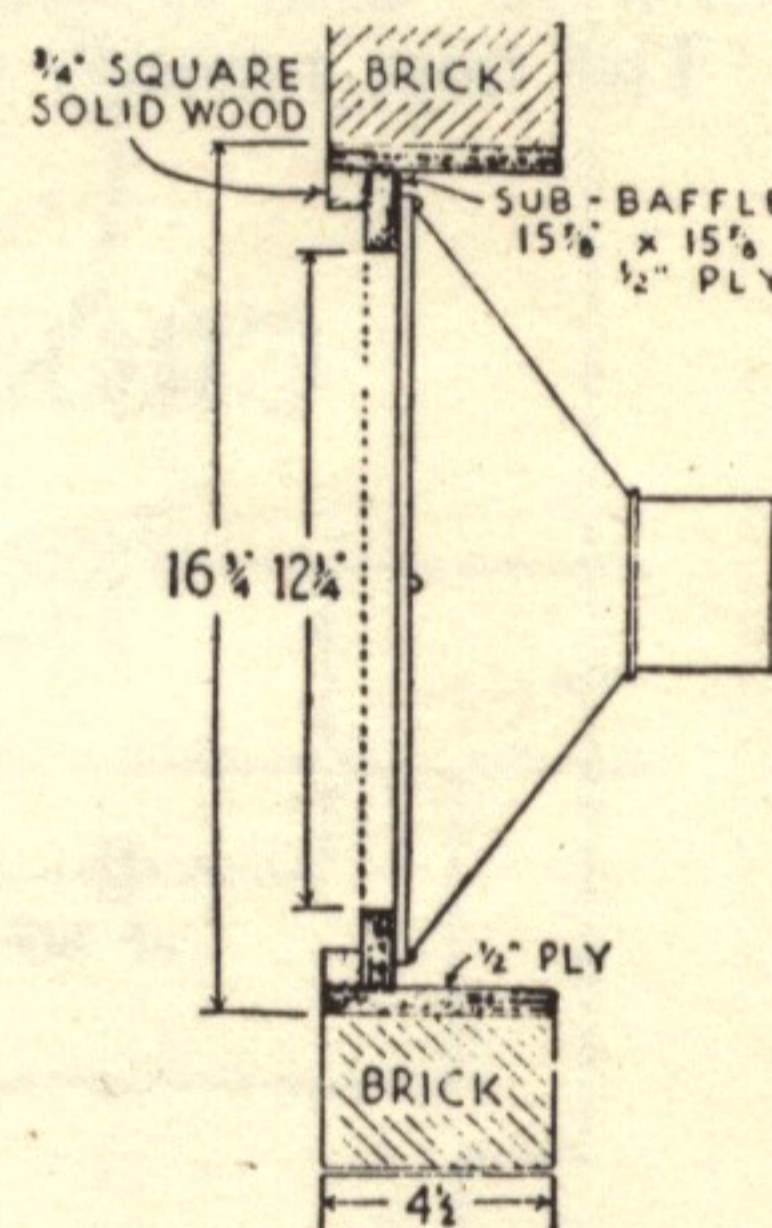


Diagram to show method of fitting sub-baffle to sand-filled panel.



Side view of brick panel showing method of fixing sub-baffle.

FIG. R9 BRICK REFLEX

Readers who may be removing, redecorating, or building a house are strongly advised to construct a brick enclosure along the lines of this drawing. The cost is low, but the results are superb.

The wooden frame is recessed to take a sub-baffle with bass unit. This baffle should be fixed as near as possible to the front of the structure, and may be $\frac{1}{2}$ " plywood.

The distance along the wall inside the enclosure is 23", and along the front is 27" outside. A 15" unit is the ideal bass speaker, with a treble unit or middle and top units, mounted as shown in Fig. R10.

Other speakers give a good account of themselves in brick surroundings.

FIG. R10

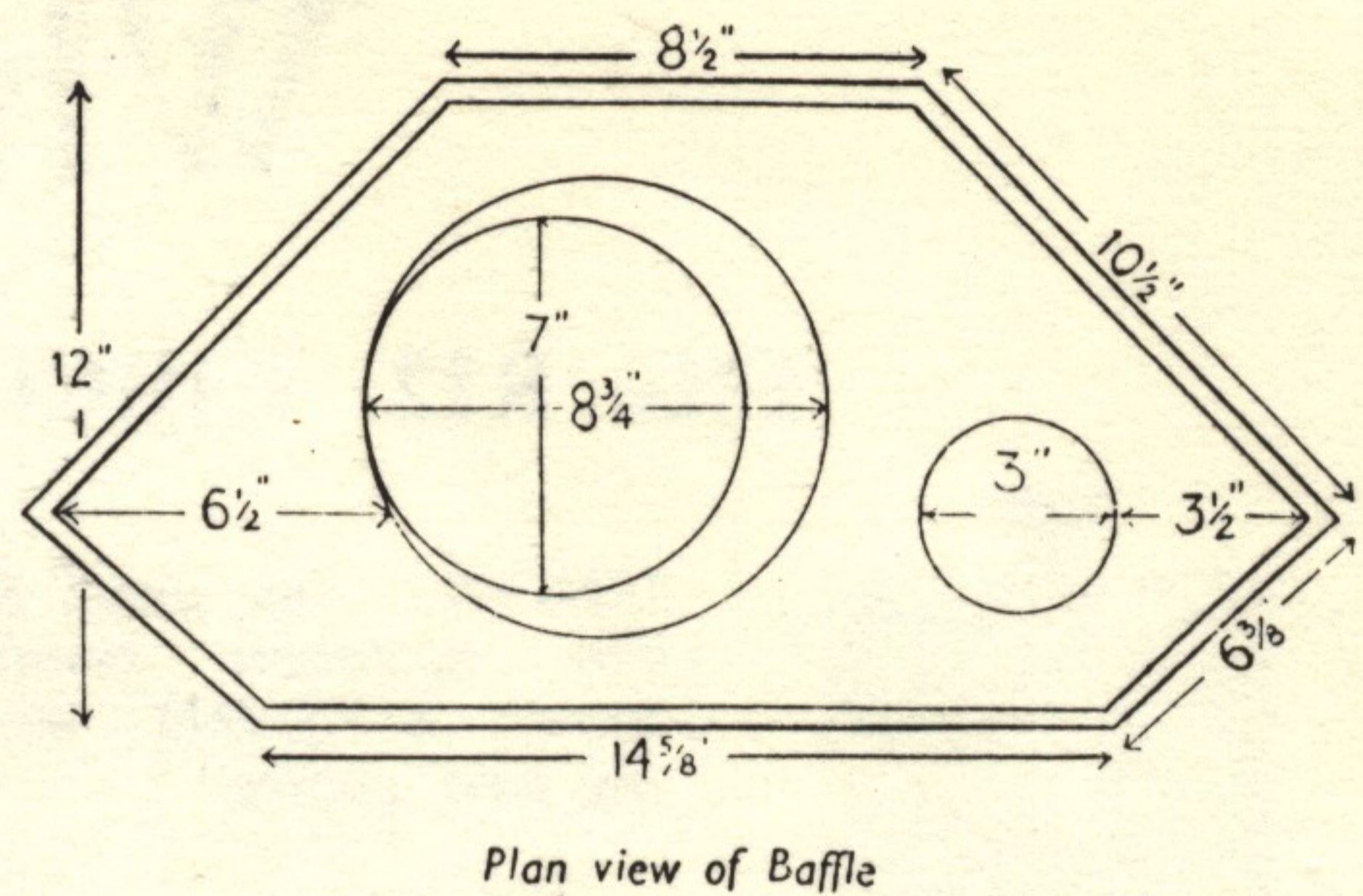
TWIN TREBLE ASSEMBLY FOR THREE-SPEAKER SYSTEM

A crossover between 400 and 1,000 c/s is satisfactory with a 10" or 8" unit for the middle and upper registers plus a 3" to improve the extreme top. The third speaker is connected in parallel with the middle speaker with capacitor of 4 Mfd in series with the voice coil of the small unit (10-15 ohms).

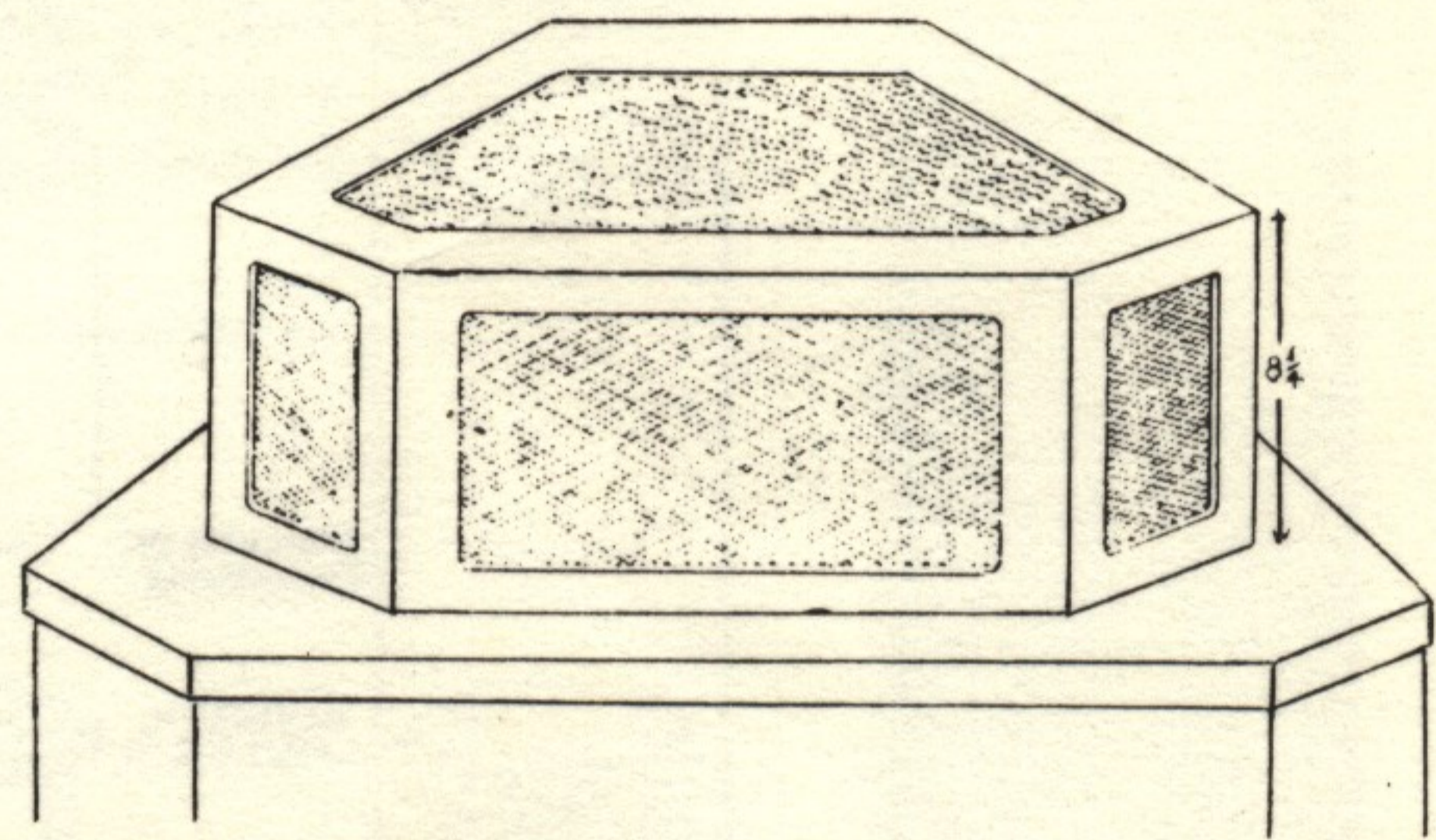
Wharfedale 8" or 10" FS and CS units are suitable for use as middle speakers. The Super 3 gives good results as the third speaker.

Non-directional and natural results are achieved by horizontal mounting on the lines of the diagrams shown. Both units face upwards and dust should be excluded by a layer of fine cotton or muslin. The baffle openings shown will suit 8" or 10" middle speakers and 3" tweeters.

The sides and back of the cabinet must be left as open as possible. Anodised aluminium mesh is a suitable covering.

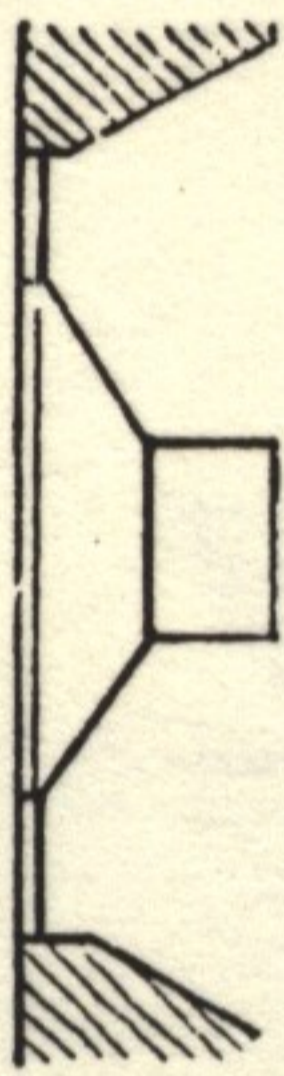


Plan view of Baffle



TWO-SPEAKER SYSTEM

The above arrangements complete a good 3-speaker system, but quite satisfactory results are often possible with only two units. If the bass speaker is enclosed in a reflex cabinet and a quarter section 800 or 1,000 c/s crossover is used, an 8" or 10" treble speaker can be mounted on an open baffle in $\frac{3}{8}$ " plywood, size 14" x 12". If a 400 c/s crossover is used, the baffle should be 3 or 4 inches bigger.



WALL MOUNTING

As a solid wall makes a perfect baffle, an opportunity of using one should not be ruled out. The diagram shows a suitable method of mounting on a small sub-baffle. Any boxing-in behind the speaker should be rigorously avoided. Bass units perform best if placed near the floor but full range types sound more natural at a height of 3 or 4 ft.

For the floor space used and low financial outlay involved, we have never heard more impressive sound than comes from this concrete column. There are, of course, solid reasons why these rigid enclosures give such excellent results.

The absence of panel and structural resonance avoids absorption of energy at very low frequencies and therefore improves bass response; it avoids mid-frequency coloration, which in turn improves transient response and allows the HF end to come through clearly.

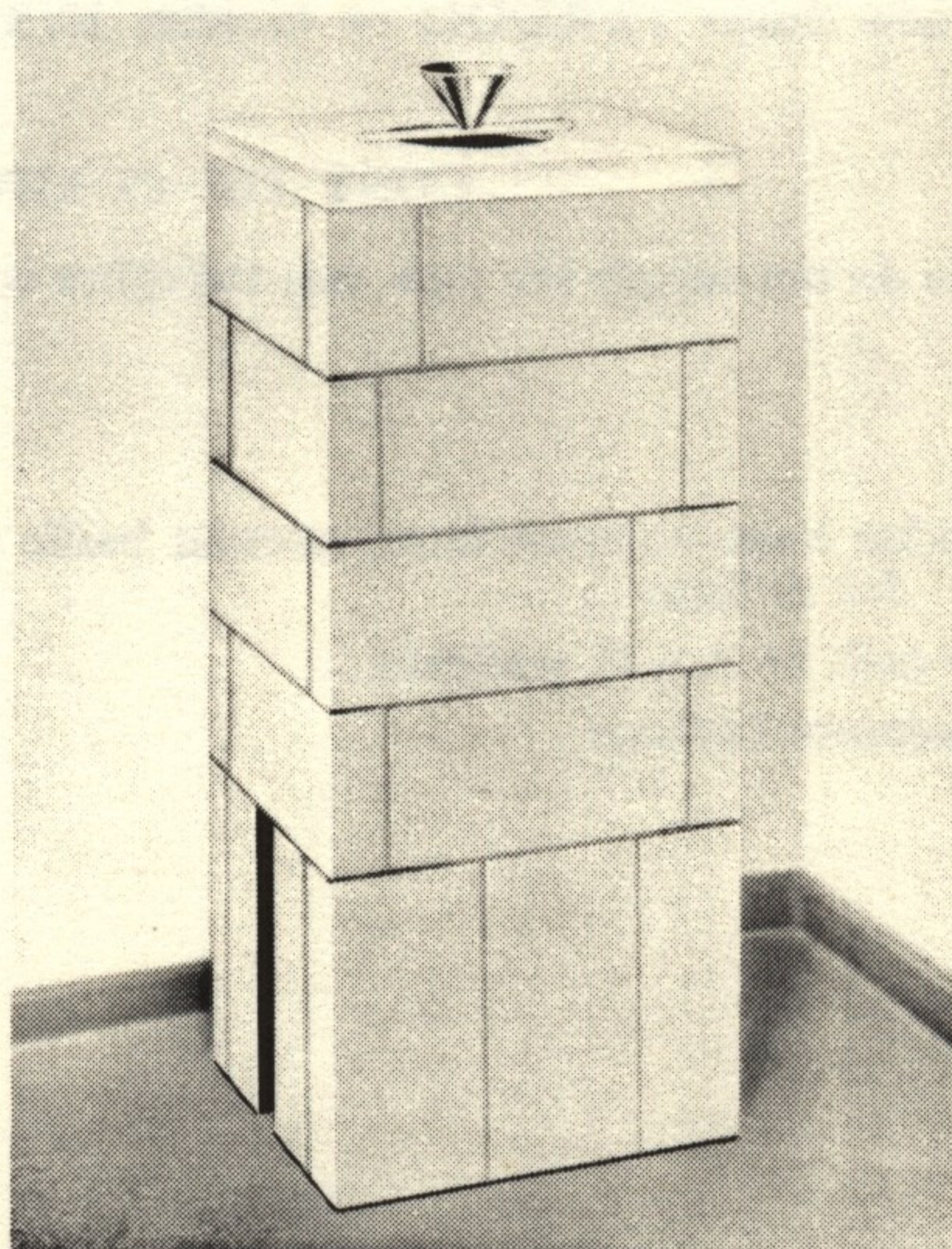
The coloured concrete blocks measure 12" x 6" x 2", weigh 10½ lb. each, and are obtainable from builders' merchants. The entire structure weighs about 2½ cwt.; but if fitted to brick wall or corner up to 50% of the blocks can be omitted and the twin ports arranged to clear the skirting-board.

A column 36" high is satisfactory with an acoustic filter inserted one-third of the way up. This takes the form of one piece of plywood with seven slits 9" long and $\frac{1}{16}$ " wide, fitted across the column between the slabs.

The baffle on which the speaker is mounted must make an air-tight fit to the top of the column, which is lined with 1" absorbent material above the filter.

The finished column is easily painted or papered to match the walls of the room, or may be covered by thin plywood panels.

FIG. R11 CONCRETE COLUMN

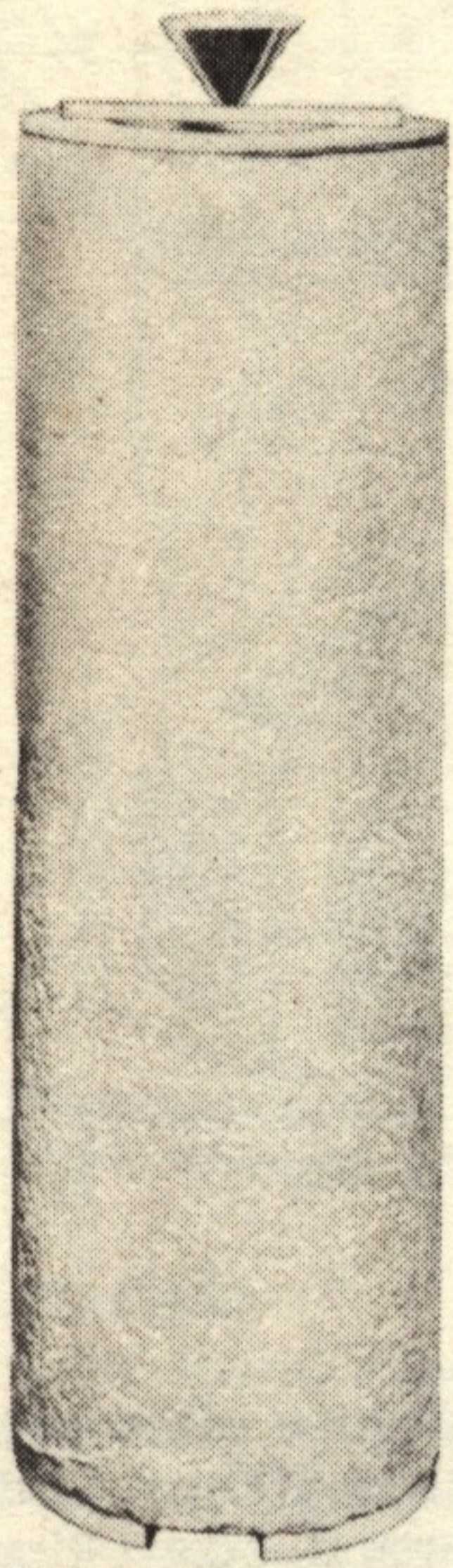


Concrete column 3 cu.ft.
Outside dimensions 17" x 15" x 36".
Twin ports 12" x 1".
Suitable for 8" and 10" units.

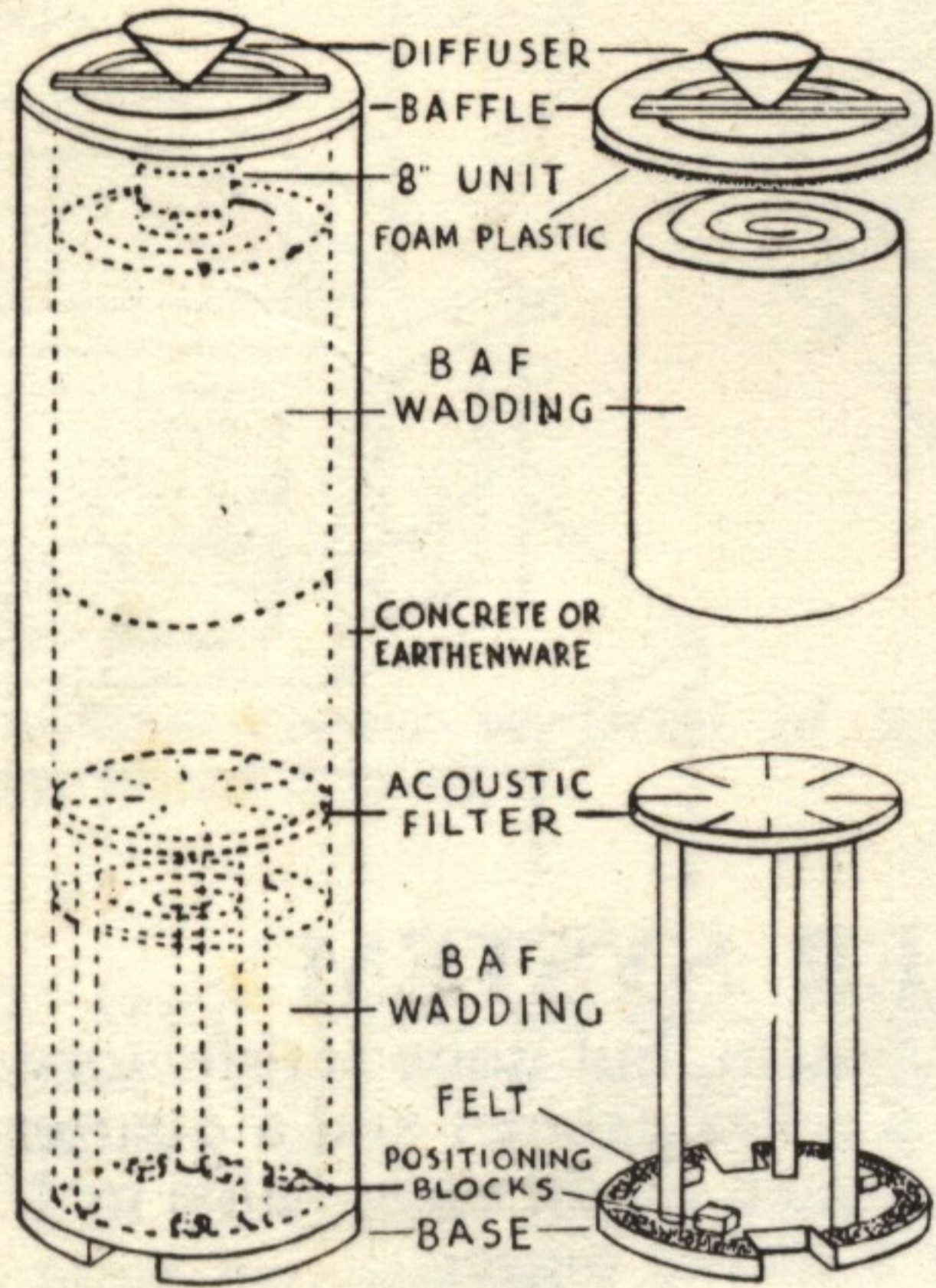
Wharfedale

(Regd. Trade Mark)

FIG. R12 CIRCULAR COLUMN for 8" UNITS



UNITS: Any good 8" type. For optimum results the Super 8/RS/DD would be the best choice.



Cheaper, lighter, smaller and easier to install than a column built of concrete blocks, this model is movable but results are not quite so good. The pipe costs about 12/6 from builders' merchants. The acoustic filter and two rolls of wadding are essential to counteract the small volume and circular shape.

Length of pipe 3 ft. Weight 106 lb. Diameter 9" inside, 11" outside. Internal volume 1.3 cu.ft. The pipe shown is in porous concrete and it was necessary to use some plaster on each end of the pipe in order to obtain a level surface for an airtight fit. (Plasticine could also be used for this purpose.) Pipes of glazed earthenware or spun concrete would require less treatment.

There is a circular baffle at the top with diffuser, and a wooden base with suitable vent openings. The underside of the baffle is fitted with a layer of foam plastic, and the circular base has a layer of felt on which the pipe rests.

FIG. R13 CIRCULAR COLUMN for 10" UNITS

This drain pipe costs about 25/- and gives excellent results with a suitable 10" unit and the same internal treatment as above.

Turned upside down, a 12" unit can be fitted, but this is not recommended as results are most unsatisfactory. (A large sewer pipe with 14" or 15" inside diameter would be the minimum size here.)

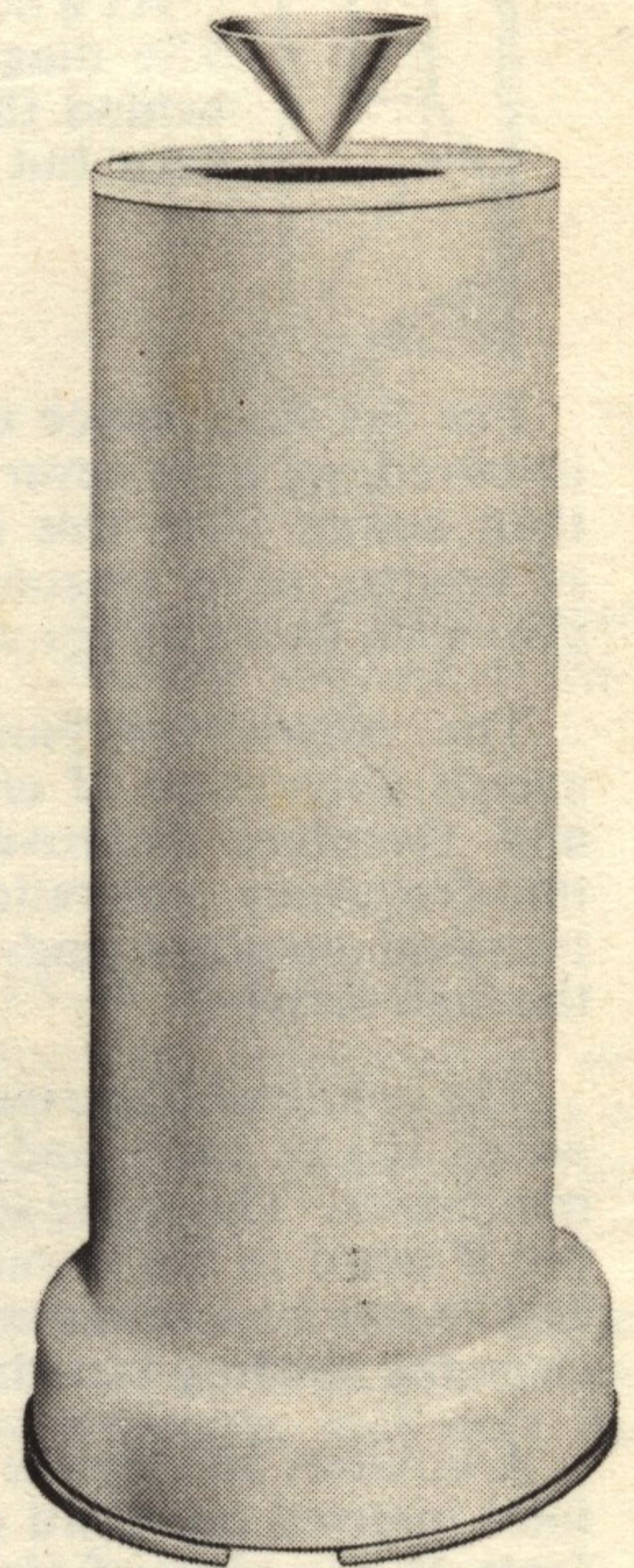
Length of pipe 3' 3". Weight 145 lb. Diameter 12" inside, 14½" outside. Internal volume 2.5 cu.ft.

UNITS: Any type of 10" unit can be used here, but for optimum results the new Super 10/RS/DD or Golden 10/RS/DD would be recommended.

COST OF COMPONENTS

We do not supply the pipe, but the other components are available as follows:

	8" Type			10" Type		
	£	s.	d.	£	s.	d.
Wooden base, acoustic filter, circular baffle and strut for diffuser	4	0	0	4	12	0
Two rolls of B.A.F. wadding		12	6	1	2	6
Aluminium Diffuser		7	6	10	6	
	£5	0	0	£6	5	0



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