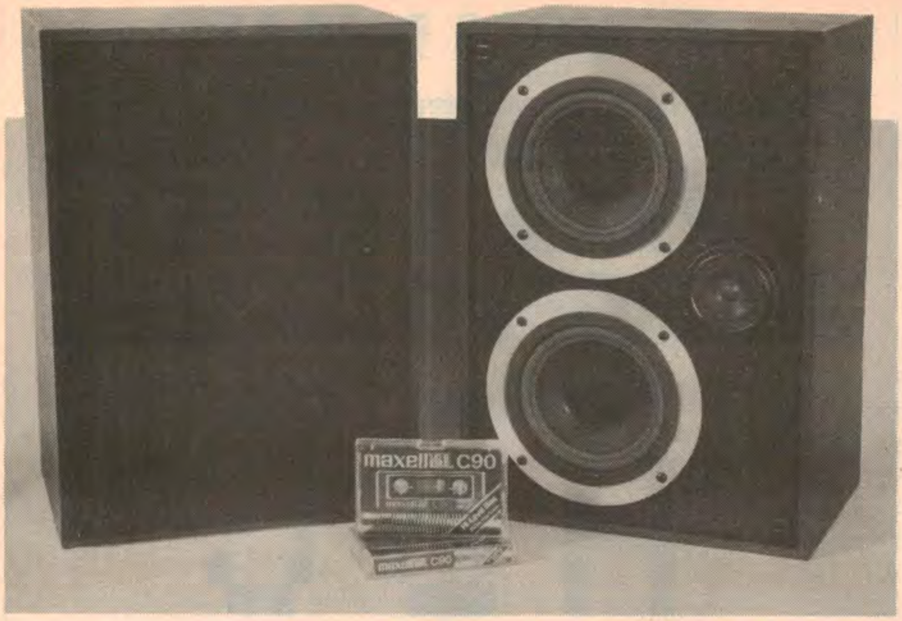

The prototype Playmaster 3-13L enclosures, with and without grille and compared in size to a compact cassette. At the top is the woofer-thru mid-range driver and, below it, the passive radiator. To the right is the tweeter, crossing over at 1500Hz: three cones and a cubic content of just over 13 litres. Dimensional and constructional details are shown on the facing page.

by NEVILLE WILLIAMS

A BIG SOUND FROM TWO SMALL ENCLOSURES

So you are pushed for space, with no room to stand large loudspeaker enclosures? But you still want big sound, be it for jazz, orchestral or classical organ? Then read on: this brand new build-it-yourself Playmaster loudspeaker system may be the solution to your problem — without costing you a fortune! We've called it the Playmaster 3-13L.

What immediately impresses about the new system is its modest overall size: in round terms 390mm x 270mm x 195mm or 15 x 11 x 7½ inches. As such, a pair of 3-13Ls can rest easily on a mantel shelf or book shelf, or be attached directly to a wall or partition.

But, despite their modest dimensions — and their modest weight — the new 3-13Ls can produce agreeably big sound, with rumbling bass and crisp transients. During some of our listening tests, we had them standing on top of a couple of full-size enclosures and it was hard to believe that the small systems alone were making all the noise!

How were they being driven? We'll get around to that a little later.

The new Playmaster 3-13Ls are the outcome of an approach made to us, a few weeks back, by the Australian manufacturers of ETONE loudspeakers. In recent years, the company has built up quite a connection in the field of public address and music loudspeakers, as well as supplying local drivers for big-name imported music systems. However, they have been keen to diversify into the Australian do-it-yourself hifi market.

This is understandable, considering the huge numbers of systems which are assembled by local hobbyists every year. Topping the list easily is the still-current Playmaster 3-75L, followed by its smaller counterparts, the 3-53L and the 3-26L — the figure in each case indicating the approximate internal volume of the enclosure in litres.

These still-current systems are based on imported drivers and cross-over networks, all so solidly entrenched and so economically priced that it seemed pointless to encourage a local manufacturer to mount a head-on challenge. Well then, was there some other approach that would be worth looking at?

Yes there was: a system that would meet the needs of music lovers who want big, full-range sound from even smaller enclosures. Such systems are available from specialist hifi dealers — at a price — but they are not represented, to any extent, on the do-it-yourself market. Perhaps it's not surprising.

The fact is that there is far more to producing a full-range compact system than merely scaling down a successful large one. The usual result of such an approach is an equivalent scaling down in performance, particularly at the bass end, with a severe reduction in bandwidth and power handling, and a sharp increase in distortion at anything but a very modest level. It can be very disappointing indeed.

If one is to obtain good bass response and a good power handling capability from a compact enclosure, it is essential to treat it as a distinct exercise — and one logically based on work on vented systems done right here in Australia by Thiele and Small. Cutting across decades of guesswork and folklore, the two aforesaid engineers have set down firm relationships between bass driver parameters, enclosure volume, system efficiency and bass roll-off. Results using their methods are predictable and reliable.

Amongst other things, they pointed up the weakness of starting with an off-the-shelf driver and then hopefully trying to devise an enclosure to suit it. Failure to understand the attendant problems, in past years, has largely been responsible for vented systems being dubbed "boom boxes".

They needn't be and shouldn't be!

The proper approach is to make an

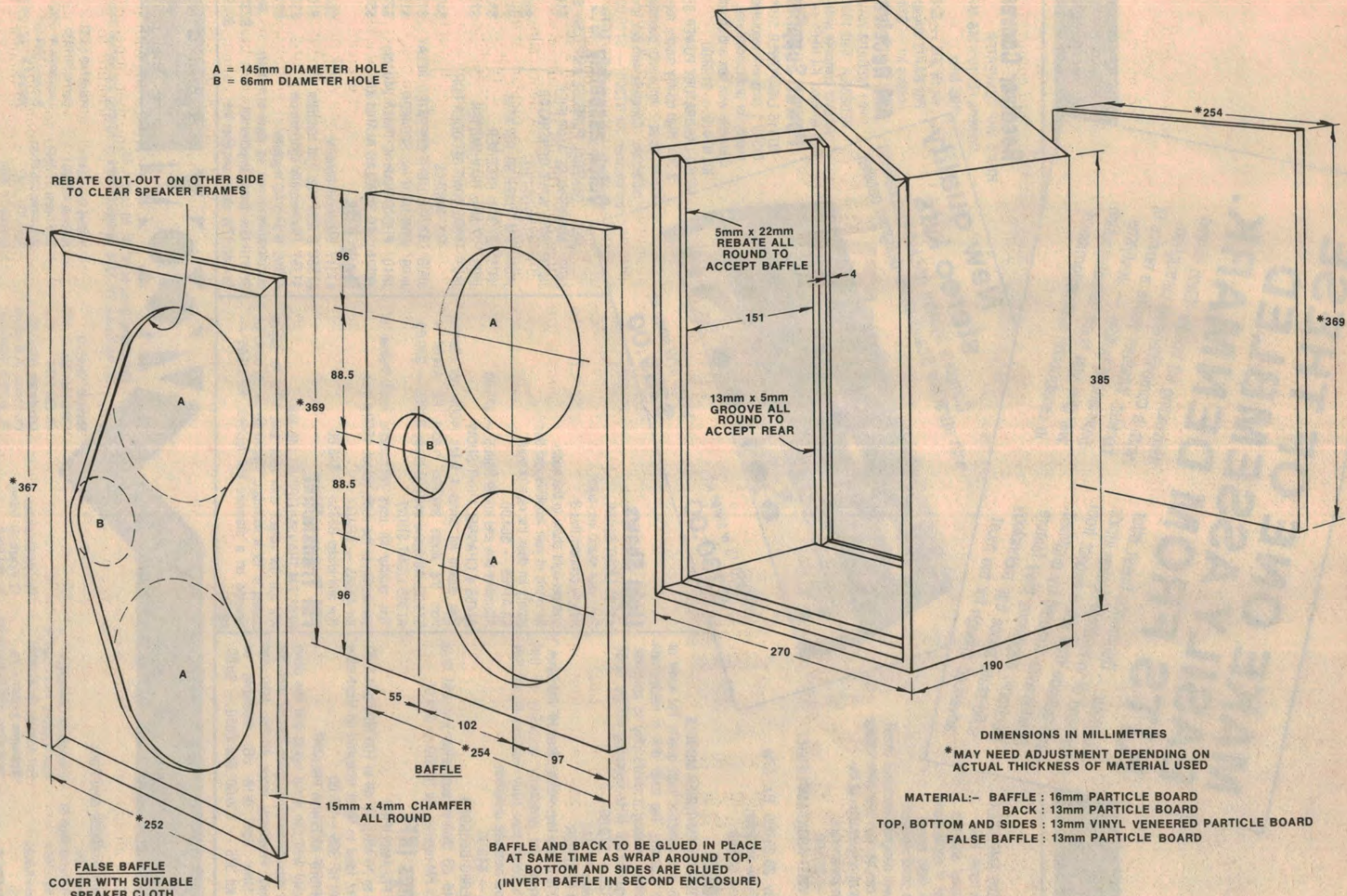

FIG. 1 EA PLAYMASTER 3-13L LOUDSPEAKER SYSTEM

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initial decision about the desired bass roll-off and the permissible enclosure size, and then to work forward to the type of driver that will be necessary to complement the stated requirements. If the driver parameters turn out to be impractical for one reason or another, you modify the requirements and try again.

And that is where we started with Etone engineer Nick Kay. Knowing that many commercial compact systems roll off around 80Hz, we suggested that the "corner" frequency (-3dB) should be at 50Hz or below. This should ensure good, foundational bass, particularly as the system would be further assisted, in a listening situation, by the proximity of walls, etc.

As a further requirement, we wanted an enclosure considerably smaller than for the existing 3-26L, and certainly well below 20 litres. We would accept the Thiele/Small dictum that acoustic efficiency would have to be sacrificed to reconcile small size and extended bandwidth. After all, we were after a special-purpose system and if it needed a few more watts to drive it, that should not be too great a problem these days.

Etone's first response was an on-paper design which involved a specially made 6-inch woofer and a matching enclosure having a large port formed by a partial shelf across the lower end. We didn't like it very much, partly because of the volume added by the port, and partly because it would not lend itself to simple fold-around enclosure assembly. Why not a conventional port tube, of more modest dimensions?

Unfortunately, that seemed not to meet the requirements of the Thiele/Small formulas, relative to the driver/enclosure combination envisaged.

Out of the seeming impasse came the suggestion to use a passive radiator instead. In essence, this usually involves the housing and cone of a woofer, minus magnet and voice coil, mounted in a second hole in the baffle. It serves the purpose of a vent or port, except that the mass and springiness of a physical cone assembly substitutes for that of the air within a port.

We liked the idea immediately. It would conserve space, allow a simple cabinet structure to be retained, and offer the visual advantage of an extra (and very active) cone. And this is what we settled for, after the appropriate amount of calculation and experiment. The bass driver would be a specially designed unit, to be designated Etone type 608; it would be mated with a passive radiator type 600 and accommodated in an enclosure with a volume in the range 13 to 14 litres — half the size of the 3-26L! Estimated corner frequency would be 50Hz, as originally envisaged.

Although illustrating a somewhat larger enclosure, the diagram emphasises the extreme simplicity of the fold-around method of construction.

So much the bass end.

Consideration of the 608 cone assembly suggested that it should not be expected to perform too high up and a crossover at about 1500Hz was indicated — meaning that the tweeter had to operate down to at least this region. This tended to rule out the usual dome tweeter, unless we were prepared to specify an accurate high-slope filter or trap to counter possible tweeter resonance around 800-1000Hz.

Rather than get involved in an exercise that would have added markedly to the cost of a stereo pair, we settled for an Etone cone tweeter type NT2FS and a straightforward crossover network giving a nominal 6db/octave roll-off for the woofer and a nominal 12dB/octave roll-off for the tweeter.

Circuit details of the crossover network. The capacitors shown are non-polarised electrolytics. Note speaker polarity, involving a plus sign or a red dot.

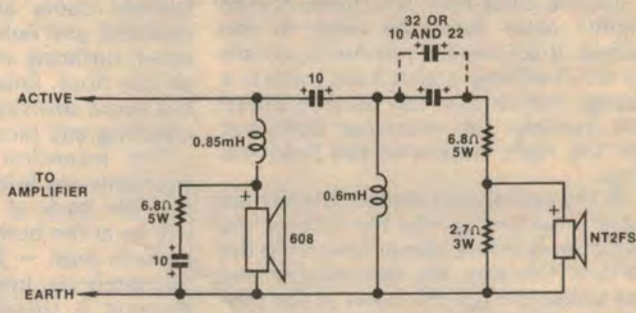

FIG. 2

When the units were actually interconnected, it became immediately obvious that the output from the tweeter would have to be reduced drastically to match that of the woofer. In fact, it is fed from the active line through 6.8 ohms and shunted by 2.7 ohms, giving a loss of about 13dB.

Even allowing that the tweeter may be more than usually sensitive, the figure does indicate the kind of sacrifice that must be made in woofer sensitivity, in the interest of bigger bass from smaller enclosures. The fact is that most modern enclosures trade sensitivity for bass response, on the grounds that adequate drive power is available from modern solid-state hifi amplifiers.

What does this mean in practice?

In a typical,not-too-noisy home situation, a pair of 3-13L enclosures will provide adequate, even loud volume when driven by an amplifier delivering a genuine 20 + 20 watts on program material.

If you want to "show off" a bit and/or turn up the bass a notch or two, then a twin-40W or a twin-50W rating would be more appropriate. In fact, it should meet all ordinary requirements for domestic listening.

But for the "big" sound we spoke about earlier, go for an amplifier in the twin-70W to twin-80W grouping. That would be about their limit, running with the bass and treble controls set for "level". With drive of this order, compact systems like the 3-13L will not cope with artificially boosted bass — nor will they cope with spurious cone excursions caused by turntable rumble or eccentric grooves.

What if you don't have even a 20+20W amplifier? Well, the options are fairly straightforward:

- Build the 3-13L and settle for wide-range listening at a very modest level;
- Search out a compact loudspeaker system that emphasises sensitivity rather than bass response. Drivers in low-cost radiograms usually exhibit this approach.
- Settle for a larger loudspeaker system which may well combine adequate bass with higher sensitivity. The Playmaster 3-26L, for example, offers 3dB higher sensitivity, equivalent to a 2:1 increase in amplifier power output. The 3-53L and the 3-75L are somewhat more sensitive again.

The prototype enclosures which appear in the lead photograph were produced for us by H.S.C. Timber Industries Pty Ltd, of 25 Pritchard Place, Peakhurst, NSW 2210. (Phone 02 534 1746). They have a simulated wood finish, a black lacquered baffle face and a removeable grille of black open weave fabric stretched over a particle board frame.

The dimensions shown in the drawing of Fig. 1 were taken off the

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prototypes and should be representative, in that they were selected by a cabinet manufacturer to ensure economical use of particle board sheets.

We envisage, however, that 3-13L enclosures will be handled by various suppliers throughout Australia and New Zealand, in both kit form and built up. They will doubtless be produced by various cabinet makers, with their own ideas about details and finishes. We would not want to prejudice their discretion but certain points must be stressed:

- Panel sizes may be varied slightly to suit available materials but the internal volume of the enclosure must not be reduced below the 13.2 litres provided for in our drawing. Equally, it should not exceed 14 litres.
- Materials should not be lighter than specified. The construction must be rigid, airtight and rattle-free, with the drivers held snugly and securely against the baffle face.
- The drivers, passive radiator and crossover network must be as specified.

And here a further word about the loudspeaker mounting arrangements:

Assuming the baffle is of particle board, use screws which are of no heavier gauge than necessary, and drill a suitable pilot hole for them, angled slightly away from the edge of the cutout. If screws are too heavy, or are driven in without a pilot hole, there is a strong chance that the particle board will crumble. Nip them just tight, but not too tight, otherwise the hole will strip.

In the prototype cabinets, the drivers were mounted against the face of the baffle, protruding about 5mm from the surface. This way, the mounting screws can utilise the full thickness of the particle board to hold the drivers firmly in place. However, it does mean that a frame grille must be used to keep the cloth clear of the cones.

Alternatively, some manufacturers may choose to recess the baffle to accommodate the drivers flush with the surface. This permits the use of a foam grille but it can also reduce drastically the thickness of material available to the mounting screws. In such a case, it may be desirable to mount at least the main driver with bolts and nuts, using access through the passive radiator hole to secure them. Better still, cement nuts on the rear side of the baffle, so that bolts can be used for all three.

However mounted, it is absolutely essential to provide some kind of a gasket between the speaker frames and the baffle surface to ensure a continuous airtight seal. Air leaks produce

Plan ahead so that the join will be out of sight when each cabinet is placed in position on a shelf.

a dissipative energy loss, which can defeat the whole function of the passive radiator. No matter how good it looks, surface/surface contact between drivers and baffle is not reliable.

As on past occasions, we used Engels 5C adhesive-backed foam strip, sold by hardware merchants as a draught excluder. Alternatives are adhesive backed felt, or resort to non-hardening caulking compound, or a liquid silicone rubber.

Such details aside, it is likely that all kits will be presented and assembled in much the same way. The sides, top and bottom come already cut and pre-grooved, and held together only by the other surfacing material. Lay them flat on the floor, finished side downwards, but avoid stressing or flexing the outer covering any more than necessary.

The intention is that, when the segments are folded around the baffle and the back of the cabinet, the join will be at the bottom — or where it will be seen least — when the enclosure is ultimately put into use. That is why our drawing is shown upside-down, with the bottom flap yet to be closed.

If the enclosure is to be used in an upright position, plan to have the main driver at the top and the tweeters to the outside (in the case of a mirror pair) so as to gain as much separation as possible. If to be used on its side, have the tweeter towards the top and the main drivers to the outside. On this basis, plan how the baffle and back are to fit.

We would recommend that most of the inside surfaces of the enclosure be padded with ordinary Innerbond, of nominal thickness about 2cm. A piece measuring 1m x 0.5m cut into strips 1m x 45cm, would just about cover the sides, top and bottom of each enclosure, with a couple of strips left over to attach to the back, clear of where the divider network will sit.

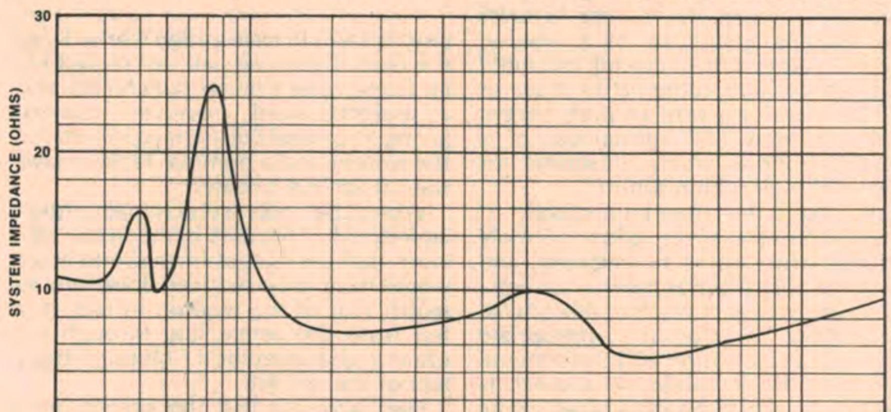
Attach the Innerbond securely to the relevant surfaces with thumb-tacks before the enclosure is folded up. It must not be stuffed into the box as an afterthought, as it would then become space filling.

When all is ready, run PVC glue ("Aquadhere" etc) into all V-grooves and slots and smear it to wet all the mating surfaces. Also wet the edges of the baffle and back plate. Slip them lightly into position and carefully fold the sides and bottom up around them, bumping them into position with the ball of the hand. With the final joint firmly closed, hold it tight with straps of adhesive tape and leave overnight.

Before proceeding further, carefully examine the enclosures to ensure that the glue has filled and sealed all corners and joints. If you detect a possible leak, prop up the cabinet as necessary, run glue into the space and leave to harden long enough to ensure that it will stay put.

Also check the output terminal arrangement. Provide a gasket if a plate or fitting is involved and seal any other possible leaks with caulking.

This done, the crossover network can be attached to the inside rear of the cabinet, working through the aperture for the passive radiator. Attach the leads to the respective drivers, and to



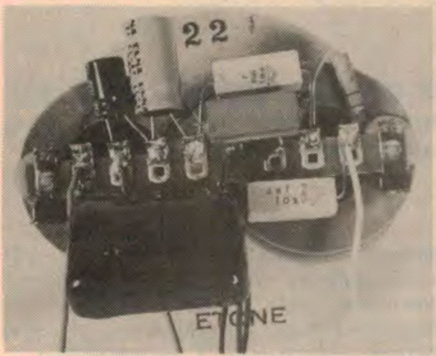
The impedance V frequency curve of the 3-13L. It falls below the nominal 8 ohm figure in some areas but not enough to be unusual. Note the double-hump centred around 50Hz — characteristic of a vented (or passive radiator) system.

the output terminals, making sure to observe polarities, as marked. Then screw the drivers and passive radiators into place, and the job is done.

As an alternative to the above, the enclosures could be hand-made using particle board, cleats, pins and glue. Use the diagram as a general guide to dimensions but make due allowance for the volume occupied by internal cleats.

Finally, a few words about the crossover network, originally designed by Etone and subsequently adapted for the 3-13L system. The circuit is shown in Fig. 2.

The woofer is fed through a simple 0.85mH inductor intended to produce a



The prototype crossover network, assembled on a disc of particle board. The 10uF polystyrene capacitor in the foreground would normally be an electrolytic.

roll-off through -3dB at 1500Hz. To make the woofer look like an 8-ohm resistor and secure the desired roll-off, an R/C network is shunted across it, as shown.

The network feeding the tweeter is more complex, being designed to give a 12dB/octave roll-off below the crossover, while also reducing the effective tweeter output. The resistor ratings may seem modest, in the light of the drive power figures mentioned earlier, but past experience with domestic speakers indicates that they should be adequate for program type signals.

Normally, the divider networks will come as part of the loudspeaker kit package but, if you have a special reason to do so, it should be practical to build your own. The inductors could be wound on a non-metallic bobbin made up from a scrap of broom handle (25mm dia, 20mm long) fitted with two cheeks (50mm dia) made from plywood or Masonite. For 0.85mH wind on 189 turns of 18B&S gauge wire or 19SWG enamelled wire. For 0.6mH, you will need 152 turns of the same gauge.

THE COST

At the time of writing, the 3-13L has not been costed by kit suppliers. However, it seems likely that the price for complete system kits will be in the region of $150-$170 per pair.