Simulated Quadraphonic

As yet, very few audio enthusiasts have had the chance to listen at length, and in their own homes, to four-channel or "quadraphonic" sound. It is possible, however, to obtain a pseudo four-channel effect from ordinary stereo equipment. It's a fake but it's fun!

By NEVILLE WILLIAMS

But, first, why use the word "quadraphonic" when, to date, we seem to have preferred quadrasonic? Simply because quadraphonic appeals as the more logical choice, in view of the wide use of "monophonic" and "stereophonic".

The basic idea of quadraphonic sound has been explained at some length in earlier issues. It requires four distinct channels of audio information, four amplifiers and four loudspeakers; the loudspeakers are usually placed, one in each corner of the listening room.

One basic approach to quadraphonic reproduction is to use the two front loudspeakers, as in an ordinary stereo system, to recreate the sound pattern of the orchestra and artists on stage. The two loudspeakers behind the listening position recreate the sound "ambience" which the listener might be aware of in a typical auditorium. This would include reflections from the sides and rear of the auditorium and, perhaps, the sounds of a live audience. See figure 1.

The other main approach is to use the four channels and the four loudspeakers to project the sound of the performers towards the listener from any desired direction, at any instant, at the whim of the producer and/or recording engineer. This is commonly referred to as a "gimmick" application but it can be quite startling and very effective for some program material.

It remains to be seen whether quadraphonic reroduction will gain large-scale acceptance in the home situation and, if so, whether the ambience (or "purist") concept will be dominant or the gimmick application. If stereo provides any precedent, both will be exploited.

But these trends will only emerge – if at all – according to public reaction and the availability of genuine quadraphonic program material, whether in the form of four-track tape or specially encoded discs or radio transmissions. The public cannot react to genuine quadraphonic reproduction while the only commonly available program material is two-track stereo.

But "cannot" is a provocative word to an audio enthusiast, as evidenced by the fact that, during the past month, we discovered three members of our staff (including the author) all independently experimenting to see what kind of a pseudo four-channel effect could be obtained from their domestic stereo system. This article is largely the outcome of these experiments and observations.

It is appropriate to remark that none of those so involved was basically dissatisfied with their existing stereo equipment. In each case, the system was doing the job it was supposed to do – recreating a sound image spread across the loudspeaker end of the listening room, as in figure 2.

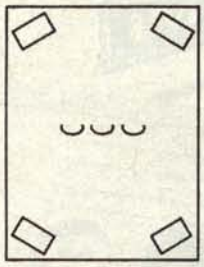

Figure 1

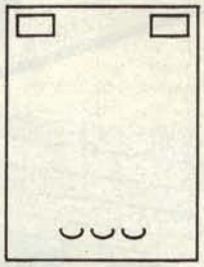

Figure 2

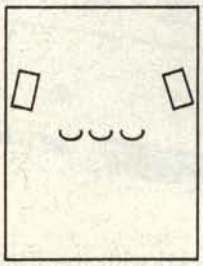

Figure 3

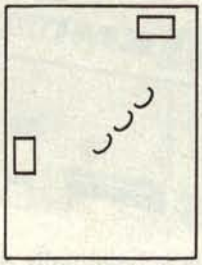

Figure 4

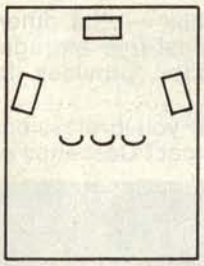

Figure 5

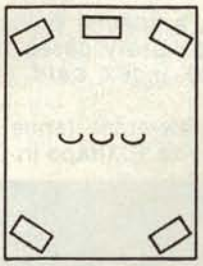

Figure 6

But, having achieved good frontal spread of the sound source, there remained the challenge awakened by all the talk about quadraphonic sound: Was some extension of the stereo system possible, such that an illusion of ambience, or even an illusion of four-channel gimmickry could be achieved? In other words, what about the rear of the listening room which contributed little more than an acoustically blank wall?

For almost as many years as there has been stereo in the home, it has been argued that, to surround himself with sound, the listener first has to get away from the traditional arrangement of having the loudspeakers at one end of the room and the listening position at the other. Arrangements which have been suggested are shown in figures 3 and 4.

Such arrangements will certainly tend to surround the listener with sound but they produce two fairly obvious problems. The first is that the listener is no longer seated effectively in the audience but on centre front-stage, with the instruments and/or performers seemingly arranged on either side of the listening position. This is certainly not acceptable to those who like to hear an orchestra as an entity in front of the listening position.

The second major problem is that, with more than one person in the listening group, relaxing in high-backed and padded chairs, each listener will tend to hear most sound from the loudspeaker on his own side of the room.

Installing a third (central) loudspeaker, fed with the sum of the left and right signals, tends to improve matters somewhat but still leaves the situation where the orchestra is spread unnaturally in respect to the listening position. This arrangement is illustrated in figure 5.

What of the arrangement in figure 6? Here the main stereo pair, possibly aided by a centre "sum" loudspeaker, are ranged along one wall of the listening room and recreate the main sound image. Another stereo pair, presumably operating at a lower level, are placed in the rear corners behind the listening position. They are simply fed with the same signals (though probably attenuated) as the main stereo pair.

This arrangement can offer very little, unless aided by some fortuitous accident of listening room acoustics. If the rear loudspeakers are kept at a low level, they are swamped by the front loudspeakers. If operated at a higher level, they may simply blur the stereo image or, at worst, dominate the distribution so that the sound seems to be coming from behind, rather than in front of the listening postion.

It emerges, as virtually a fundamental requirement, that the sound emanating from the rear loudspeakers be different from that heard from main system. The rear sound must have a characteristic of its own and, hopefully, should add to the total pleasure of listening.

In seeking a "different" sound, one possibility is to feed the rear loudspeakers with signals which have been passed through a reverberation unit and a separate power amplifier, as is common with electronic organs. In practice, however, this kind of reverberation has never found much acceptance in conjunction with high fidelity sound reproducing systems and it seems doubtful that it will do so now, as a means of simulating quadraphonic effects.

It so happens, however, that a signal can

be derived from an ordinary stereo system which will at least fulfill the elementary requirement of being different from the signals utilised by the main loudspeaker system. It corresponds simply to the difference between the two stereo signals – a quantity which, to date, has been regarded as purely incidental to the operation of the system. Let's examine this idea more closely:

A normal stereo system provides and uses two distinct signals, one for the "L" or left-hand channel and one for the "R" or right-hand channel. When components of the two signals are in phase and are heard together in a symmetrical system (as in figure 2) they create the illusion that sound is coming from the space between the two loudspeakers. Thus a typical stereo system uses sound stimuli based primarily on "L" signals for the left-hand side, "R" signals for the right-hand side, and in-phase ("L+R") components to fill in the centre.

Some have questioned whether the subjective L+R effect is adequate with some program material or in some listening situations and have added a centre loudspeaker fed with an actual L+R signal. In some cases, they have picked up the signal by suitable connection to the outputs of the L and R power amplifiers. In other cases they have used a separate power amplifier fed with a mixture of the two signals, obtained through a resistive pad.

However, whether the centre stage area is filled in subjectively, or with the aid of an extra loudspeaker, the basic idea is unaffected: conventional "up-front" stereo depends on L, R and L+R information.

No use is normally made of the difference between the L and R signals and none was envisaged until recently. But the fact remains that there must be a difference between two dissimilar signals and, by suitable interconnection or sampling, a signal can be derived which is equal to the difference between L and R. This might be written down as L-R or R-L.

Mathematically, it might seem necessary to differentiate between these two quantities but, acoustically, the difference is largely one of phase; this, it may be argued, is unimportant in this context. Thus changing the phase of L-R turns it into -L+R, which is the same as R-L. We may care to argue about this but it does not affect the basic concept.

So the idea emerges: Having discovered a "different" and unused signal in a two-channel stereo recording, can it be used to good effect to drive one or more loudspeakers placed behind the listening position? Can it double for ambience? Can it provide a source for quadraphonic gimmickry?

First reaction may well be that the difference signal has no possible value or significance. It would appear to be a purely incidental – and accidental – component that would produce little more than a "noise".

In fact, it is possible to advance a case for regarding it more optimistically, at least where the recording has been made using a classic 45/45 stereo microphone.

The reasoning follows along this line:

Even though the stereo microphone is facing forward, directed obliquely towards the respective sections of the orchestra, the microphone is not completely deaf to sounds from other directions. It will respond to the general ambience and produce a resultant signal which is recorded along with the signal from the orchestra.

When the recording is ultimately reproduced, this ambience (echoes and audience noise) is actually heard along with the main signal. However, in a normal stereo system, it is largely swamped by the main signal and what of it is heard appears to be coming from the wrong direction; from in front of the listener rather than from around and behind.

The contention is that, if the L and R signals are mixed out of phase, there will be a substantial order of cancellation in the components which represent sound coming from the centre-stage area, as well as in the low frequency components originating over a still wider angle. There will, on the other hand, be very little cancellation in the ambience signals which energise the respective elements of the microphone from the entire side areas of the auditorium.

On this assumption, the ratio of ambience to original signal in the L-R (or R-L) component is much greater than that in the L+R component. What is more, the ambience component is not just random or accidental noise. Predominantly, it represents signal components created by reverberation and audience noise. In short, it is the very quantity we have been looking for and which has been assumed lost for all time!

The reasoning is that, if this can be presented behind the listening position in a suitable manner, it will simulate auditorium ambience to a useful degree.

Figure 7 represents a hook-up, which seeks to take advantage of this effect, and which has been publicised by David Hafler, president of Dynaco. Signals from the respective amplifiers are fed to the L and R stereo loudspeakers, as for a normal stereo system.

However, a third loudspeaker, wired between the two amplifier active terminals is energised only by the difference signal. This is placed behind the listening position, as shown. It must be assumed that it will be so placed in respect to the listening position and adjusted to such a level that it will produce the desired ambience effect. To permit such adjustment, a constant impedance pad is suggested between the amplifiers and the third loudspeaker.

If the layout of the room is such that there is a danger of a "hole-in-the-middle" effect, a fourth loudspeaker can be added, as shown in figure 8.

Reports from overseas would seem to indicate that a lot of hi-fi enthusiasts have credited one or other of these approaches with adding a new dimension to their sound reproduction.

However, there is little doubt that such a system would be heard to best advantage in large listening rooms, where the rear loudspeaker could be placed well back from the audience, or high above their heads. In such a room, further assistance would be forthcoming from natural reverberation.

Not all, however, are likely to be blessed with rooms of these dimensions and the placement of a rear loudspeaker relative to the audience could be a problem. It would too easily be heard as a point source of sound, reproducing a mixture of ambience and of non-cancelled signal, belonging predominantly to one channel or the other. This last remark will be explained at greater length a little later.

Figure 9 illustrates what is probably the most widely applicable arrangement.

The two existing stereo loudspeakers occupy their normal positions and are connected, again as normal, to the respective stereo amplifier channels. They reproduce the direct "on-stage" sound.

Two other loudspeakers occupy the "rear" corners of the listening room. They may typically be of similar impedance to the main loudspeakers, although higher impedance loudspeakers could be used. They are, however, connected in series and out of phase, being fed with the "difference" signal picked up from the two active amplifier outputs.

Being in series, and therefore presenting a higher total impedance than the main loudspeakers, those at the rear will absorb (and therefore deliver) less power than those at the front. This is in line with normal requirements and reduces dependence on attenuator pads. Further, by keeping the impedance of the extra loudspeakers as high as possible, loading problems on the power amplifiers will be minimised.

Being located in the corners, the rear loudspeakers can be kept a little more remote from the listening position and, being out of phase, they will tend to produce a more diffuse sound.

HAFLER/DYNACO SYSTEM

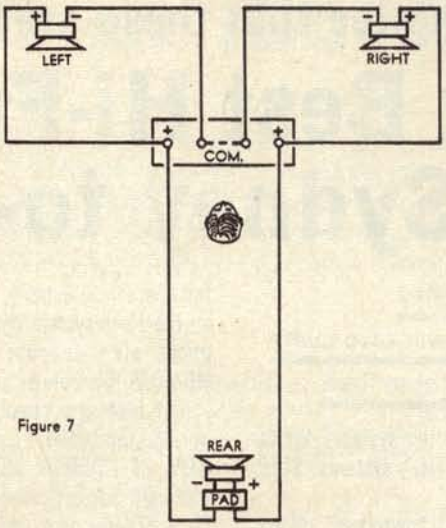

Figure 7

Simulated ambience provided by one loudspeaker behind the listener, with a constant-impedance pad to control output.

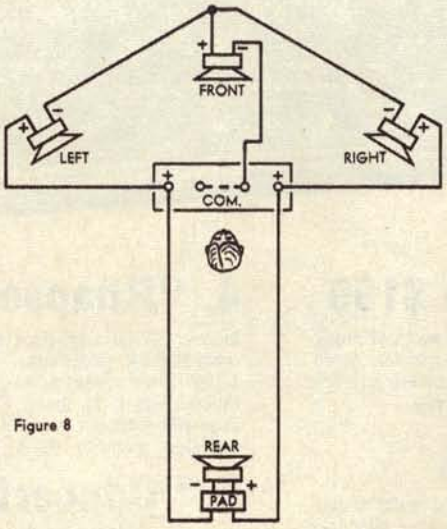

Figure 8

Similar in principle to the setup shown above, this uses a centre loudspeaker to reinforce the up-front image and widely splayed side loudspeakers to increase spread.

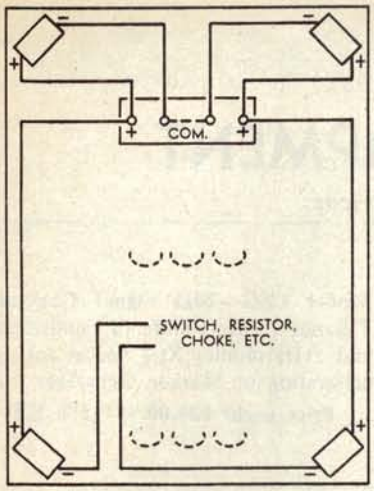

Figure 9

The system which formed the basis for our own experiments. As explained in the text, the position of the seating and the size and position of the rear loudspeakers would be governed by the size of the listening room.

To set up this kind of system, the loudspeakers should be arranged and connected as shown. Now play a mono record and have someone gently rotate the balance control while you listen to one of the rear loudspeakers. With the balance control somewhere near the centre position, it should be possible to observe an almost complete null, where very little signal is heard from the rear loudspeakers. This is the condition, in fact, where there is no difference signal.

Whether or not a complete null is achieved will depend on the frequency balance between the two halves of the stereo cartridge and the symmetry of the compensation and tone control circuitry in the two halves of the amplifier.

And whether such a null position corresponds to balance between the front loudspeakers will depend, in turn, on the symmetry of the main loudspeakers and their acoustic environment.

If one is going to be highly critical and demand a complete null in the rear loudspeakers, coincident with perfect balance from the front, a more elaborate system may have to be envisaged. This has led to suggestions overseas for a special unit which derives its signal from as early as possible in the stereo chain, reverses the phase of one channel, mixes the two channels and delivers a difference signal to an entirely separate power amplifier driving the ambience loudspeaker(s).

To date our zeal has not stretched this far and our reaction is that the simpler approach should give results to satisfy most listeners.

Unless there is a gross lack of symmetry somewhere in the system, it should be possible to set it up so that, with a mono record on the turntable, all the sound will appear to be coming from between the stereo pair in front, with vitually no sound from the rear. At least, this is the objective.

Before seeking to evaluate the behaviour of the system with a stereo record, extend the link between the two rear loudspeakers so that the circuit can be opened or closed from the listening position. Use a switch if you want to, but it will suffice simply to touch the leads together. This makes it easy, also, to close the circuit through a resistor, so that the level in the rear loudspeakers can be varied and observed.

For a first test on stereo, select a record of orchestral music which has even spread and which (hopefully) has been recorded with a central stereo microphone. A classical or semi-classical recording from the EMI stable would be a fair bet. Now settle down to listen.

The situation is reminiscent of a slogan once used by a popular sandwich spread: "Too much spoils the flavour".

Excessive output from the rear loudspeakers will have massed strings seemingly playing from the rear. Bringing the loudspeakers into operation will make the orchestra seem to jump towards you and stereo definition will largely be lost.

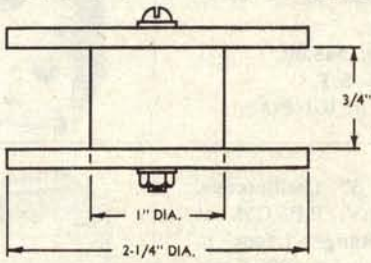

Figure 10

A typical bobbin for loudspeaker chokes, made from non-metallic oddments and held together (preferably) with a brass bolt. See text for suggestions in regard to the winding.

If this happens, move your chair forward. Or turn the rear loudspeakers around so that they are facing into the corners. Or use a series resistor in the connecting lead to reduce their output. What you should aim for, with this kind of record, is a gentle whisper of sound from the rear to enliven an otherwise dead area.

However, you will probably find that ANY sound from the rear will tend to cloud the stereo image from the front, and some enthusiasts have got "hung up" on this.

If clarity of the stereo image is the main criterion by which you judge a stereo system, then additional sound from the rear is possibly not for you. A favourable reaction to simulated quadrophonic will necessarily be based on an overall evaluation, where some element of "presence" in the otherwise dead corners of the room is judged to be a worthwhile gain, considered against some loss in frontal stereo definition.

Now try a record more in the "ping-pong" style, with sounds emanating from strongly defined zones from centre to the respective sides. You will find that gimmick stereo comes very close to gimmick quadraphonic. Centre front sounds stay where they are; sounds from either side may tend randomly to jump to the back of the room, depending on the relative levels and the exact listening position.

Sometimes the effect will be less than successful. A singer wandering from centre-stage to one wing may suddenly pop up behind you!

The best approach, really, is to listen to a selection of records, with the wiring to the rear loudspeakers still accessible in the listening position. Try to settle on a level which will give the best overall effects. If desired, a switch and/or a control could be retained so that the simulated quadraphonic could be disabled or adjusted at any time, according to requirements.

But what about the expense of the extra loudspeakers? What about the problems of locating them in a small listening room where the audience has to be seated close to the rear wall?

This may, in fact, be the most common situation.

In such a case, the extra loudspeakers will almost certainly have to be mounted high up in the rear corners of the listening room. In such a position, large loudspeakers would be an eyesore and it may be necessary to

consider small, cheap loudspeakers, in boxes that will be large enough to house them but not large enough to provide an adequate enclosure in the acoustic sense.

Would such loudspeakers be worth considering?

The answer, fortunately, is "yes".

One reason for this is that, with the majority of records, the heavy bass is common to both channels, and therefore subject to heavy cancellation in the difference signal. What bass component there is, need only be reproduced at lower level along with the rest of the difference signal, and is shared by two loudspeakers, anyway.

It is reasonable to suggest, therefore, that the extra loudspeakers can be of modest variety. Our advice, therefore is to use single-cone loudspeakers, with modest top response and a fairly low natural bass resonance. Low frequency speakers intended for use in compact systems would appear to be very suitable. They would have favourable bass characteristics, limited high frequency response and modest sensitivity, which would help to keep their acoustic output down.

In the writer's experimental set-up the high frequencies still seemed a little too prominent on some records and a very simple corrective measure was found to produce the right results. In series with the interconnecting lead a choke was inserted, taken from a discarded loudspeaker divider network.

In some transistor amplifiers the loudspeaker terminals may be at a DC potential relative to chassis. Use two electrolytics as shown to act as a non-polarised blocking capacitance.

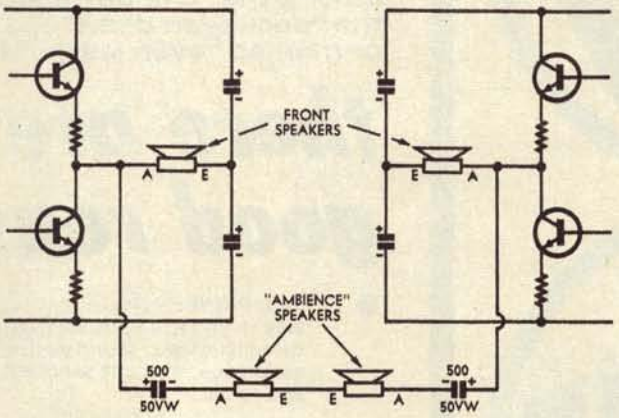

Figure 11

specifications, provided they are not so modest as to actually overload on typical signals. For a typical listening room, a couple of 5-inch or 6-inch loudspeakers would appear to be a reasonable choice.

How should they be baffled?

A fully enclosed box is probably not a good choice, because it would need to be quite large to avoid raising the bass resonance of the loudspeaker and producing a boom in the 150-200Hz region. A smallish, decorative box is therefore indicated, which will permit radiation from both sides of the cone. And, since ambience is being sought, this is not necessarily a bad thing.

How should these rear loudspeakers be phased in relation to the main units?

Argument here and overseas has produced two diametrically opposed viewpoints. One suggests that the cones should travel nominally in the same direction "so that the path between them should neither be stretched nor compressed". The other is that they should travel in opposite directions so that they will nominally "co-operate in compressing or rarefying the air in the room".

In fact, for the reasons stated, the rear loudspeakers will play little part at the bass end while, at other frequencies, phase relationships will be so random at the listening position that argument about phasing seems pointless. All we do suggest is that the rear loudspeakers be mounted as symmetrically as possible relative to the listening position and wired out of phase in respect to each other.

One more point should be made:

Since the difference signal will tend to contain a preponderance of higher frequency components, propagation of the difference signal into the room will have the effect of adding to the total high frequency signal present. It will give the illusion of treble boost.

The effect will be aggravated if the rear loudspeakers are of the wide-range twin-cone

The inductance required will vary in each case with the impedance of the rear loudspeakers, whether or not there is additional series resistance, the treble response of the loudspeakers and the amount of attenuation that is decided upon.

As a guide, we show the type of wooden former on which these indicators were customarily wound. Such a former will typically accept 200 turns of 18B&S or 19SWG gauge enamelled wire giving an inductance of about 1mH. If you can get hold of a small quantity of wire of about this gauge, a choke can be wound up and the number of turns manipulated by trial and error to give any desired treble attenuation. If you don't fancy winding and unwinding turns, with a little care, a few tappings can be brought out and the section used which gives the desired results.

Finally a work about the stereo amplifier. With a valve unit, the output terminals are almost invariably connected to the secondary of an output transformer, with one side grounded to chassis. There are no DC potentials to worry about and nothing drastic is likely to happen if you make a wrong connection. It is simply a matter of identifying the "earthy" or "minus" terminals and the two "active" terminals, and connecting as indicated.

With transistor amplifiers, the method of connection of the additional loudspeakers will vary, according to the configuration of the output stages. If the amplifier has balanced positive and negative supply lines or has a single output coupling capacitor in each channel, the method of connection will be the same as for valve amplifiers – the additional loudspeakers are simply strung between the "active" terminals of the existing loudspeakers.

If, however, the amplifier uses a capacitive divider network to couple the signal to the loudspeakers, the method of connection is

(continued on page 115)

LIBERACE PLAYS THE CLASSICS. Music for Pleasure stereo MFP-A8208.

Interest: Classical snippets.
Performance: With his usual flair.
Quality: Good.
Stereo: Normal.

While recognising that Liberace is not in the same class as Rubinstein, Horowitz and other great classical pianists, one can still appreciate that he is nevertheless a very competent keyboard performer, and that he has given millions of people a great deal of pleasure. Undoubtedly he has introduced a great many listeners to classical melodies which they might not otherwise have appreciated, and in thus broadening their musical horizons has performed them a service.

Here Liberace, with orchestral accompaniment elects to play 11 popular classical melodies, plus the pseudo classic "Intermezzo" from the film "Escape to Happiness". First movement from "Moonlight" Sonata (Beethoven) – Waltz of the Flowers (Tchaikowsky) – To a Wild Rose (MacDowell) – Contentedness (Schumann) – Lullaby (Brahms) – Melodies from "Unfinished" Symphony (Schubert) – The Swan (Saint-Saens) – Chant D'Amour (Stojowski) – Serenade (Schubert) – Andante Cantabile from Symphony No 5 (Tchaikowsky) – Child Falling Asleep (Schumann). The quality which all these pieces has in common is a fine melody, and the disc should give considerable pleasure to those who appreciate Liberace's brand of entertainment. The sound quality is satisfactory, with genuine stereo spread. (H.A.T.)

QUADRAPHONIC SOUND . . .

(continued from page 95.)

different, since the voice coils of the loudspeakers will be above chassis potential. This means that DC blocking capacitors must be connected in series with the additional loudspeaders to avoid creating a DC path between the two channels via the loudspeakers. The method of connection is shown in figure 11. Two 500uF/50VW electrolytic capacitors are connected in series with the additional loudspeakers so that together they form a non-polarised capacitor. There may or may not be a voltage across the network depending on the DC balance between the amplifiers.

If you are not certain as to what configuration is used in your solid state amplifier then you should either check the circuit diagram or measure the DC potential of the loudspeaker voice coils with respect to chassis of the amplifier. If it is zero, then the method of connection shown in figure 9 can be used. If not, use that shown in figure 11.

In this diagram, the loudspeaker connections have been marked "A" and "E" to avoid confusion with the voltage polarity markings in the circuit. The "A" (active or positive) end of the voice coil is usually designated with a red or green spot or washer; the "E" (neutral or negative) end is either designated with a black spot or left unmarked. The polarity of the electrolytic capacitors within the amplifier will, of course, depend on the polarity of the supply voltage and whether NPN or PNP output transistors are used.

The polarity of the electrolytic capacitors coupling to the "difference" loudspeakers is strictly not important, provided they are effectively in series, with like polarities together. However, it makes sense to connect them with positive to the amplifier, in the case of a positive supply rail, and negative to the amplifier in the case of a negative supply rail.

Some readers may wonder if the additional loudspeakers will not constitute an excessive load for their amplifier. Whether or not this is the case can be determined simply as follows: In the worst case, where the amplifier channels are delivering completely contrary and out-of-phase signals, the load on each channel will consist of the main loudspeaker and one ambience loudspeaker in parallel. Thus if four 16-ohm loudspeakers are used in a "quad" system the worst load presented to the amplifier will be 8 ohms in each channel. This is a good argument for using ambience loudspeakers with a higher impedance than the main units.

In practice, this effect has been discounted by overseas enthusiasts on the basis that the chance of presenting the amplifier with a catastrophic load condition is relatively remote, especially if ambience loudspeakers with twice the impedance of the main units are used. ■