Forum

Conducted by Neville Williams

They were worried about loudspeaker phase in the 1930's but . . .

The subject of audio signal phase has received a fair amount of attention during the past 12 months, but we find ourselves with a number of loose ends which it may be as well to tidy up. These range from one suggestion as to where it all began, to another which writes phase off as a non-issue!

The first suggestion, an historical reference, was brought to our notice by a reader H.S. of Bulimba, Qld, and is in the form of a photostat of pages 31 and 32 of "High Fidelity Techniques" by James R. Langham, Gernsback Publications Inc, New York, 1950. It refers, in turn, to a situation which obtained in early sound movie theatre practice, and which I retell, substantially as I've heard it through the years:

Around about the time that "talkies" were introduced, dynamic (i.e., moving coil) loudspeakers came into vogue and these made it possible for listeners, in both theatres and homes, to hear reproduced sound containing a substantial bass content.

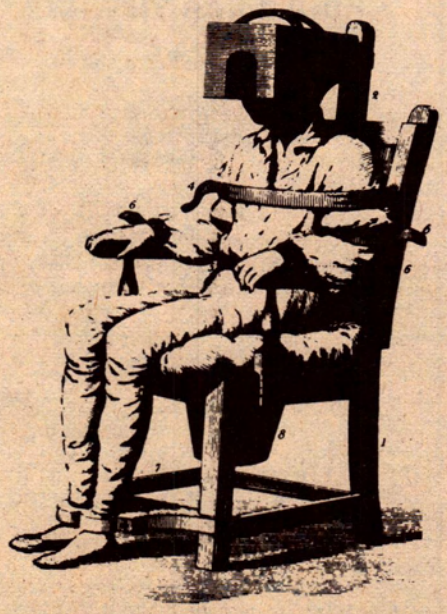
Prior to that, with the old gooseneck horn and unbaffled cone speakers, bass had been implied rather than heard. With the arrival of dynamic speakers — and in a classic over-reaction — weight of bass became one of the criteria by which sound quality was judged!

Theatres were in a good position to give expression to this because they had — by the standards of the day — very powerful amplifiers, large and efficient loudspeakers, and a fair amount of room behind the screen to deploy loudspeaker enclosures. What should be more natural than to mount the woofer at the small end of a large, folded exponential horn with a mouth aperture large enough to stand in? Separate drivers, usually in smaller horns, were provided for the mid-range and treble.

The efficiency was high, the bass was ponderous and the sound on most material very impressive — again, by the standards of the day.

But there were some sounds that didn't fare too well: percussive sounds, like the tap dancing of Fred Astaire and his contemporaries. Apart from the problem of picture/sound synchronisation, the sound itself seemed to be dismembered, with the "click" obviously leading the "thump".

Here I must confess that I am relying entirely on what I have been told. My own experience of talkies during the period was largely confined to country situations, involving the local Mechanics' Institute and such places. There were no large horns and the audience had to grapple with more elementary acoustic problems: like subjectively differentiating between the sound from the loudspeakers and echoes bounced off the galvanised iron roof — or the noise of passing trains!



"You're right, you know. It certainly tightens up the phase response!"

However, in more "refined" situations, it was soon realised that the problem of Fred Astaire's hoofbeats arose from the very different path length for the high frequency components, compared with the bass energy working its way through a long, convoluted horn.

As Langham points out in the aforementioned textbook, the movie industry smartly settled for the alternative of a much shorter bass horn expanding rapidly from a large "throat" that often accommodated four 15-inch drivers. This greatly reduced the disparity in path length and in bass/treble timing or phase.

Again, according to Langham, quite a few private hifi enthusiasts (pre 1950) had to learn the same lesson. Their ponderous horns, built into the corner of the room, or down the unused chimney, were magnificent on some programs, but . . . and I quote:

"On organ records it isn't at all bad — the bass notes come booming out beautifully. But play that one section of Tchaikowsky's Fourth, with all the pizzicato strings, and it sounds crummy!"

In so saying, one can almost hear the cheers of the present day champions of linear phase loudspeaker systems — those units where the tweeter and mid-range units have been set back by a few centimetres to equalise the path lengths to the listener's ears. Seemingly, the observations dating back forty years or more, lend maturity and credence to what might otherwise be seen as the latest hifi fad.

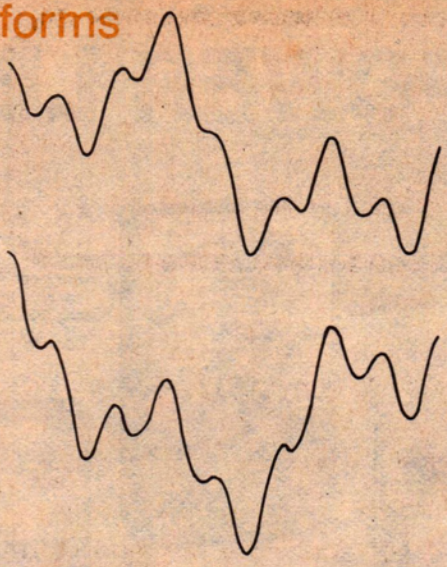
In fact, I doubt that they do. The historic situation concerns allegedly obvious effects arising from path differentials measured in feet; present day phase linear arguments are concerned with path lengths measured in inches (oops, millimetres) and effects which are, at most, extremely subtle. There is a huge difference in degree.

I am aware, of course, that in the April 1978 issue I recounted a demonstration set up Technics engineers in Osaka, which seemed to indicate that differences between high and low frequency drivers did produce an audible effect.

In conversation since then, quite a few audiophiles have re-echoed the reservations expressed in that article as, for example:

- In the test reported, a difference was observed using a square wave from a mono source in an anechoic chamber. It cannot be assumed that it would be apparent with program signal from a stereo pair in a normal room.
- Merely to note a difference does not mean that the respective sounds are right or wrong. Moving a microphone arbitrarily in a studio in relation to a sound source will also produce a difference!
- The phase relationship of audio signals suffers multiple arbitrary

Audio resultant waveforms



The waveform at the top is a copy of one specifically referred to in "HiFi Topics" elsewhere in this issue. The lower waveform results from shifting the instantaneous phase of the same three components. To the eye, the resultants have obvious differences; the as yet unresolved argument concerns whether such a difference is apparent to the ear.

variations along the complex chain between the mic. diaphragm and the amplifier output terminals. Why seek to preserve in the loudspeaker a relationship which is arbitrary, elsewhere?

While prepared to concede these very practical objections, our own attitude was to accept the phase linear concept as a technically valid step in the right direction, even though it may not be subjectively very significant at this point in time.

We finished up with a warning that: "A manufacturer who spends more money on a stepped enclosure and then compensates by using cheaper drivers might well effect an "improvement" sideways or backwards!"

Incidentally, in seeking to illustrate "HiFi Topics", and the spillover into these columns, we went a step further than usual and opened up a line of thought which I can't remember having heard expressed before.

Most observations and articles to do with phase involve square waves or other contours formed from harmonically related sine waves. In either case, the contour can be plotted or viewed on an oscilloscope, and does not vary with time.

Our own illustration was based on three waveform segments, with the centre one not harmonically related. When we asked our draftsman to fiddle the phases and produce another contour for purpose of illustration, he made the very valid observation that, with non-harmonically related waveforms, the contour would itself be constantly changing and would in fact, tend to be cyclic or repetitive. Any contour he might draw would be approximated naturally in due course.

And, when you think about it, the components in normal program material are never phase locked in the way they are from a square wave generator. Even in an ostensibly sustained chord, they will drift to form an ever-changing pattern. Can a listener really be expected to discern a specific change in a pattern that is, itself, subject to constant change?

Put like that, it would seem that, if phase is going to have any audible effect, it will be confined to transients, not of the "Fred Astaire" kind, but at the percussive leading edge of er . . . er . . . er . . .

In the light of all this, it was intriguing to hear a spirited reply to a question on the subject by Vice President of AR (Teledyne Acoustic Research), Herb Horowitz.

As reported in our last issue, Herb Horowitz was in Sydney to explain and demonstrate his company's current line of loudspeaker systems, including the new AR-9 designed to be "the best speaker in the world". But the AR family is noticeably flat faced, as compared with the protruding chins of many of their phase-linear rivals.

How come?

According to Herb Horowitz, Teledyne engineers made a special study of papers on the subject and discovered a basic flaw in the maths. The engineers were keen to make a "big deal" of their discovery but were restrained by AR management on the grounds that prizes are not awarded for being negative! However, Herb Horowitz indicated that the word had got around and that we could expect to see some of the champions of phase linear loudspeakers backing off from their earlier attitudes.

It will be interesting to see whether this does, indeed, happen!

One other observation about phase relationships flows from the "HiFi Topics" feature elsewhere in this issue. In constructing a resultant from three sine waves, and talking about preserving that resultant, I made the deliberate decision not to complicate the discussion by bringing in the subject of phase.

In fact, by simply shuffling the phase relationships of the components relative to one another, the original contour of Fig. 1d becomes something quite different, as indicated.

Phase shifts of this kind will occur along the recording and amplifier chain, if only because frequency conscious networks and processes are involved. For this reason, if for no other, the groove tracing on a mono, lateral disc will be an audio resultant

FORUM — continued

waveform but not necessarily of the same visual shape as at the amplifier input.

Ideally, I suppose, after all the fiddling in the recording and amplifier chain, the ultimate output waveform should be the same as the original input, with components, amplitudes and phases restored to the original relationship. But that's really what the argument is all about.

The traditional view, supported by a wealth of traditional research is that the ear is sensitive to frequencies and amplitudes but not to relative phase; that changes in contour, shown up by plotting, or as depicted on an oscilloscope are purely visual, with no auditory significance.

But the phase linear proponents think otherwise. And that just about brings us back to where we were in April last!

"NOISE FREE" RADIO

To change the subject, we reproduce the letter below from a New South Wales reader, concerning car ignition hash and FM radio.

The whole subject was raised by a correspondent J.R. in the September issue and, as noted above, mentioned further in December.

J.R. was concerned because his reception of FM/stereo, in an ostensibly reasonable location, was bedevilled by ignition interference from passing cars. We tended to blame his antenna or his tuner but left the matter open with the thought that other readers might have similar problems. If they have, they have been remarkably reticent, remarks being confined to FM interference problems in vehicles.

We'll leave that subject open, too, to see what comes out of it but, in the meantime, I note T.B's reference to antenna polarisation.

Early in the piece, the now defunct Australian Broadcasting Control Board adopted the guideline for FM that the transmitted signal should have the same polarisation as had already been set for television stations in the relevant areas. This meant horizontal for most places, but vertical in a few others, and notably in Canberra.

It seemed a fairly routine decision at the time, with the conveniece that listeners could take a split from the TV antenna to feed the FM tuner.

More recently, it has become apparent that the majority of FM receivers in use will be portables and car radios, in every case with a vertical whip. About the worst signal you can provide for them is one that is horizontally polarised! Yet to standardise on vertical polarisation would be to disadvantage users of more elaborate equipment operating from a TV or TV-style antenna.

The seemingly obvious course is to standardise on mixed polarisation for all FM stations in Australia, with signals having both a vertical and a horizontal component. Based largely on overseas experience, it would appear that circular polarisation is the best all round proposition, giving the listener the choice of either a vertical or horizontal antenna, or a more complex unit designed to take full advantage of the signal.

The problem seems to be that the present administration hasn't yet got around to confirming a standard based on local findings. In the meantime, we're likely to end up with a true mixture of polarisation, with some stations following the old guidelines and others, with departmental acquiescence, taking a punt on circular!

The way things look at present, the answer will be established by practice and confirmed officially mush later.

More about ignition hash and FM

Dear Sir,

I read with interest, in your December edition, Mr William's article about "FM AND IGNITION HASH" and the letter from Mr N. H. about Melbourne problems in mobile FM reception.

As I have been involved for a long time in car radio and car interference suppression development, I felt that I should add a few words.

It is true, that interference was almost an insurmountable problem when FM reception was first introduced into mobile applications. The car wiring and even the chassis and the body are very effective radiators and re-radiators around 100MHz. Metal panels, which shield effectively on medium wave lengths become vicious interference sources and aerial cables if not terminated with the correct characteristic impedance can add to the difficulties.

Even so, with a lot of care and time, and fully understanding the sources, any car can be made interference free while it is alone on the highway. As soon as another car approaches the whole procedure is wasted!

This has been realised by quite a few FM radio manufacturers and several methods were developed which solve this problem by selecting out the offending pulses and cancelling them by phase reversion. The electronics is involved but still far more simple than the microprocessor controlled car radios, which soon will appear on the market, and it works very well.

These devices are sold either as additional suppressors or are built into better products. As with most devices these days, they exist as an integrated circuit (monolithic or thick film) and are modestly priced. The surprising fact is that Mr N. H. does not know of these suppressors, because for every practical reason they render the interference problem non existent.

Unfortunately the polarisation problem is still with us; most of the FM transmitters in Australia are horizontally polarized. The car radio manufacturers requested the ABC several times to change to mixed polarization but with no result. The polarization problem emphasizes the multipath problem (this is for some reason worse in Melbourne than in Sydney) which sometimes can mar good stereo reception in moving vehicles. Again special care in ratio detector design can help quite markedly, but in certain areas the receiver has to be switched back to mono reception.

T. B. (St Ives, NSW)