WALL OF SOUND

Is fighting sound with sound the future for noise control? James Macneil *hears how active noise technology is slowly being fine-tuned for commercial use.*

NOISE control has traditionally been a passive affair with engineers relying on stiff or absorbent construction materials to stop the passage of sound through buildings.

So it may come as a surprise that engineers are turning to a method that, at its most sophisticated, involves getting structures to vibrate.

Active noise control turns traditional passive acoustic principles on their head. Instead of trying to deaden the sound, it fights fire with fire, cancelling out offending sound with more noise.

To date it has been applied to ships, submarines and sports cars. In construction it has been used to dull sound from generators and fans coming through ducts, but researchers are laying grander plans to use it to stop noise entering through curtain walls.

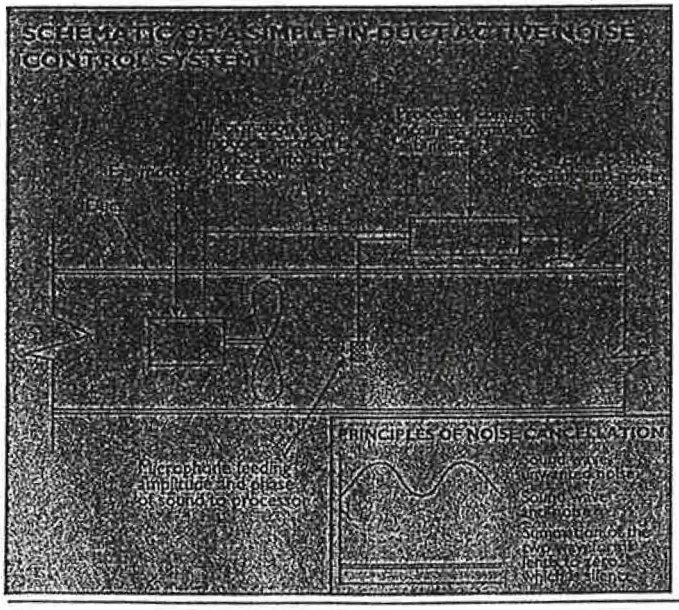
The theory behind active noise control is simple – fight noise with anti-noise. Sound travels in waves which are a series of air pressure fluctuations. A pressure wave that is the exact opposite to the one creating the sound will cancel it out (see diagram below). A peak in one is cancelled by a trough in the other and vice versa.

Building acoustics experts have been toying with the idea for 30 years. Says Arup Acoustics' Dr Raf Orlowski: "The reason it didn't take off is because the electronics were not sophisticated enough to produce the anti-sound signal."

One of the main advantages of active noise control is that it is effective with low frequency sounds, such as the deep throb of generators and rotary engines, which are hardest to control with passive techniques. "If you are trying to match a low frequency sound you have a long, well-defined wave length and you can create a clear cancelling signal," says Orlowski.

At higher frequencies the signal is harder to contradict. "The danger with active noise control is that if the anti-noise signal is not exactly the equal and opposite of the noise you will amplify the sound."

The simplest way to produce the opposite pressure pattern is to use a speaker to produce anti-noise. A microphone is placed near the sound source and the signal it receives is sent to a processor. The processor analyses the sound and produces an exact opposite through a speaker further down the noise's path.



This approach has been successfully used where the direction of the sound can be defined. Applications include dulling exhaust, engine and fan noise in confined spaces such as ducts. Alan Fry, technical director of the Salex Group which manufactures active noise control systems through its subsidiary Contranoise, explains: "Dealing with a pure tone on a predictable repetitive basis is quite easy."

Good vibrations

Researchers see potential for active noise control to prevent noise passing through thin walls, such as curtain walling. This requires more sophisticated technology which can cancel out sound waves arriving from more than one direction by vibrating the panel in the right place at the right time to counteract any sound waves hitting it. This would allow noise control without significantly increasing the mass of the cladding.

Researchers at a US university have achieved sound reductions of up to 20 dB in an experimental system. With passive systems the thickness of the wall needs to be doubled for a 5 dB reduction. In this experimental system at the Virginia Polytechnic Institute and State University, vibrations are picked up by sensors built into the panels. The sensors relay information to a computer processing unit which then operates the transducers – the electronic devices that cause the panels to vibrate at the required frequency to cancel the sound.

"With this system all the electronics can be contained within the panel. This is a positive step towards linking it in a building," says Orlowski.

The trick is in the speed with which the vibration is measured and the response calculated. The latest signal processors are fast enough to respond to the wave they measure. But before this can be applied to a building, extremely sophisticated electronics will have to be developed to cope with random traffic noise.

Orlowski expects the system is between five and 10 years away from a commercial application. But it remains to be seen whether an industry that has trouble successfully erecting a standard curtain wall can cope with one that is stacked with sophisticated electronics.

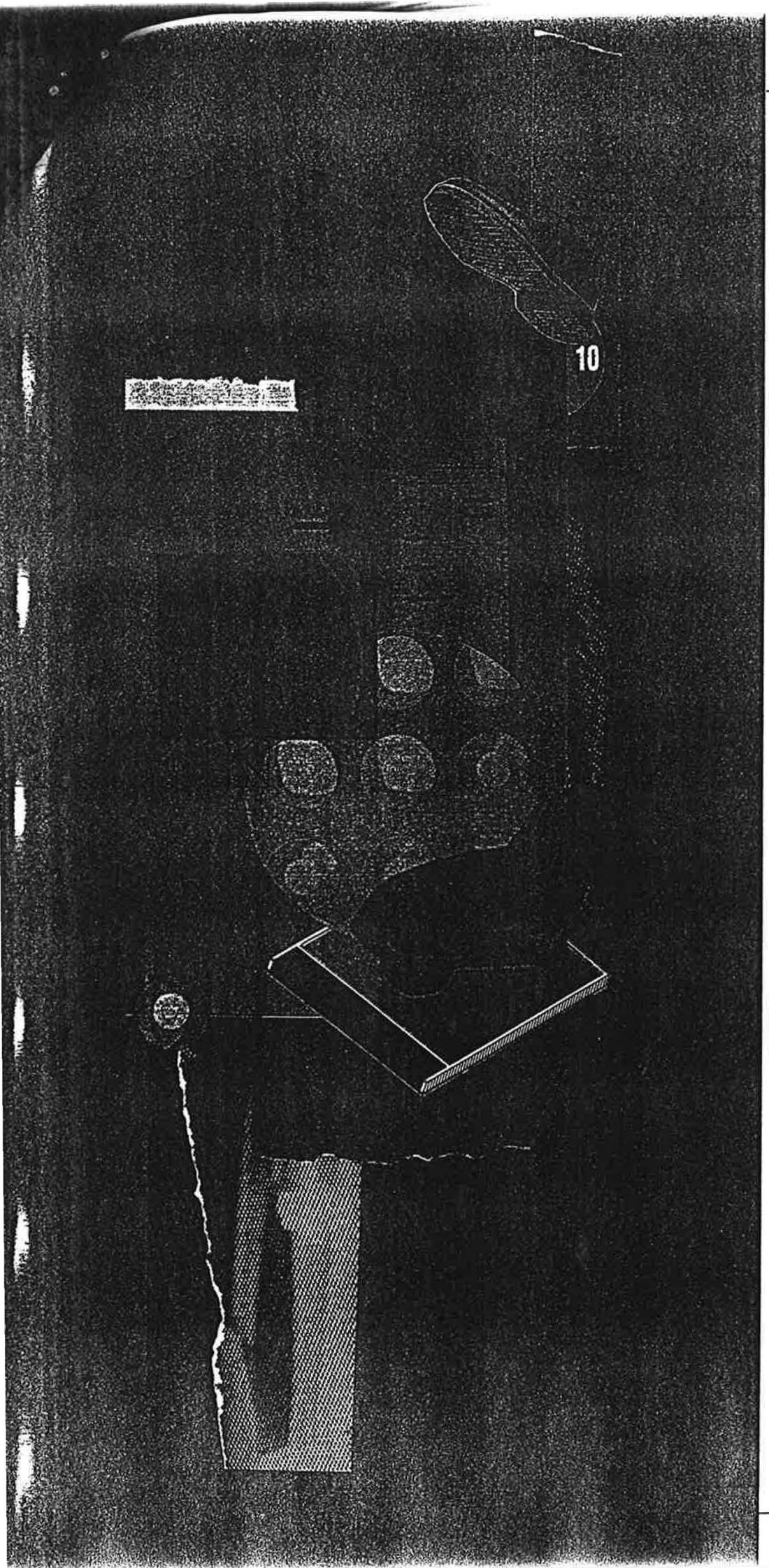
According to Fry, the main application for active noise control will be in remedial works where passive systems have not performed as expected.

But he points out: "It is rarely used in building services. It is still cheaper to incorporate passive techniques in the first instance."

And it is not possible to build an off-the-shelf system. "It has to be sold on a project-by-project basis as each system has to be tailored to its particular application," says Fry. In remedial uses it has the advantage of being able to be fitted without shutting down the equipment generating the noise.

Trying to control noise in larger spaces such as rooms is also still beyond the capabilities of the technology because it is so difficult to predict the passage of the sound waves.

"The sound can go anywhere and it will not necessarily be repetitive or predictable," says Orlowski. Although not commercially viable in large rooms, systems have been developed for more compact areas such as sports cars (see opposite).



VERONICA BAILEY

Ships to sports cars

ACTIVE NOISE control has its origins in maritime engineering. When dual propeller ships were introduced, an engineer came up with the bright idea of turning the engines in the opposite direction. By doing this the vibrations from one engine effectively cancelled those generated by the other, as long as their operation was synchronised.

The MOD has worked on its own active system primarily for submarines. Vibrations from the hull of a submarine can be detected by enemy sonar and researchers have tested active noise control systems as a way of damping vibration beneath the waves. Unfortunately the results of this research are not available to civilian exponents of active noise control.

One glamorous application is using the method to dull engine noise entering the interior of performance cars. Although it is difficult to predict the behaviour of sound waves in a large space, the cabin of a car is small enough for effective noise control.

By careful computer analysis, engineers design an anti-noise pattern which will cancel sound waves arriving in the spaces occupied by the driver's and passenger's heads when they are seated.

A firm called Contranoise worked with a US partner on a system that plays anti-noise through the car stereo system. Lotus uses this to dull the throb of its sports car engines. The rights to the idea have been sold to a Japanese electronics firm.