

ACTIVE SUPPRESSION OF THE NOISE

Operation and characteristics

The noise can be controlled by methods:

- Assets, that annul or cushion the noise centers.·Liabilities, using silencers or isolations, encapsulamientos or atenuadoras barriers.
- They do not introduce external energy to the system and look for to interrupt the propagation of the noise.

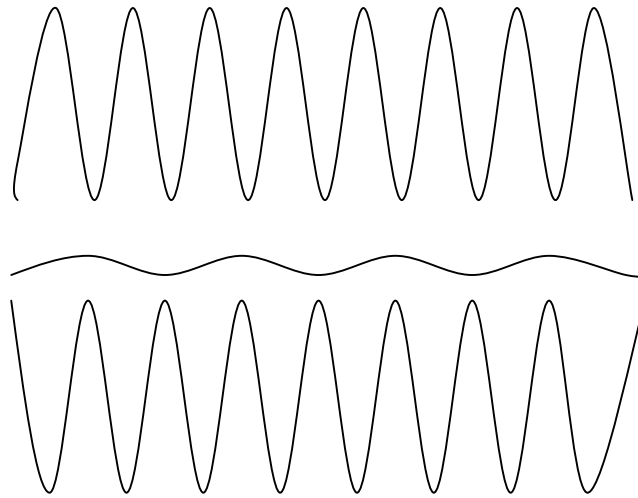
The technology of the passive control of the noise is in a very mature state and is very useful by its effectiveness and attenuation on a wide rank of frequencies, averages and discharges. Nevertheless, in low frequencies, they are expensive and little effective. In this margin of low frequencies or long wavelengths, it is where the techniques of active control of the noise can be applied. The active methods allow improvements in the noise control, and benefits in size, weight, volume and cost of the system.

The active cancellation of noise is a new technique to attenuate, to eliminate or to cancel the acoustic noise. The attenuation of this noise is made generating a new noise (anti noise) by means of acoustic devices electro of such form that in a zone of interest of the average hearing aid takes place a destructive interference (compression waves in phase opposition).



Operation:

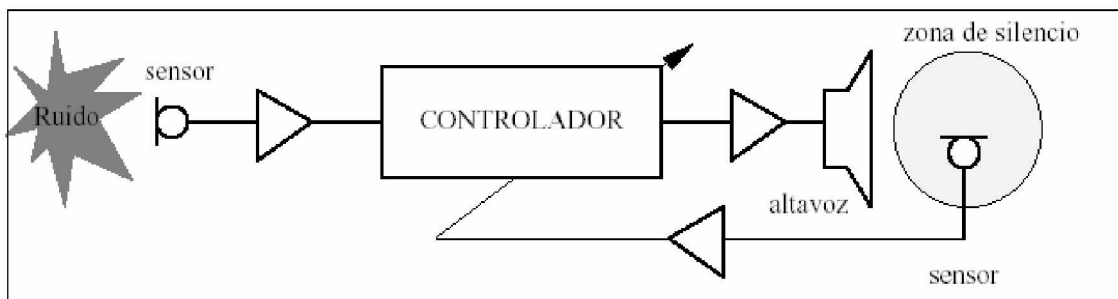
1. The system takes a sample from the noise that we want to annul.
2. Next a anti-noise obtained from the sample of the same out of phase amplitude is generated vice versa but 180° so that the tips of the noise agree with valleys of the anti-noise and.
3. The system emits east anti-noise annulling therefore the noise.



Las ondas fuera de la fase se cancelarán

An active controller of noise is formed by:

- a reference sensor (a microphone, tachometer, accelerometer, etc.).
- an electronic controller who modify in amplitude and phase the signal of the reference sensor, a loudspeaker that generates compression waves and a microphone of refeeding to the system that serve to modify its operation and to obtain diminutions of sound pressure exactly where are placed the same one.



Elements of a system of active control of noise.

The systems of active cancellation of noise usually appear in EPI form usually are helmets in which this technique with the passive cancellation of noise is combined. These helmets catch the sample of noise of the interior of the helmet with passive cancellation and also emit in their interior the anti-noise by means of a small loudspeaker. These helmets also include a system of transmission of the human voice by means of bone microphones.

The systems of active cancellation of noise are effective with noises with a regular cadence, like the generated ones for example in a production line where an

effectiveness of around 70% is obtained. They are not it as much however with irregular noises as the bottom conversations.

The systems of active cancellation of noise also appear in machines to annul the noise that these generate. Nowadays they have begun to appear in computers and other electronic devices to annul the noise generated by his ventilators, more and more great to dissipate the heat generated by the modern electronics.



The technique of transmission of the human voice by means of bone microphones is used associate to the active cancellation of noise and also it contributes to protect to the workers of the noise facilitating in addition the noisy atmosphere communication. It consists of catching the human voice from the vibrations of the skull by means of a microphone that presses the head of the subject. This voice thus caught is transmitted to an amplifier that as well emits it by means of a loudspeaker located in the outside of the helmet.

In noisy places of work where they are used this type of helmets, the workers will see drastically reduced the background noise at the same time that the human voices will be harnessed and clarify facilitating thus to a great extent the communication.

The weight of one of these equipment of is of about 800 grams and their more annoying aspect for the worker is the great dimensions of the passive protectors of the ears.

The good results of the audiometrías practiced to the workers who use these systems prove their effectiveness.

History of the system

The study of this phenomenon has had a long development in years 70. From its génesis in 1930 to its present state with products of consumption in the market, the development of the active control of the noise has been parallel and employee of the advances of electronic products of low cost. The idea of this system, like destructive interference between the primary field of noise, and one secondary one, in contrafase, generated electronically, was raised by Lueg in 1934. Its patent included three concepts of the control of the active noise: protected suppression of the noise in conduits, cancellation by interference in the points in space, and creation of "quiet zones". It had an early phase of exploration in the Fifties, in which we found some practical implementations to the reduction of noises with a very simple space-temporary structure, like the radiated one by electrical transforming.



But the true interest by the active control of the noise arises from the works of Widrow on adaptive filtrate. The power of the adaptive filters is in its capacity to adapt the system of control to the changing conditions of the noises that are tried to reduce.

In years 80 practical applications of the system in conduits (exhaust pipes of motors, systems of ventilation and conditioned air) and in auditory protectors appear. In years 90 spectacular results of the active control of the noise inside transport means are published (cars, airplanes).

East method to the periodic noise broadcast by electrical transforming, to auditory protectors, the noise propagated in conduits has been applied (systems of ventilation, conditioned air, exhaust pipes of motors), to the noise in enclosures (cabins of vehicles, motors encapsulations), to the difractado noise (acoustic barriers), and to the structural noise.

The Spanish Society of Acoustics (IT IS) has made from 1995 different studies on the application from the active control of the noise:

- development of analogical filters for the active cancellation of the noise in auditory protectors
- adaptive control monochannel in conduits

- optimization of the geometric disposition of the sources of control and the sensors of error in multi-channel systems CAR
- development of a multi-channel system CAR inside vehicles
- prototype of a system CAR monochannel of the exhaust noise of encapsulated sources
- structural acoustic active control
- design of appropriate loudspeakers for the CAR

Applications

The optimal operation of the systems of active control of noise takes place in noises confined in small spaces as they can be conduits, automobiles, exhaust pipes, earpieces, etc. For these applications already the acoustic attenuation has been demonstrated successfully that it is obtained. Little by little the first active controllers of noise for these applications begin to commercialize themselves.

- Active control of noise in auditory protectors: The active earpieces use the principle of superposition of acoustic waves to cancel the LF, allowing the passage of other signals of discharge and average frequency like conversations and sirens of alarm. These auditory protectors are provided, aside from the loudspeaker, of a small microphone and an East chip DSP. circuit is the one in charge to generate the signals that will act like compression waves in phase opposition. Widely they are used by the pilots, specially in helicopters.
- Active control of noise in conduits: In a tube the waves of LF propagate like flat waves throughout their axis. Placing a microphone of reference, one or several loudspeakers, and an error microphone, in this same order according to the propagation of the waves and next to the noise source, is possible to obtain excellent results of attenuation in all the length of the conduit.
- Active control of noise in airplanes: The active control of noise in airplanes is a subject of constant interest and investigation, which had without a doubt to the improvements as far as weight and volume can offer this technique in the design of airships with respect to the passive techniques of control. Such improvements entail a considerable fuel saving reason why they will not take in implementing itself in the new models of airplanes. The reference sensors usually are accelerometers placed in the proximities of the motors. The loudspeakers, are placed in the head rests of each one of the seats or are distributed of form camouflaged in the panels of the cockpit. Important attenuations of all the components periodic of the noise in the margin of

frequencies included/understood between 50 and 500 Hertz are obtained. Diverse airline companies already begin to introduce these systems of control.



- Active control of noise in the automobile: The active control of acoustic noise in automobiles also begins to develop quickly for the same reasons that are applied in the airships: to diminish the size and the weight of the cockpit to obtain important acoustic attenuations inside the cars. The noise that can be found in the cockpit of a car is produced mainly by three sources: motor, tread and wind. Of these three noises easiest to eliminate it is the noise of the motor, noise of periodic components. The attenuation of the other two types of noise, to the being noises of broadband, is not as significant as it is the attenuation of the motor noise. The sensors usually are microphones, accelerometers and tachometers. The electroacústicos actuators are the own loudspeakers of the equipment of audio. The type of control depends on the application in concrete: either to create concrete aural nulls around the head rests, or to attenuate the sound pressure level of the noise of global form, that is to say, in all the cockpit. This last objective is not easy to obtain and the design of the control system is enough complex.
- Reduction of the LF noise by sources of industrial noise like pumps of aspiration, cooling towers and exhaust gases of turbines by means of the use of sources of acoustic control.
- Reduction of noise of LF propagated in the conditioned air systems by means of acoustic sources in the air conduits.
- Active control of the exhaust noise of encapsulated sources.
- Reduction of the noise of exhaust gases of the motors of internal combustion.

Concrete example

The automotive division of Siemens tries to adapt the concept to everything a car, with which it will be not only managed to diminish the noise level, but that will free space under the cowling.

The present automobiles have mounted resonadores underneath the cowling, those that when resonating dissipate acoustic energy in their outside, that is in the engine compartment, with the result of a smaller level of noise. These mechanical resonadores have an important volume, in some cases as large as a soccer ball, and as they are been in tune to certain frequency, they are necessary a few of them. Certain cars of luxury use up to 12 of these resonadores.



Then, this volume cannot be used for another thing, reason why the technology of Siemens would allow to use this volume for another aim. It consists of a microphone applied to the air intake, an electronic module, and a loudspeaker applied to the air intake. When motor works, system monitorea noise through microphone, DS happens through converter A/D, go to processor digital of signals (DSP, processor digitalis audio) that determines its frequency, and produces a signal of opposed exit with which it feeds the loudspeaker. The frequency of the exit signal cancels the noise of the admission taking.

Until now some manufacturers of cars they had applied east method to the cockpit of the cars, but Siemens was first in attacking the noise in its source, the motor. The admission noise was a problem for the manufacturers of cars since they were by the end of used plastic manifold the decade of the 80, since the manifold plastic contrapartes of aluminum vibrates more than his, producing more noise.

Even, with this technology it would be possible to give "character" to the noise of the motor, causing that a luxury car is quieter, but a sport model has a deeper roar, which could help to the manufacturers with its strategies of sales.