PROCEEDINGS OF

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THE 1997 INTERNATIONAL SYMPOSIUM ON ACTIVE CONTROL OF SOUND AND VIBRATION

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AN ACTIVE NOISE CONTROL DEVICE FOR ELECTRIC POWER PLANTS

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1. SUMMARY

The large electric power generators are powered by diesel engines which produce very high noise levels, usually attenuated by passive mufflers systems, installed along the engines exhaust channels.

In this paper, a new active noise control device is proposed, designed to be used in addition to the common passive mufflers systems, in order to achieve a more elevated attenuation of noise. The device is made up by a box, which contains two power loudspeakers fed by a control circuit; that generates an electrical signal, the spectral features of which are derived by picking up the electricity produced by the power generator. The acoustic signal emitted by the loudspeakers has the same shape but opposite phase of the signal produced by the engine.

The two signals interfere across the final section of the engine exhaust pipe. The device has been installed on a power generator of a telephone exchange station: a noise reduction of about 20 dB was obtained. Furthermore, the mostly attenuated frequency range is 40-200 Hz, where the common passive mufflers systems show a very low efficiency.

2. THE ELECTRIC POWER GENERATOR

The used electric power generator shows the following features:
- nominal electric power 250 KW;
- nominal voltage 380 V;
- number of dipoles 2;
- frequency 50 Hz;
- 12 combustion chamber diesel engine;
- rotation speed 1500 rpm.

The electric power generator is located inside the telephone station building, on the base floor; the exhaust gases flow out through a circular section duct; the outlet section is on the roof. When only the passive muffler is present, the noise spectrum produced by the engine at 1 meter far from the outlet section is reported in fig.1. The acoustic power is about 12.5 W.

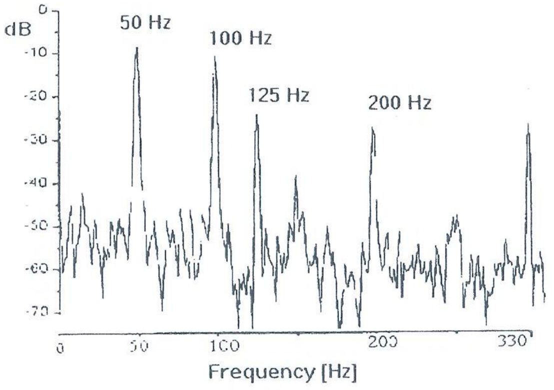


Fig.1: Noise spectra produced by the engine 1 meter far from the outlet section. Only passive muffler is present.

3. THE ELECTRONIC MUFFLER

The new prototype is made of an iron box inside which two loudspeakers are installed as shown in fig.2: the terminal part of the the exhaust pipe is completely all contained inside the electronic muffler. Photos of the apparatus are reported in figg.3a,3b ; the outlet section of the exhaust pipe is coaxial with the box terminal section (fig.4).

The control signal produced by the loudspeakers propagates inside the exhaust pipe; the external box walls are covered with an insulating painting to limit acoustic losses. The maximum power of each loudspeaker is 200W (r.m.s); the frequency response is flat on the range 40 ÷ 600Hz.

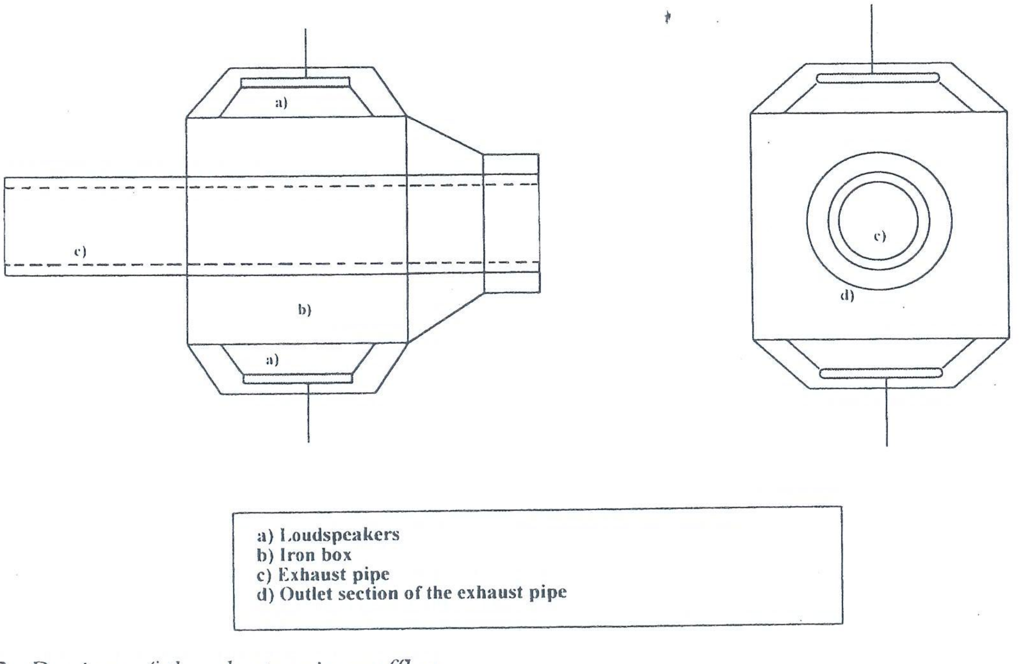


Fig.2: Design of the electronic muffler.

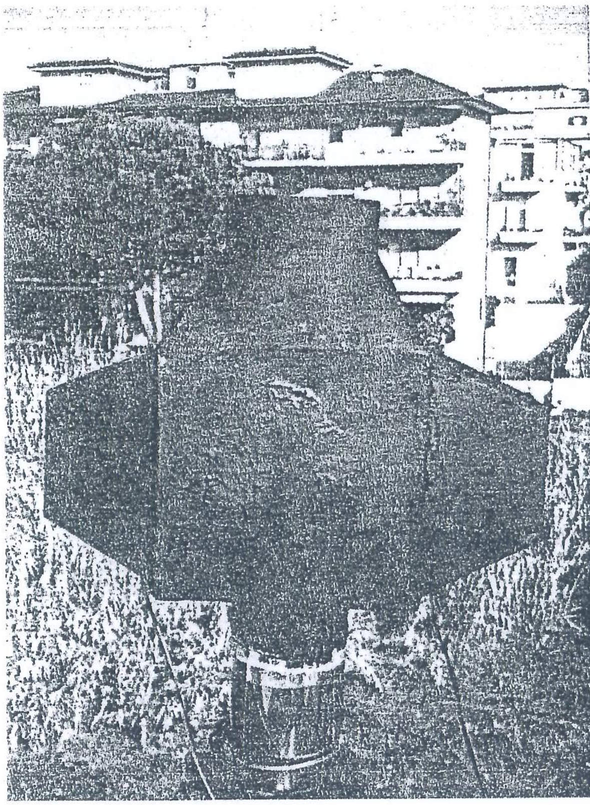


Fig.3a:The electronic muffler (photo)

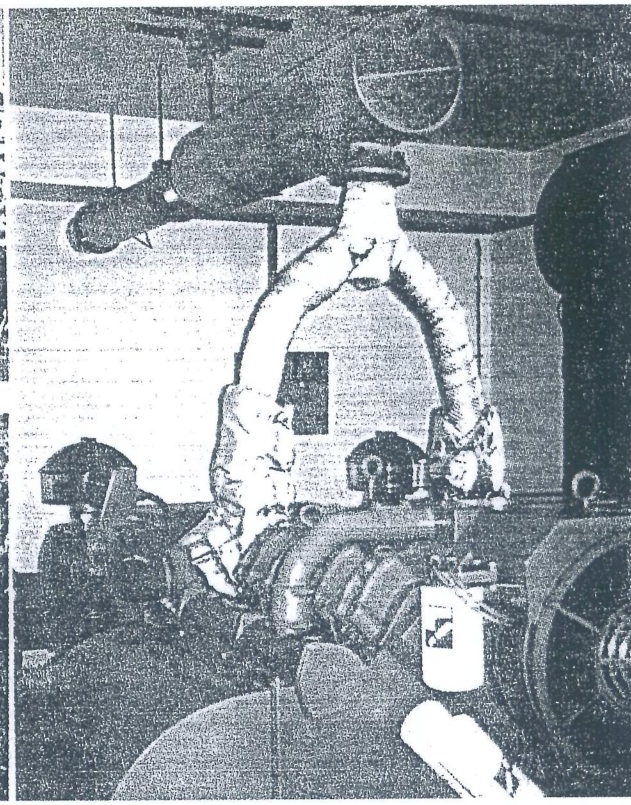


Fig.3b: The engine with the passive muffler (photo)

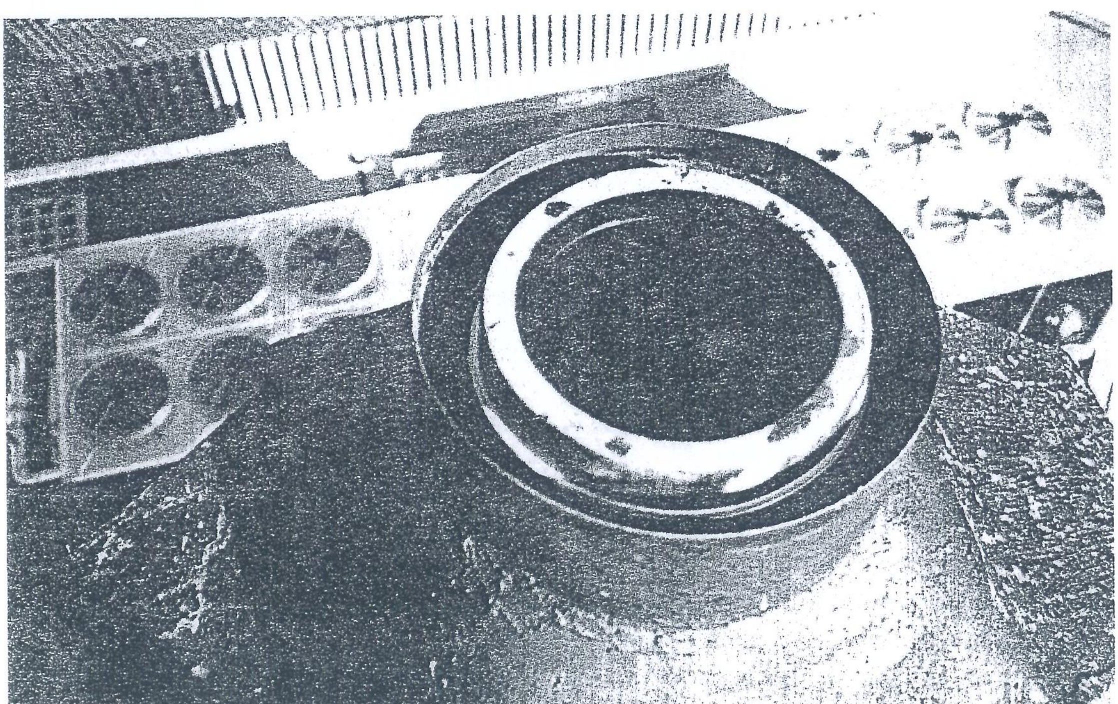


Fig.4: Final section of the electronic muffler (particular photo).

The loudspeakers are fed by a two channels amplifier (maximum power 190 W r.m.s), the input signal of which is generated by a control unit. The engine stationary rotation regime produces a constant acoustic spectrum (fig.1), so that a modal control technique can be used. The control unit generates three sinusoidal signals having the same frequencies as the three main components of the noise spectrum (fig.1). The block diagram of the control unit is sketched in fig.5. Each component of the prototype is designed, built and tested in the Acoustic Laboratory of the University of Perugia.

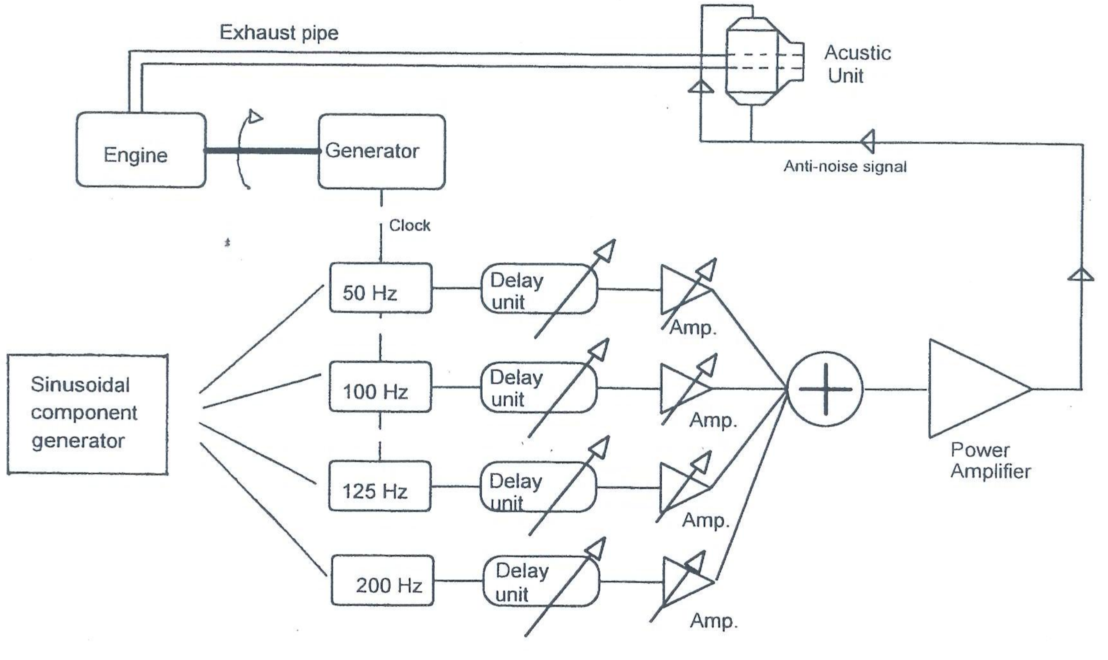


Fig.5: Block diagram of the control unit.

4. OPERATING CONDITIONS

The spectrum generated by the control unit is very close to noise spectrum when the rotation velocity is 1500 r.p.m.

The main components of noise spectrum are the following:

1) 50 Hz;
2) 100 Hz;
3) 125 Hz;
4) 200Hz;

Component 1) is due to gas explosion inside the engine combustion chamber; component 2) is the first armonic of component 1);
component 3) is caused by a resonance phenomena in the exhaust pipe;
component 4) is the second armonic of component 1).

Amplitude and phase of each componènts (see fig.6) are respectively controlled by a delay and an amplifer units as shown in fig.5. All components are then mixed to get an anti-noise signal; the signal is then amplified to get amplitude equal to the noise one .

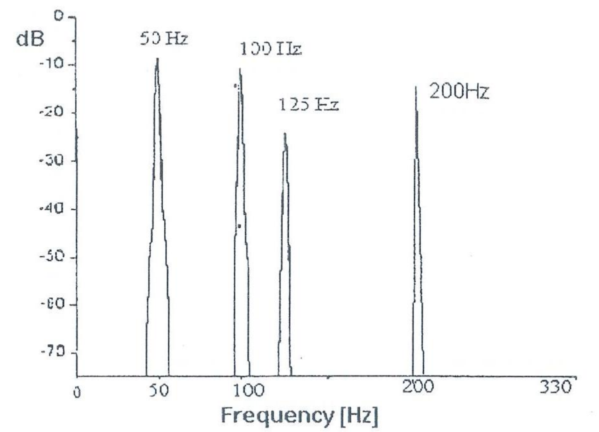


Fig.6: Power spectra of the signal produced by the control unit.

5. EXPERIMENTAL VERIFICATION

The prototype is installed on the electric power generator of a telephone exchange station (see figg.3a, 3b). Fig. 7 rapresents the photo of the exhaust pipe with and without the electronic muffler. The noise attenuation produced by the control system has been verified at 5 points, disposed as shown in fig.8. The equivalent acoustic levels are measured under the following conditions:

- control system off;
- control system on.

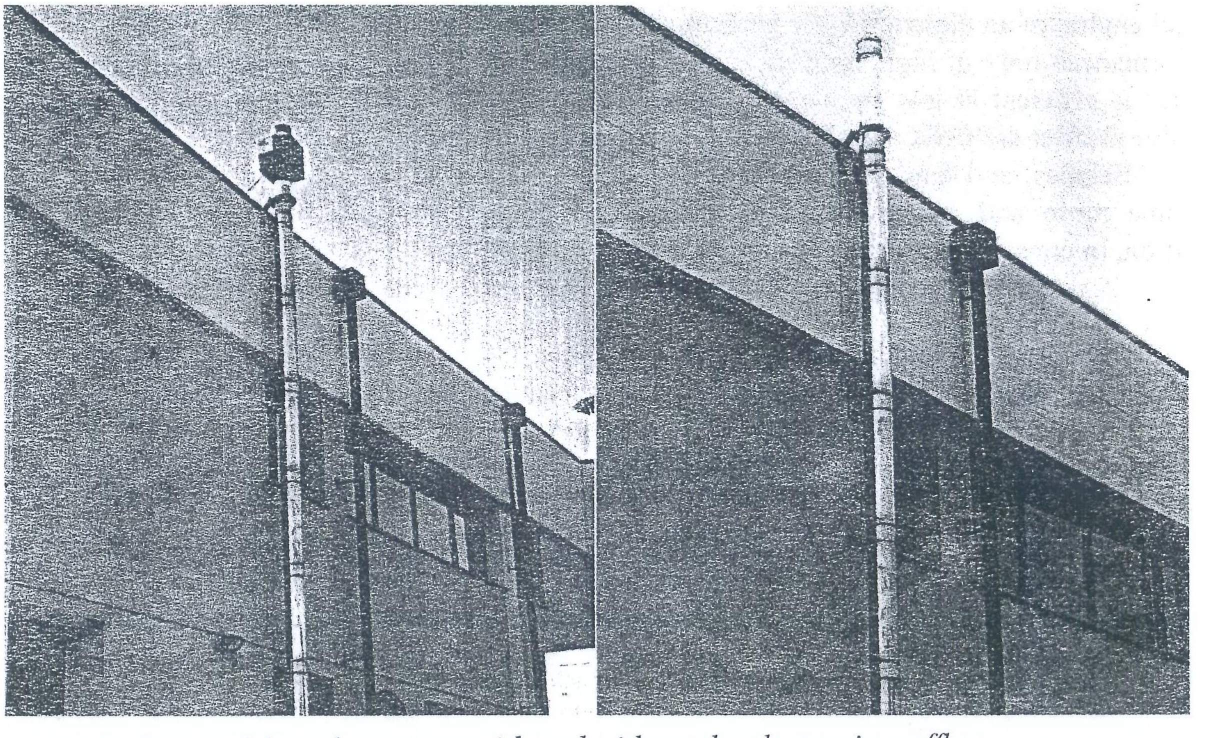
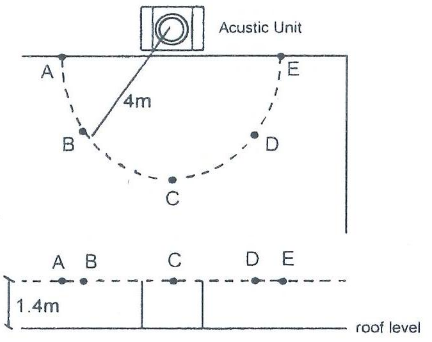


Fig.7: Photo of the exhaust pipe with and without the electronic muffler

Each measurement lasted 1 minute and no filter was switched on. The acoustic levels are very close to one another, so that the acoustic emission may be considered omnidirectional.

The average attenuation is about 12 dBA and it is over 10 dBA in every point; that is achieved controlling four frequencies only (50,100,125,200 Hz), for which the airborne attenution is very low; so the efficiency of the control increases with the distance from the noise source.

Measurement points position



Measured levels (dBA)

Status / Point	Active control OFF	Active control ON	Attenuation
A	82.5	71.5	11.0
B	84.5	72.0	12.5
C	86.0	73.0	13.0
D	84.5	71.0	13.5
E	82.5	71.0	11.5
Average	84.0	71.7	12.3

Fig.8: Experimental results.

6. CONCLUSIONS

A new active noise control device has been designed and built in the Laboratory of Acoustics of University of Perugia. The system attenuates the noise emitted by the diesel engine of an electric power generator. The common passive muffler, shows good performances only at high frequencies, in the range 300-3000 Hz. The active control device is efficient at low frequencies, in the range 50-200 Hz. So, if both active and passive muffler are used, a higher attenuation may be get all over the spectrum.

Besides, and that is another goal of this noise control device, its perfomances become more and more elevated with increasing distance from the noise source position, in consequence of the airborne selective absorption.

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