Noise control of a table fan

N. Tandon
ITMME Centre, Indian Institute of Technology, Hauz Khas, New Delhi 110016, India

The cause of high noise generated by a table fan has been investigated. The noise source was identified by sound intensity mapping and frequency analysis of noise signal. The base of the fan stand was radiating high noise. The cause of this noise was found to be due to the resonance of fan stand. The excitation forcing frequencies were traced to the magnetic noise of the fan motor. A substantial noise reduction was achieved when the natural frequencies of fan stand were altered by stiffening its base and by increasing the mass of the base.

1. Introduction

Table fans are commonly used for personal comfort in several countries during summer months. It is desirable that these fans do not produce high noise levels whether being used in homes or offices. Noise control of one such particularly noisy table fan model is described in this article.

All the table fans of a particular model had high noise levels even without the fan blades. These fans had a single phase AC motor mounted on a stand as shown in Figure 1. The fan speed was around 1400 rpm. The overall sound pressure level of the table fan (without fan blades) was measured to be 60 dB(A) at a distance of 250 mm. These and the subsequent measurements were performed in an acoustic chamber [1] with its door open. The average background noise level in the acoustic chamber was 29 dB(A). It was decided to, first, investigate the cause/causes of high noise by analysing the table fan noise.

2. Investigation of the Cause of High Noise

Two-microphone sound intensity measurements [2] were performed on the table fan to locate the noise sources. Sound intensity was measured at each of the 18 points of a 6 row and 3 column grid on the front side of the table fan as shown in Figure 2. A 3-dimensional sound intensity map of the front side obtained after interpolation is shown in Figure 3. In this map (Figure 3), line 1-2 corresponds to the bottom and line 3-4 to the top of the front side vertical surface of the fan. Figure 3 indicates that in addition to high intensity levels obtained in the region of fan motor, unexpected and higher intensity levels were obtained in the region corresponding to the base of the fan stand, indicating that the base was radiating high noise levels. The highest

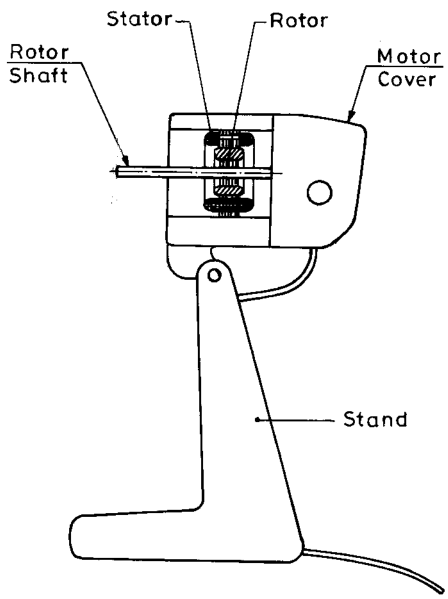

Figure 1. Table fan motor on fan stand

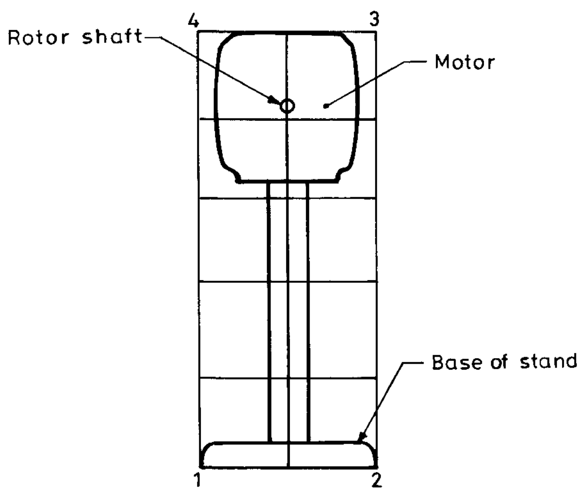

Figure 2. Sound intensity measurement grid on the front side of table fan

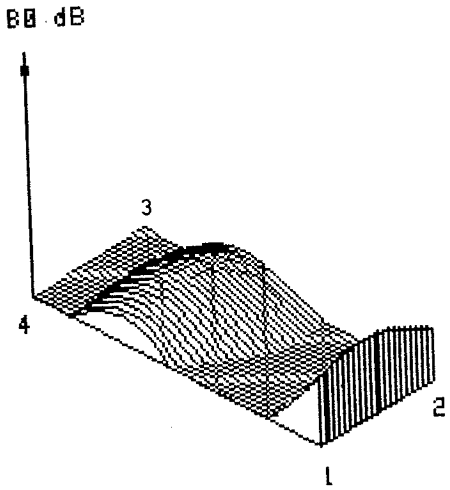

Figure 3. Three-dimensional sound intensity map of the front side of table fan

sound intensity level was obtained at the 1st row and 2nd column. The intensity spectrum at this point was obtained and is shown in Figure 4. It shows high intensity peaks at 524, 620, 720, 744 and 816 Hz.

Natural frequencies of the fan stand were measured by hammer test and some of the peaks were very close to the frequency peaks of Figure 4. This indicated that the cause of high noise was the excitation of the natural frequencies of the stand. The excitation forcing frequencies were traced to magnetic noise of the fan motor. The magnetic noise frequencies because of slot harmonic force field depend upon the number of rotor slots, rotor speed and the line frequency. These frequencies calculated at the fan motor speed of 1400 rpm are given in Table 1.

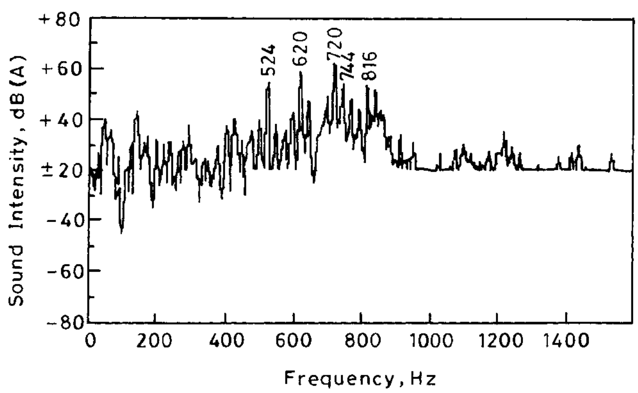

Figure 4. Sound intensity spectrum at 1st row and 2nd column of grid on the front side of table fan

Table 1. Magnetic noise excitation frequencies of the table fan motor at 1400 rpm.

S. No.	Magnetic Noise	Frequency, Hz
1.	kRn	419.4, 838.8
2.	kRn + 2bf	519.4, 619.4, 719.4 819.4, ...
3.	kRn – 2 bf	391.4, 219.4, 119.4, ... 738.8, 538.8, 538.8, ...

where, k is number of harmonics (1,2,.....), R is number of rotor slots, n is rotor speed in revolutions per second, b is positive integer and f is line frequency (50 Hz).

The diagnosis was further confirmed by removing the motor from the fan stand and measuring the noise of motor alone. A noise level of only 42 dB(A) was measured at 250 mm distance.

3. Noise control measures

It was decided to change the natural frequencies of the fan stand so that its resonance can be avoided. This was achieved by increasing the weight of the stand and by stiffening its base. The base was stiffened by providing ribbed connections in it. Increasing the stiffness of the base resulted in a reduction of about 6 dB(A), and 10 dB(A) noise reduction was achieved by increasing the weight of the base of stand.

4. Conclusions

The cause of high noise in the table fan, identified by measuring and analysing sound intensity, was found to be the excitation of the natural frequencies of the fan stand. The excitation forcing frequencies were due to the magnetic noise of the fan motor. The noise generated by the table fan was reduced substantially when the natural frequencies of the fan stand were changed by stiffening its base and by increasing its mass.

References

1. *Tandon, N. and Kristiansen, U.R., An acoustic chamber for sound intensity measurements, Pramana, Vol. 27(3), 1986, pp. 413-416.*

2. *Tandon, N., A brief summary of sound intensity measurements and their applications to noise control, Applied Acoustics, Vol. 28(1), 1989, pp. 37-47.*