DD09

A New Method to Reduce Detent Force in Permanent Magnet Flux-Switching Linear Motors

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Permanent magnet flux-switching (PMFS) linear motor which combines the merits of both PMFS motor and linear motor is cost-effective, since the expensive coils and magnets are both set on the short mover. The savings in manufacture costs can make a great advantage when the stator is long; therefore, they are suitable for a wide range of applications. However, the detent force which is induced by both slot-effect and end-effect [1] deteriorate the performance of the PM flux-switching linear motor. Some useful methods to reduce detent force in PM linear synchronous motors, including adjusting the PM or teeth width, adopting a suitable mover length and installing chamfering [2-3], are noneffective in PM flux-switching linear motors due to the particular structure. This paper investigates a new method to reduce detent force by fixing assistant teeth on the mover ends as shown in Fig. 1, In a conventional motor, there is no assistant tooth on the mover, whilst in the proposed motor; an assistant tooth is fixed at each end of the mover.

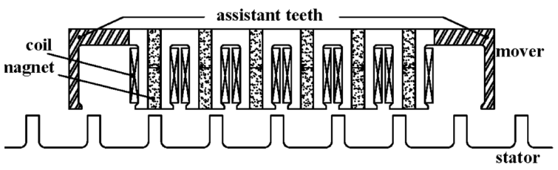

Fig. 1. Configuration.

The assistant teeth can alleviate the end-effect by concentrating the end flux to a particular position, as shown in Fig. 2. Choosing a correct position for the assistant teeth can reduce the detent force effectively by ~65%. On the other hand, the output of the end coils is enhanced with the assitant teeth, including inprovement of the self-inductance and the amplitude of the back-electromagnetic force of the end coils, which become more sinusoidal. In addition, the efficiency of skewing, which is the most common method to reduce cogging torque/detent force, is more remarkable in the case that assistant teeth are used.

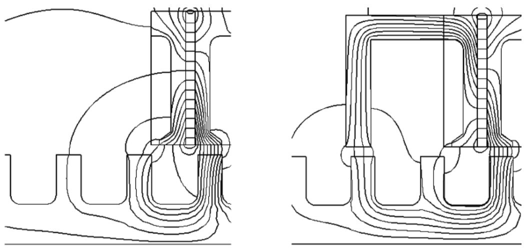

Fig. 2. Flux constributions at the left end. (a) Without assistant teeth (b) with assistant teeth.

Therefore, assistant teeth of suitable position combined with proper skewing will make an obvious improvement in the performance, viz. thrust with smaller ripple, steadier speed and precise controllable.

REFERENCES
[1] Z. Zhu *et al.*, IEE Proc. Elec. Power Appl., 144(4), pp. 277-282 (1997).
[2] S. Youn *et al.*, IEEE Trans. Mag. 44(7), pp.1785-1790 (2008).
[3] M. Inoue *et al.*, IEEE Trans. Mag. 36(4), pp.1890-1893 (2000).

DD10

In Pursuit of Increasingly Linear Loudspeaker Motors

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The world of loudspeakers has more and more demands regarding their ability to accurately reproduce sounds with good efficiency. Numerous researches have been performed to improve the behaviour of each part of the loudspeaker but no real innovations have grown. Especially the drawbacks due to the iron in the loudspeaker motors are now really well known [1,2], and loudspeakers producers just begin to consider its removal from their motors [3,4].

In this paper a review of these existing loudspeaker motors totally made of magnets is proposed. When iron is removed from a loudspeaker, Eddy currents and reluctant effects are also removed, improving the linearity of the loudspeaker. Moreover, the good understanding of the behaviour of different magnets assemblies and analytical calculations [5,6] of the induction created by these whole structures lead to a so called "linear structure", able to create a very uniform induction (Fig. 1). When this is achieved, the force that makes the diaphragm of the loudspeaker oscillate is proportional to the current running through its voice coil. Thus, this loudspeaker motor is linear as well as using a reduced magnets volume. Performances of each proposed magnetic structures of motor are compared, from the intensity of their created induction to their ability to respond as an accurate image of the driving current. That is to say that each motor should be used in a restricted frequency range that corresponds to the width on which its created induction is uniform.

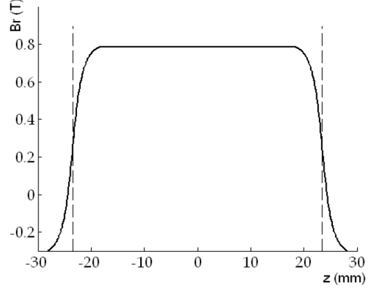

Fig. 1. Example of radial magnetic induction (Br) created by the linear structure along the trajectory (axis z) of the voice coil; the vertical dashed lines represent the total height of the structure.

REFERENCES
[1] J. Vanderkooy, J. Audio Eng. Soc., 37, 119 (1989).
[2] G. Lemarquand, IEEE Trans. MAG. 43, 3371 (2007).
[3] Ohashi *et al*., Patent EP 1 553 802 A2 (2005).
[4] W. House *et al*., US Patent 5 142 260 (1992).
[5] R. Ravaud *et al*., IEEE Trans. MAG 44, to be published in July (2008).
[6] H. Rakotoarison *et al*., IEEE Trans. MAG 43, 1261 (2007).