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## A Novel Three-phase Tubular Switched Reluctance Linear Machine with Transverse-flux path (Wed-Mo-Po3.12-11 [106])

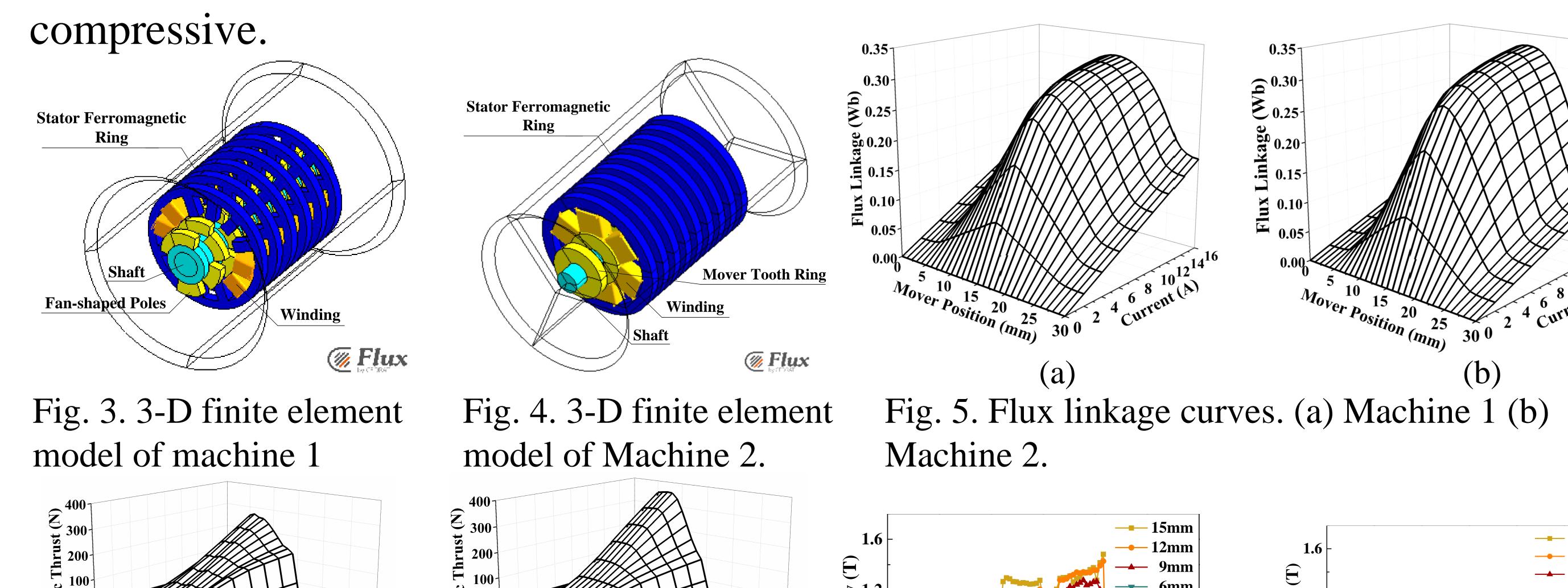
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## Model Establishment

Fig. 6. Electromagnetic thrust curves. (a) Machine 1

(b) Machine 2.

The ferromagnetic material used in this machine is 50DW470. The mechanical set of stator, outer boundary and windings are fixed. The mechanical set of mover is translation along the axial direction. The mechanical set of the air gap is



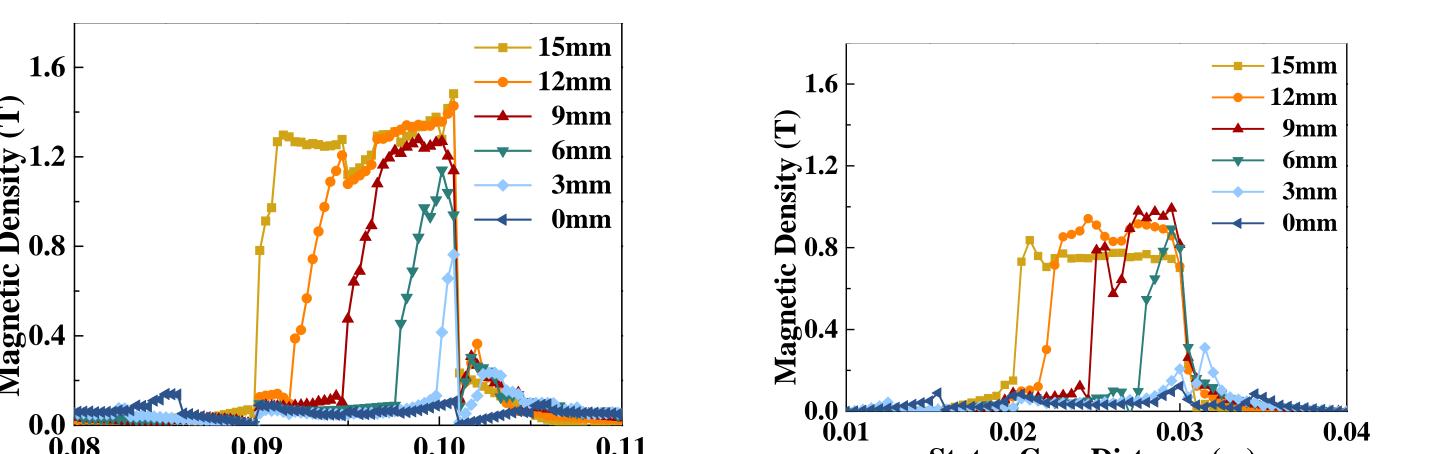


Fig. 7. Magnetic density distribution. (a) Machine 1 (b) Machine 2.

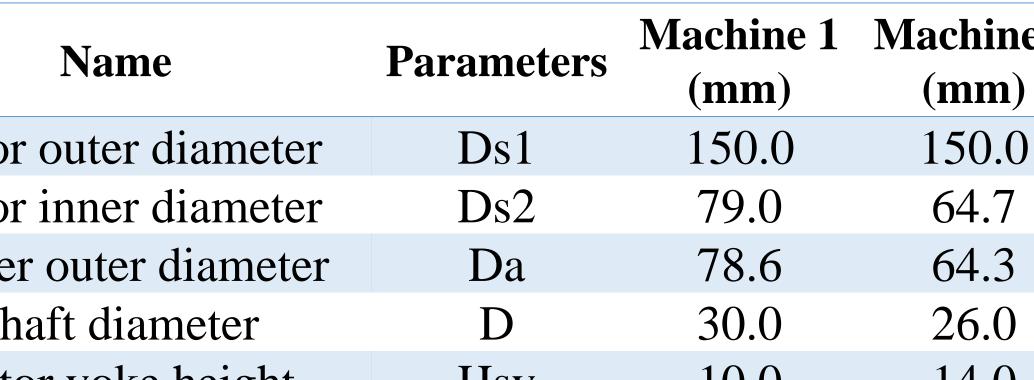


Table I Dimensions of Both TSRLMs

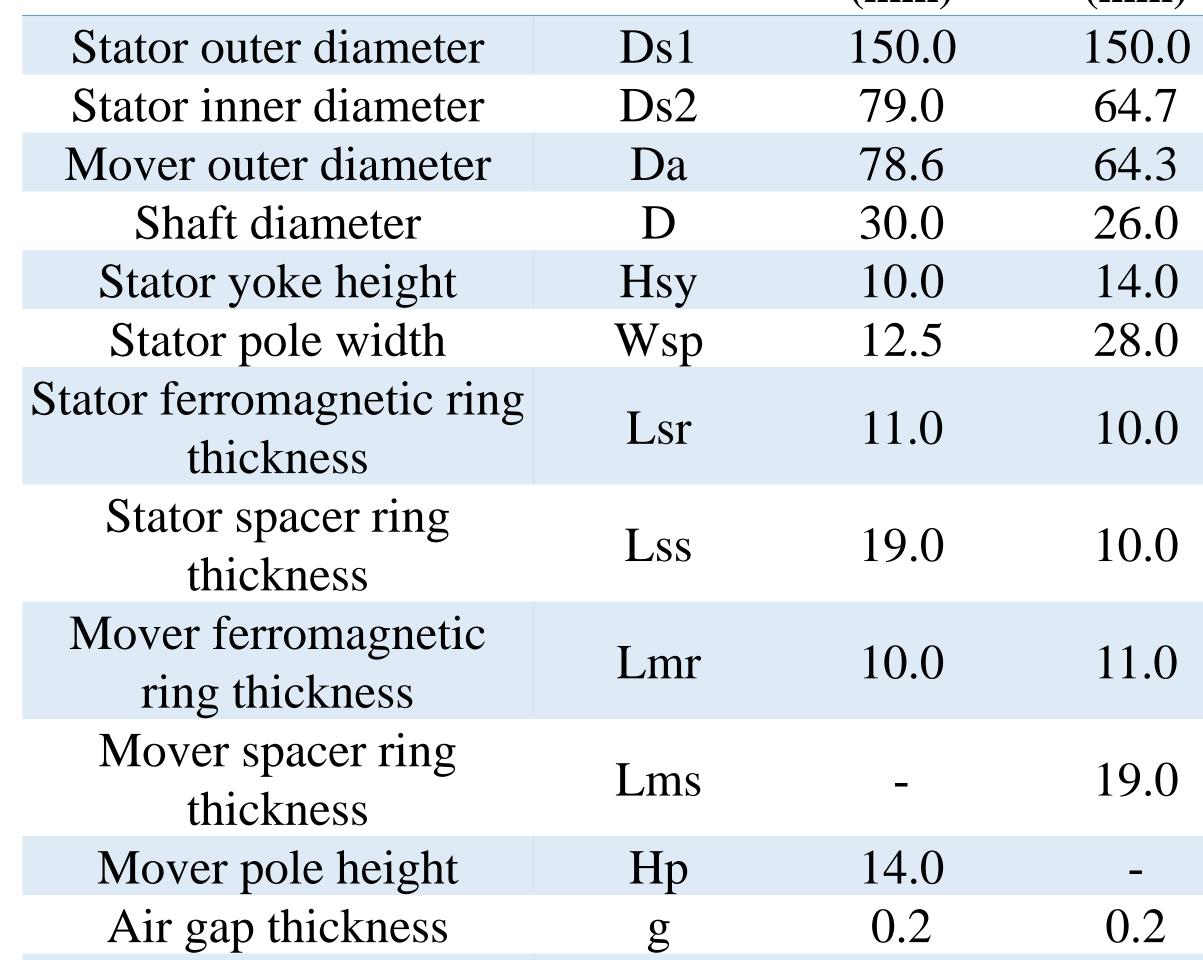


Table II Comparisons of Both TSRLMs

600.0

Laminated thickness

<b>Parameters</b>	Machine 1	Machine 2	
Volume (m <sup>3</sup> )	$4.241 \times 10^{-3}$	$4.241 \times 10^{-3}$	
Mass of core (kg)	10.888	18.512	
Mass of aluminum (kg)	2.616	1.636	
Mass of coils (kg)	3.567	3.227	
Average thrust (N)	153.250	184.822	
Average thrust per unit core mass (N/kg)	14.075	9.984	

Structures

Abstract — Several tubular switched reluctance linear machines (TSRLMs) with transverse flux

are proposed for improving thrust density recently. A novel three-phase transverse-flux TSRLM is

proposed in this paper, whose stator sleeve is composed of six ferromagnetic rings and five spacer

rings. And the mover is composed of an aluminum tube and several fan-shaped poles. The adjacent

fan-shaped poles are placed at 120 degree intervals. The novel structure permits that the winding

coils can be all through connections. This winding way helps addressing the problem of the coils

placement that exists in other transverse-flux TSRLMs. In order to verify superiority of the novel

TSRLM, a conventional transverse-flux TSRLM which has the same main dimensions is presented.

Finally, the finite element calculation results show that the average thrust per unit core mass of

Fig. 1. Structure of the proposed TSRLM. (a) Cross section of the machine (b) Mover (c) Overall structure (d) Prototype

proposed TSRLM is greater than conventional TSRLM.

Fig. 2. Structure of the TSRLM developed from [12]

## Simulation

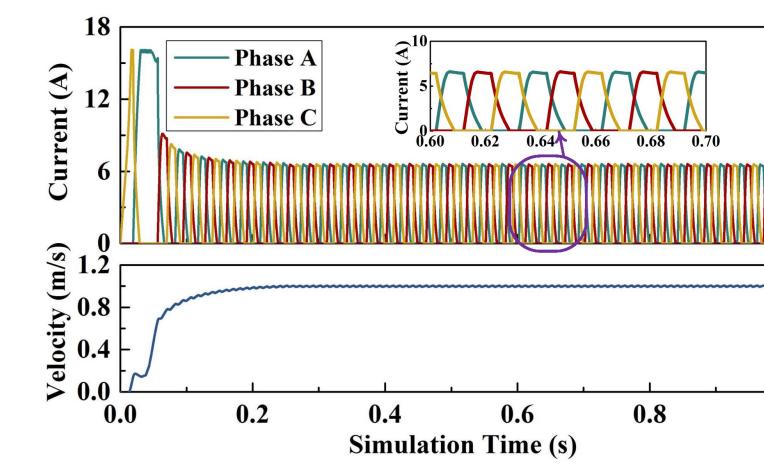


Fig. 7. Velocity regulation simulation of machine 1

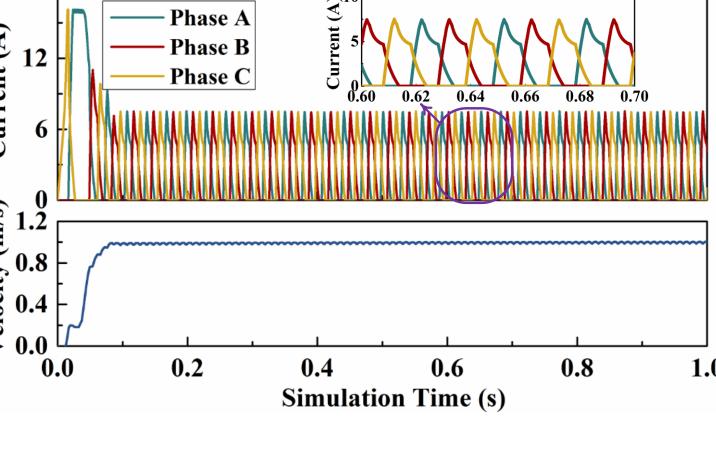


Fig. 8. Velocity regulation simulation of machine 2.

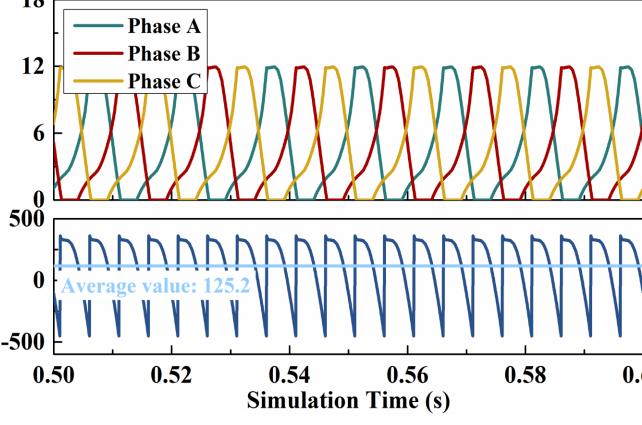
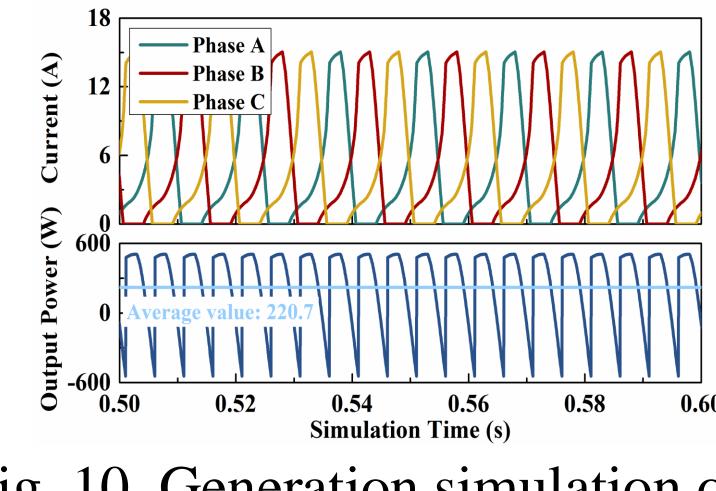


Fig. 9. Generation simulation of Fig. 10. Generation simulation o topology.



TSRLM1 with separately excited TSRLM2 with separately excited topology.

Conclusion ---- This paper presents a novel three-phase TSRLM with transverse flux for addressing the coils winding problem appeared in [12] (Machine 2). In order to verify the superiority of this structure, performance comparisons between Machine 1 and the Machine 2 are listed in Section II. It can be seen that the average thrust per unit core mass of machine 1 is 11.315 N/kg, which is greater than that of the Machine 2. The comparison table shows that it is nearly 40% higher than that of the Machine 2. It proves that the novel structure can increase the electrical utilization of TSRLMs and save core materials. Electrical simulations show that the current waveforms machine 1 are close to flat waveforms, which are good for itself and power electronic devices in the whole system. Machine 1 can be a strong candidate for velocity regulation system. But after generation simulations, it can be found that the ability in energy conversion of machine 2 is stronger. Thus, if one linear machine is used as a generator in direct-drive system, the structure of machine 2 is a strong candidate.