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[Continued on next page]

(54) Title: METAMATERIALS FOR SURFACES AND WAVEGUIDES

Figure 3: Wave-guided Complimentary Negative Index Metamaterials

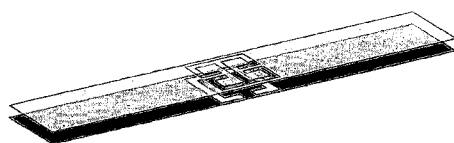


Figure 3A

Figure 3B

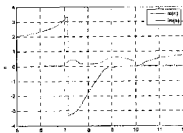
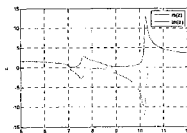
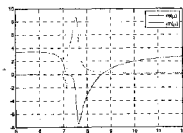
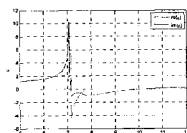


Figure 3C

Figure 3D

(57) Abstract: Complementary metamaterial elements provide an effective permittivity and/or permeability for surface structures and/or waveguide structures. The complementary metamaterial resonant elements may include Babinet complements of "split ring resonator" (SRR) and "electric LC" (ELC) metamaterial elements. In some approaches, the complementary metamaterial elements are embedded in the bounding surfaces of planar waveguides, e.g. to implement waveguide based gradient index lenses for beam steering/focusing devices, antenna array feed structures, etc..

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