In this paper, we present a strategy of shape-adaptive radial basis functions (RBF) based on potential functions. We also propose a neural network topology, which is based on RBFs and synthesized potential fields. The originality of the presented approach is in the training algorithm, which sequentially adds basis functions (centered on training data points) if this improves the classification performance. The experiments with several datasets demonstrate the algorithm’s power in generating classification solutions for learning samples of various shapes. We discuss the implementation of the presented method with two large data sets (vehicle silhouettes and shuttle control sets). We compare the classification performance on the training and test sets achieved by the proposed approach and some other neural network models.