A model for magnetic reconnection

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If you're not too dreadfully weary,
You may ask: what's the point of this theory?
Just please recollect
That **B***-lines reconnect;*
I hope that will answer your query!

1. Introduction

Magnetic reconnection is a diffusive process whereby the topology of a magnetic field imbedded in a highly conducting fluid may change with time. The process is frequently represented by the simple diagram shown in figure 1 in which the oppositely directed lines of force AB, CD reconnect to the configuration AC, BD. A huge literature emanating from the early papers of Sweet (1958), Parker (1957) and Petschek (1964) has evolved; for a recent thorough exposition including discussion of the important application of the theory in solar, magnetospheric and other contexts, see Priest & Forbes (2000).

Despite the prolonged research on this topic, there seems to be as yet no simple model which demonstrates unambiguously the necessarily time-dependent process indicated in figure 1 which takes account of the curvature of the field lines before and after reconnection. It is the purpose of this short paper to provide such a model. We restrict attention here to two-dimensional evolution in an incompressible fluid; generalisation to the more challenging problem of three-dimensional skewed flux tubes may however also be possible.

2. The initial configuration

It is natural to represent the curves AB, CD in figure 1 by the hyperbola

$$y^2 - k^2x^2 = Y^2 \tag{1}$$

where k and Y are constants. We first construct a magnetic field