Heat conduction in a photocopier

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In 1996 the project of which the content is described here, was carried out for Oce-Nederland B.V. in Venlo. One of the activities of this company is the design and development of photocopiers.
In a photocopier many processes from the various fields of physics take place. For example, in the fuse stage of a photocopying process a dry ink called toner is printed upon a sheet of paper. The sheet of paper is moved between two cylinders. A top layer of toner has been placed upon one of those cylinders. The pattern of this ink is a mirror image of the original. For optimal attachment of the toner to the paper, a high temperature of the toner is necessary. Therefor, the toner needs to be heated during the fuse stage.
Nowadays, one of the interests in research is the reduction of energy costs. A model for the various heat processes is necessary to research the effects of applying new techniques and/or materials. This model must be built out of components, one of which should represent the heat conduction process during the fuse stage.
The cylinders consists of layers, with each having its own thermodynamical properties. So, during the fuse stage, the following layers are in contact: the layers of the first cylinder, the toner, the paper and the layers of the second cylinder. The fuse stage takes about 4 milliseconds, which has lead to the assumptions that the main flow of heat is one-dimensional, and is in the direction perpendicular to the layers. The contact between two layers can be perfect, for example between two layers of a cylinder, or there can be a contact resistance, for example between the paper and toner. These assumptions lead to the heat conduction equation in a finite one-dimensional multilayered medium.
Two different mathematical approaches are discussed. First, the classical analysis approach considers the heat conduction equation as a Sturm-Liouville Problem. An extension of the Sturm theory can be used to derive the asymptotic behaviour of the eigenvalues in our situation. Secondly, a functional analytic approach shows the relation between the heat conduction equation and the evolution equation. A formal solution for this evolution equation is derived and has been used to obtain an approximation for the temperature. Finally, some results using this approximation are shown.