The History of Molded Fiber Packaging; a 20th Century Pulp Story

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ABSTRACT

Molded fiber packaging, which is also referred to as molded pulp packaging, has been around for a little over a hundred years now. From the first patent, dating from 1903, until approximately 25 years ago molded fiber packaging was a niche product used mainly for packing eggs. However, in the last two decades scientific understanding of the material properties and technology development improved the possibilities of application. Combined with an increased demand, due to a call for environmentally sound packaging materials, molded fiber has finally found a wider field of application.

INTRODUCTION

Molded fiber packaging, which is also referred to as molded pulp packaging, has been around for a little over a hundred years now. After being restricted to niche markets such as egg trays and boxes for a long time, its market share has increased as it is perceived as environmentally friendly material. This paper describes the historical development of industrial applications of molded fiber packaging, starting in 1903 when a patent is awarded to Martin L. Keyes [US 740,023] for an apparatus for making pulp articles.

METHOD

The approach taken in this paper is a review of several types of information on molded fiber packaging. Data sources used include patents, packaging handbooks, scientific papers, magazine articles and contacts with three molded fiber manufacturers; Huhtamaki in Franeker (NL), Fiberform engineering in Lichtervoorde (NL) and Brødrene Hartmann in Lyngby (DK). Of these data sources patents were used mainly to paint the picture of the pre-WWII developments, while books, papers and articles were used mainly in describing developments after WWII. Patents which are referred to, are accessible through www.espacenet.com and www.google.com/patents.

THE PROCESS: INDUSTRIAL PULP MOLDING

Fiber molding first appears in North America. Industrial application starts in the first half of the 19th century. In 1903 Martin L. Keyes, from Cambridge, Massachusetts, acquired a patent (US 740,023) for an apparatus for making pulp articles. From the patent search it becomes apparent that Keyes´ company is very active in molded fiber developments. Another early company is the Holed-tite corporation from New York. In Europe major players are Brødrene Hartmann and Universal Pulp Packaging.

Keyes' invention uses a mold with two parts with a space in between in which the product is formed. Basically his invention comes down to a perforated mold which is immersed into a pulp slurry. Suction is applied to the mold, which causes a layer of slurry to stick to the mold. The other face of the mold is moved in to properly shape the pulp article under pressure. Through the proper application of pressure and suction the pulp layer stays with the movable face of the mold, from which the article is transferred by a third arm to a conveyer belt, again using suction. By now the article has dried enough to sustain its own shape. The conveyer belt takes it through an oven to dry it further.

This basic process has changed very little over the years, although the second face of the mold is no longer seen as essential. Often the pulp article is transferred by a contra-mold directly from the original mold to the conveyer belt. Current day molds are usually made from bronze (for long running designs like egg cartons) or plastic (for shorter runs like cushioning for a consumer electronic product, that will only be in the market for several months). Over this mold a fine wire is laid which allows for the evenly distribution of the applied suction.

The emergence of this new technology around the turn of the century seems logical in the context of the general papermaking. As Twede (2006) describes, wood pulping emerged in the mid-1800s. In the US the post-civil war period sees newspapers, magazines and books become available to the common reader. As prices drop more applications emerge.

APPLICATIONS: EGG PACKAGING

Molded is quickly used as packaging for eggs. First several combinations with cardboard appear [US1,413,047; US1,429,207; GB206,997; US1,510,625; US1,746,838; US1,987,525]. Then attempts are made to make an entire packing out of molded fiber, which does not necessarily require a cardboard box [US1,780,264; US1,967,040; US1,975,128; US2,093,280]. The basic shape of the packaging still in use today, already appears before WWII [US 1,846,561]. Figure 1 gives an overview of the evolving design of egg cartons.

OTHER EARLY APPLICATIONS

The claims of many of the egg patents state that the invention applies to all sorts of fragile items such as fruits, light bulbs and radio tubes [e.g. US1,429,207]. The earliest examples actually showing these designs are from the 1920s. For instance for lamp chimneys and light bulbs [US1,986,344; GB206,997].

Although finding one patent with a particular application of molded fiber packaging, does not imply (widespread) implementation at that time, other applications found of molded fiber articles related to packaging are a closeable spoon for medicine from 1929 [US1,708,456], and a pastry holder from 1934 [US1,945,397]. Another early example is for carton liner [US1,808,136].

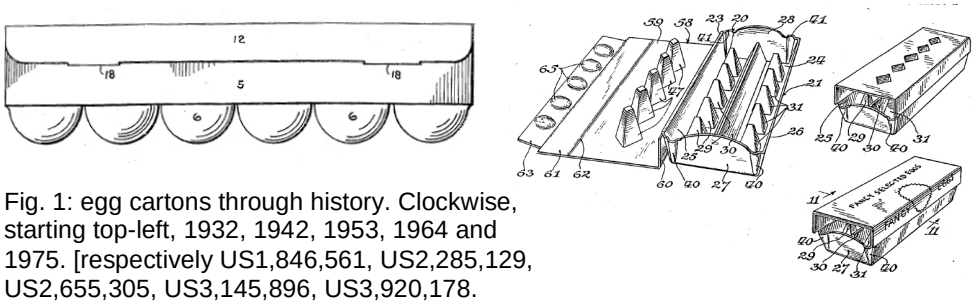
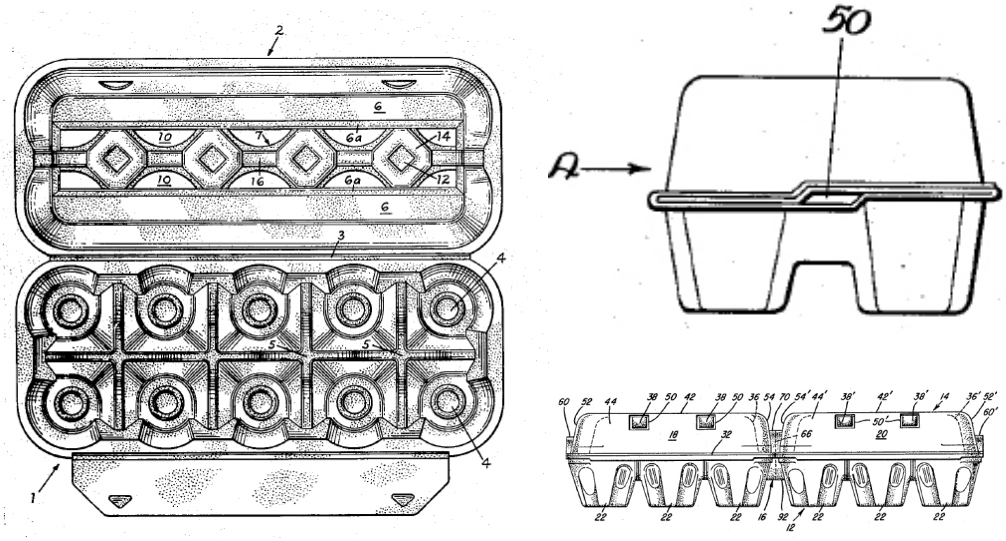


Fig. 1: egg cartons through history. Clockwise, starting top-left, 1932, 1942, 1953, 1964 and 1975. [respectively US1,846,561, US2,285,129, US2,655,305, US3,145,896, US3,920,178.



APPLICATIONS: CUSHIONING CONSUMER DURABLES

The first patent found concerning molded fiber as a packaging material for consumer durables is US patent 2,217455 by S. Price, et al. (1940). This is a packaging for a handset telephone (see figure 2).

Molded fiber doesn't acquire a relevant market share until consumers develop an interest in the environmental (un)friendliness of the products they buy (in the late 1980s). This picture is confirmed by the well-known *Deutschen Verpackungswettbewerb*, which awards prices to packaging innovations each 3 years. The first time molded fiber protective packaging is among the winners is in 1996. The jury explicitly states they feel molded fiber could show many more innovative solutions as a protective packaging material (Bähr 2002).

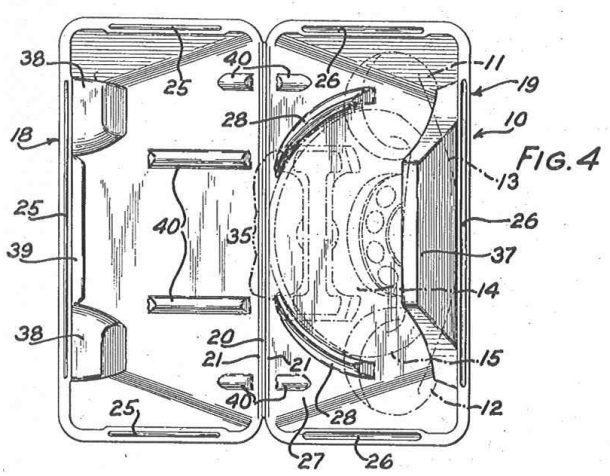


Fig. 2: Molded pulp packaging for handset telephone, patented in 1940 by S. Price.

ENVIRONMENTAL IMAGE

Due to the use of recycled materials, which are also renewable, molded fiber has a strong environmental image. As waste paper is a stream of recycling that a lot of consumers are participating in this only strengthens this image.

Not surprisingly competitors, especially suppliers of expanded polystyrene foam (EPS) have tried to attack this image. In the mid-1990s several Life cycle Assessments (LCA) were published "proving" EPS was more environmentally friendly than molded fiber (e.g. Luxenhofer, 1996); many of these studies were directly commissioned by the EPS industry. As environmental studies have to combine different environmental effects (e.g. acidification, smog, water pollution) there are usually aspects where one solution outperforms the other. By smartly picking the weights of the different environmental impacts, one can an outcome that favors either EPS or molded fiber. The weak points of molded fiber were, at that time, its weight (however, as previously discussed, for consumer electronics volume is more important), energy consumption for the drying

ovens and in water pollution. Especially in the last two areas considerable improvements have been made in the last decade (Goddard, 1996).

Furthermore the cushioning characteristics of molded fiber are very good. Several sources have indicated that, if properly designed molded pulp can be more volume efficient than EPS, thus allowing for smaller pack sizes (De Bever et al, 1996, Eagleton, Marcondes 1994, Lambourne, 1990). As Wever (2005) showed for most Consumer Electronics the density of the packed products is low enough that the volume is the limiting factor in transport efficiency. Furthermore transportation is at least up to twice as important as the impact caused by the packaging material itself (Wever, 2005). Hence the good cushioning characteristics of molded pulp provide a second environmentally favorable characteristic.

IMPROVED PRODUCTION QUALITY

Parallel to increased interest in the material because of its environmental profile, the possibilities of production improved. Advances in de-inking technology result in a much lighter shade of grey, which improves the quality appearance of the material drastically (Van den Berg, 1995). Also colored trays are possible by dying the slurry (Hogarth, 2005).

An other improvement is after-pressing (Goddard, 1996). Due to the production process, standard molded fiber has a fine mash pattern on one side, resulting from the mold, and a rather rough surface on the other side. By after-pressing the molded fiber shape both sides can have a reasonably smooth appearance.

UNDERSTANDING OF MATERIAL BEHAVIOR

Due to the increasing demand for application of molded fiber for industrial goods, a need arose for a better understanding of the material behavior. Due to the high cost of molds it is essential for the design to be first time right. Without proper design rules this is impossible. During the 1990s several projects were executed to gain this insight. A first study into the relation of geometry and cushioning characteristics (Eagleton and Marcondes, 1994) did not find any relation. Later study showed that truncated cones have the best properties (Hoffmann, 2000, De Bever et al 1996). This insight was translated into several designs that tried to utilize this insight to the full. Figures 3 shows two designs by Huhtamaki, from a European molded fiber producer (WO02076848 and WO02076849). Later scientific work attempted to apply finite element modeling to get an understanding of more complex shapes (Guruv, 2003). This produced promising results, but still presents some problems be it can be applied in cushion design.

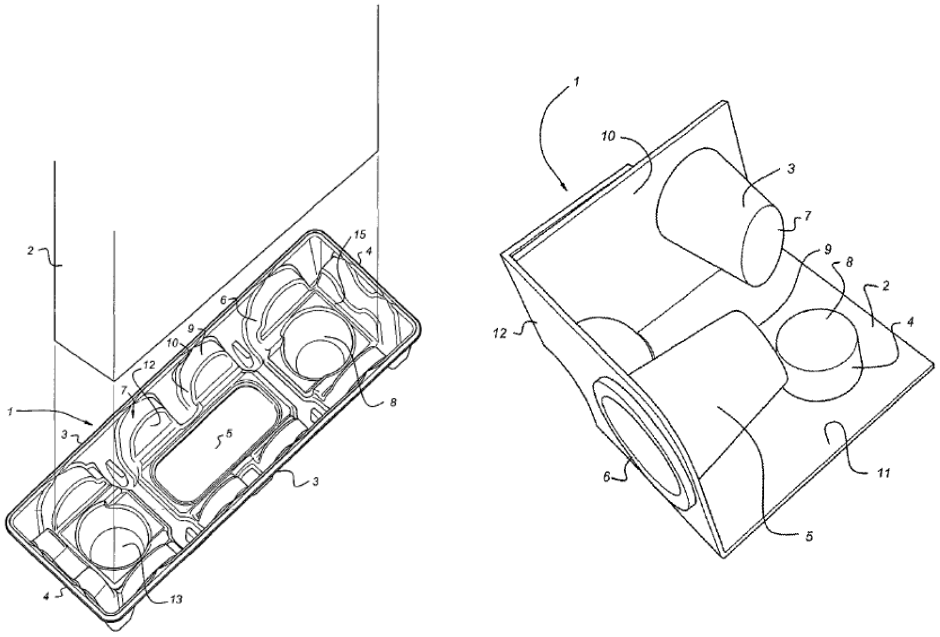


Fig. 3: Molded pulp cushions that apply the insight that truncated cones work best.

CONCLUSIONS

Molded fiber packaging is looking more vital than ever on its centenary. Due to its environmental characteristics interest in the material has increased. Due to improved production techniques the appearance has improved. And due to better understanding of the mechanical properties, performance has improved. Hence molded fiber is appearing in more and more applications.

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