The Adhesive Backing Paper Cutter

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Abstract

This paper will give an in-depth description of the need, the design process used, and the results achieved. The Adhesive Backing Paper Cutter was designed and created to cut slits into adhesive medical tape products to help users who had difficulty using the adhesive tape. Of particular interest is the technical description and corresponding diagrams.

Introduction

Adhesive medical tape products, or pads, are used to help various patients coping and overcoming cancer, burns, or other medical conditions. The pads can be used for a various number of applications; they may be used to cover burns and scar tissue or to attach silicon prosthetics. Patients use these adhesive tape products to help them return to their normal lives but the patients are often impeded by the physical application of the pad. The pad is comprised of an adhesive tape, which is attached to a removable backing paper. Some of the users may be handicapped and have problems removing the backing paper successfully because the thickness of the tape is less than a thousandth of an inch and the tape is closely bound to the backing paper. Thus, failure to remove the backing paper efficiently results in both frustrations to the user and inadequacy of the tape. To solve this problem, the manufacturers, Capital Marketing Technologies, proposed adding a slit in the backing paper to make the pad application easier for the user. During the initial manufacturing process the pads were manually slit and this primitive process could not keep up with the consumer demand. Capital Marketing Technologies needed a device that would slit the backing papers of a large quantity of pads quickly.

Group 1, of Baylor University, was invited by Capital Marketing Technologies to create a device that would slit the backing paper of a pad. Group 1 was a part of the junior design class, and had taken math through ordinary differential equations, statics, electric circuit theory, and basic physics classes. After twelve weeks of research and development, Group 1 created the Adhesive Backing Paper Cutter, or ABPC, and believes it is the best solution for the client.

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Capital Marking Technologies set specifications for the ABPC to meet. The device must be able to accept and slit a range of pad sizes and types. The pads range in size from 2.4 x 3.5 in. to 4.5 x 4.5 in. for rectangular pads or 2 x 3.5 in for the kidney shaped pads. The rectangular pads are singled sided and require one slit while the kidney shaped pads are double-sided and require a slit on both sides. The device must slit at least 40 single-sided pads per minute or at least 20 double-sided pads per minute. The device must not exceed a rejection rate of 5% or less of the total production of pads.

Design Process

After the design specifications were given, Group 1 began brainstorming possible solutions for the problem. This device would need a conveyor belt system to move the pads from the feeding mechanism to the cutting blades and then out of the device. Other ideas were considered such as using multiple cutting blades for cutting the double-sided pads and using vertical shield to hold the pads on the conveyor belt; these were implemented into the general design. After a period of planning and discussing, the first prototype, ABPC-01 was built (See Figure 1).

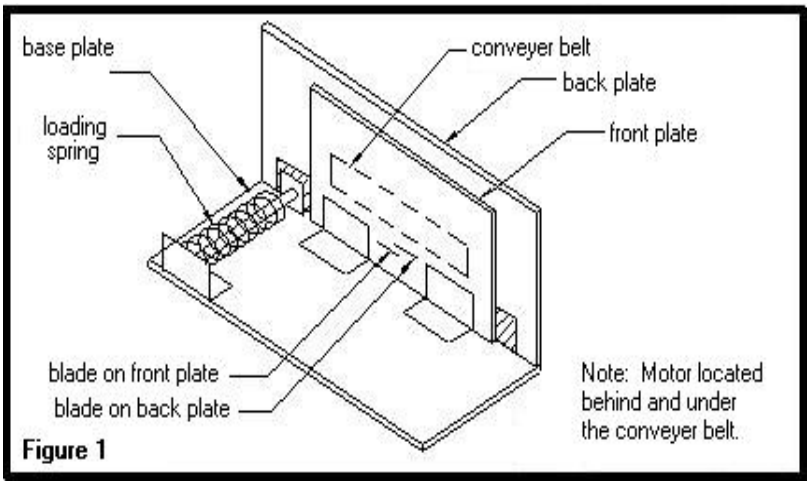

Figure 1

ABPC-01 was built of plexiglass and used a sander belt for a conveyor belt (refer to Figure 1). The plexiglass was chosen as a prototype material because its smooth surface would allow the pads to slide easily across the cutting blades. When tested, ABPC-01 did not cut any of the pads. The ABPC-01's inability to meet the requirements spawned many new ideas and considerations to Group 1. The plexiglass chosen for the ABPC-01 was difficult to cut and drill; therefore, Group 1 realized that wood had many of the smooth surface properties found in the plexiglass, but wood is easier to cut and drill. The conveyor belt used in ABPC-01 was a sander belt and did not have enough flexibility or grip to move the pads; as a result, a rubber mesh belt replaced the sander belt in the second design. The overall size of the original sander belt in ABPC-01 was 24 inches; it was reduced in the ABPC-02 by a factor of 60%. The resulting adjustments and modifications lead to a smaller, more robust prototype, ABPC-02.

ABPC-02 was constructed as a solution to several of the limitations realized from ABPC-01. ABPC-02 was built of materials that were easier to cut; it was made entirely of wood. A new conveyor belt was made using a rubber mesh, which was sewn together with thread. The overall length of the device was reduced from 24 inches to 12 inches. ABPC-02 was able to cut the pads but not with the precision required by the client. The improved design also needed some supporting rollers above the conveyor belt to hold the pad as it slid across the cutting blades. A third prototype would be needed to improve its imperfections.

ABPC-03 used a different approach than the previous prototype (refer to Figure 2). ABPC-03 was built with a metal frame and required less wood overall. Larger wooden dowels with treads for the conveyor belt replaced the dowels use in ABPC-02. In addition, a more powerful vacuum motor replaced the fan motor used in ABPC-01. Finally, the size of the prototype was restored to the dimensions of ABPC-01. The final prototype, known as simply, ABPC, took the design of ABPC-03 and further reinforced it by replacing all the wooden parts with aluminum (see Figure 2).

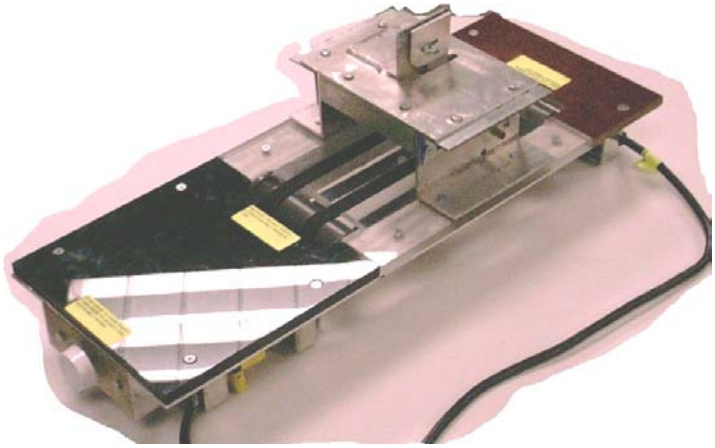

Figure 2

The ABPC utilizes a horizontal conveyor belt orientation, which transports the pads under an adjustable cutting blade. Two compression rollers are located above the conveyor belt and guide the pads underneath the cutting blade. The cutting blade is mounted between the two compression rollers on an aluminum lever arm. A 120 V vacuum cleaner motor drives the conveyor belt, which is attached to the two compression rollers; furthermore, a potentiometer adjusts the speed of the conveyor belt. Three removable top plates cover the motor and frame of the device.

The ABPC uses a compact design and durable materials to create a precise backing paper cutter. ABPC was designed with the ease of maintenance in mind; all wearable parts can be found at a hardware store. Safety was a priority; all sharp cutting blades are not exposed to the user.

Technical Description

An adhesive backing paper cutter, or ABPC, is a device used to cut a slit into the backing paper of a thin adhesive tape product. The ABPC transports adhesive tape products, or pads, on a conveyor belt, and places a slit across the backing paper of each individual pad. The slit allows the user to easily peel away the backing paper from the tape. An ABPC consists of a frame, three interlocking cover plates, a motor, a cutting assembly, and a conveyor belt (see Figure 3).

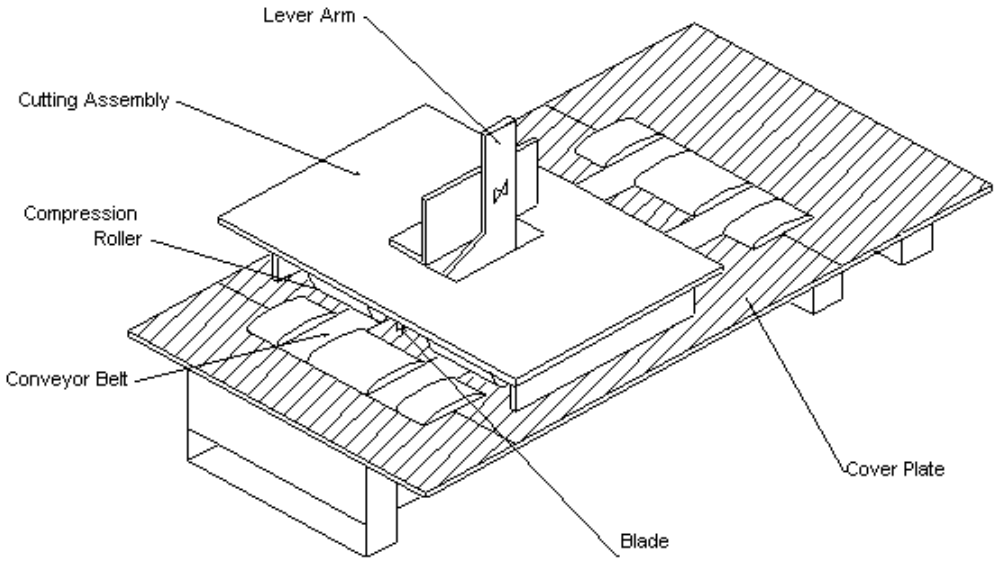

Figure 3

The frame is made of an aluminum angle gauge and is 24 inches long, 2 inches deep, and 9 inches wide. The frame provides structural support for the ABPC and secures the rollers for the conveyor belt. The frame is located underneath the cover.

The interlocking cover plates are made of plexiglass; in addition, the assembled plate, which encases the entire frame, is 24 inches long, 9 inches wide, and 0.25 inches thick. The blade assembly holding the cutting blade rests above the cover plates. Two surface grooves, which guide the conveyor belt, are carved in the center cover plate. The smooth texture of the cover plates allows the pads to easily slide across the cutting surface.

A 120-volt vacuum motor powers the conveyor belt. The motor is 4 inches long, 2 inches wide, 3 inches high, and is located inside the frame and connected to the back roller using a small, rubber 12-inch long vacuum drive belt. The motor is bolted to an aluminum motor mount, which secures the motor to the frame. The cover plates conceal the top of the motor from the ABPC operator's view. The cutting assembly is made of aluminum angle gauge and is 5.25 inches wide, 9 inches long, and 5 inches high.

The cutting assembly serves as a frame for the aluminum lever arm and PVC compression rollers (see Figure 4). The lever arm is 2 inches long and 4.5 inches high and has a wing nut at the top to lock it in place. Bolted to the bottom of the lever arm is the cutting blade for cutting the pads. The lever arm rotates about a pivot screw, which is located above the blade, and allows for fine depth adjustment of the slits made. A brass rod, which is 5.75 inches long, is threaded through the cutting assembly and functions as an axel for the two compression rollers. The compression rollers are 1.75 inches in diameter; the left compression roller is 2.25 inches long and the right is 2 inches long. The cutting assembly is located above the cover plates and is centered above the conveyor belt.

Figure 4

The conveyor belt is made of two rubber-serpentine belts and two solid PVC rollers. The two serpentine belts have a length of 24 inches and are 0.75 inches wide. The rollers have a 1.5-inch diameter and are 5 inches long. The rollers are located inside the frame and contain two 0.25-inch deep treads that guide the two belts along surface of the ABPC. The conveyor belt passes around the rollers and above the cover plates; a vacuum drive belt attaches the motor to the rollers. The vacuum drive belt is 12 inches in length and is 0.75 inches in width. The conveyor belt moves the uncut pads past the blades and carries the cut pads out of the ABPC.

The ABPC is a consistent and durable machine used to cut a slit into the backing paper of adhesive tape products. Its adjustable blade and resilient aluminum frame make it a very practical and functional instrument in the medical tape industry.

Summary and Conclusions

Overall Group 1 learned many different lessons from the semester project. During the design project, Group 1 was set back a few weeks by designing the APBC-01 with many different features and not focusing on the primary purpose of the device. After the initial setback of not meeting requirements, Group 1 demonstrated simple solutions to address

the problem by working in the lab to create many small-scaled prototypes. Group 1 also learned that choosing metal parts over wooden parts improved the resilience of the design; however, it was more difficult to make changes to metal than to wood. The final prototype was made completely of metal and cut the single sided-pads successfully, but not the double-sided pads.

References

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