Aug. 18, 1964 F. WOMMELSDORF 3,144,971

PAPER CUP AND PROCESS FOR MAKING IT

Filed Nov. 19, 1962

FIG. 1.

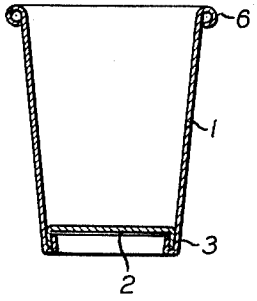


FIG. 1A.

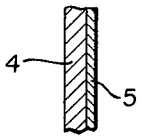


FIG. 2.

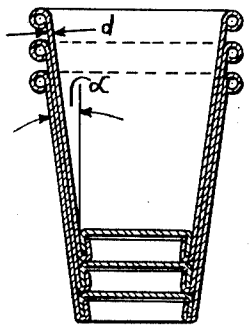


FIG. 3.

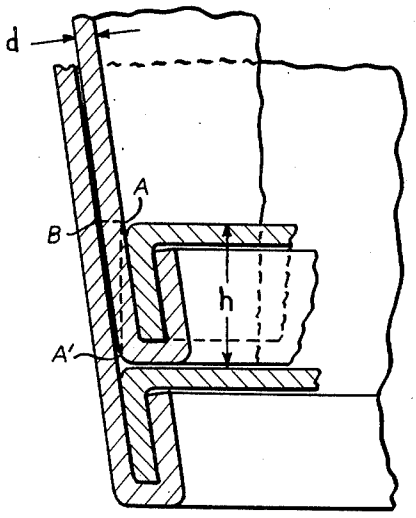
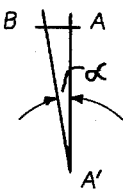


FIG. 4.



INVENTOR
FRITZ WOMMELSDORF
BY

DEZSOE STEINHERZ

United States Patent Office 3,144,971
Patented Aug. 18, 1964

3,144,971

PAPER CUP AND PROCESS FOR MAKING IT

Fritz Wommelsdorf, Eggersallee 23, Hamburg, Germany

Filed Nov. 19, 1962, Ser. No. 238,435
Claims priority, application Germany Nov. 20, 1961
2 Claims. (Cl. 229—1.5)

This invention relates to so-called two-part conical paper cups which are supposed to be used only once. Such paper cups are available e.g. in railroad stations and they are used also for packaging food products e.g. ice cream. The present invention relates only to cups which are supposed to be used for drinking and particularly for drinking hot coffee or other hot beverages.

At the beginning of the Twentieth Century when the paper cups were introduced, they were manufactured from paperboard of high density and the paper was sterilized during manufacture by strong heating in view of the intended single use as a drinking cup.

In a later phase of development treatment with paraffin was applied to cups, which this treatment was supposed to render tight, particularly at the point of the joint between bottom and side wall and also to protect the cup by the paraffin impregnation from penetration by water. It has been observed that such treatment with paraffin results in stiffening of the side walls so that it became possible to considerably reduce the thickness of the paper. However, this advantageous impregnation with paraffin could be applied only to cups for cold beverages. It an impregnated cup is filled with a hot beverage, the paraffin or other wax having a melting point of 52 to 56° C. would melt, mix with the hot beverage and result also in the formation of an unpleasant odor. For this reason, different kinds of cups were manufactured for hot and cold beverages, respectively, and these cups were denoted in commerce "hot beverage cups" and "cold beverage cups". A further development consisted in the manufacture of cups for beverage slot machines. In these machines upon dropping a coin in a charging opening, a cup is dispensed and subsequently filled with the beverage. These automatic devices required further modifications of the treatment of paper cups with paraffin. While previously impregnation with paraffin was carried out always in such a manner that a wax layer which was visible and could be scraped off, was formed on the inner and outer surace, new methods were developed in order to avoid the formation of surface layers which can be scraped off. This was done because—particularly on hot days—thick surface layers tend to become somewhat sticky and to affect the free fall of the cups.

In order to avoid this, the so-called dry waxing process was introduced. In this process the formation of wax surface layers of undesired thickness is prevented by passing the impregnated cups through long dripping chambers and sweating chambers in which they are subjected to evaporation of the paraffin to such an extent that paraffin fills finally only the pores of the paper, while outer surface layers which can be scraped off, disappear. However, cups thus prepared are likewise suitable for use only with cold beverages, while hot beverages cause the same trouble which has been already described above.

In the meantime for hot beverage cups another impregnating process was developed, which has essentially the object of coating the inner surface of the cup with a surface layer which is smooth and odorless so that upon being filled with hot beverages the unpleasant odor caused by glue and some other ingredients of the paper can be noticed to a smaller extent only. This process was developed after the last world war, when the use of synthetic plastics for such purposes has been more and more increasing. In using these synthetic materials two impregnating processes were applied. In one process the

desired layers were produced by spraying or casting the synthetic plastic into the ready cup. This required substantial additional apparatus. According to the other process, paper-board provided with the desired layer was used as starting material in the manufacture of the cups. This last mentioned process has been found particularly advantageous in the manufacture of coffee cups if for the layer of synthetic plastic high-pressure polyethylene (from the lower specific gravity range) has been used.

However, in this procedure the impregnation carried out prior to or after the formation of the cup, does not bring about stiffening of the cup walls. The paper-board remains soft and it is indispensable to use paper-boards of the same thickness as used previously in the manufacture of hot beverage cups from paper-board containing no synthetic layer, so that the cups are capable of resisting the pressure of the hand holding them and do not collapse when they are lifted whereby the hot beverage would overflow.

A process has been already suggested and used, in which food containers, particularly paper cups containing layers of plastic materials, were additionally treated with paraffin, primarily not in order to stiffen the cups, but rather in order to protect such containers on the outside from humidity and also for additional tightening, so that the thickness of the very expensive synthetic plastic layer can be kept low.

The method in which the stiffness of a paper cup is increased by treatment with paraffin on the outside and in order to save in the thickness of the paper, cannot be applied directly to hot beverage cups. Apart from the fact that the advantages which have been mentioned above in connection with food containers are without interest for beverage cups, the stiffening effect by paraffin is eliminated upon filling the cup with the hot beverage when the paraffin melts.

It has now been found by the present invention that a paper cup which has an inner protecting layer, can be stiffened by a treatment on the outside with paraffin under certain conditions and can nevertheless remain useful in this condition for hot beverages. In order to attain this result, the treatment with paraffin must be carried out by the process of dry-waxing and this dry-waxing must be kept so limited that the pores of the paper material are not filled. For the stiffening of the paper walls it is sufficient if the paraffin applied to the paper in this treatment amounts to only 90%, or less, of that weight of paraffin, which would be necessary in order to saturate the paper with paraffin. The term "saturation" is used here to denote the condition, in which the pores of the paper are completely filled, but no paraffin which is visible or can be scratched off, remains on the surface.

Such treatment has the effect that the side wall still remains capable of taking up water, due to the incomplete filling of the pores. It is well known, that all kinds of paper are hygroscopic and absorb from the air a certain amount of humidity, which depends on the relative humidity of the air. Thereby a condition of equilibrium is attained. For example, if paperboard which has not been treated with paraffin and is of the quality suitable for the manufacture of paper cups, will contain 7% b.w. humidity based on the weight of paper if it is stored in a room, in which the relative humidity of the air is about 70%. If such a paper is saturated up to 80% with paraffin, the remaining 20% will still be hygroscopic. In the above outlined example, such paper wall would still contain 1.4% absorbed water. This water content, which is somewhat lower if the air is drier, but is still present in the paper in noticeable amounts, has the effect that upon filling a cup, which has e.g. a layer of polyethylene, with hot coffee, part of the heat, penetration of which through the cup wall is already decreased by the inner polyethylene

layer, is consumed for causing evaporation of the water so that the rest of the heat is not sufficient for melting the paraffin. Therefore, the dry wax will not melt, or will melt only partially and the cup will retain the stiff character aimed at by the treatment with paraffin.

This effect is not limited to cups which are made of paperboard carrying a polyethylene layer. The effect can be observed also if the inner synthetic plastic layer is applied subsequently and consists e.g. of a dispersion of diofan (polyvinylidene chloride).

For carrying out the incomplete dry wax treatment the contact process which has been suggested by the present applicant and is described in the German publication (Auslegeschrift) No. 1123189, can be used with advantage.

In applying this process an important detail should be considered. As already mentioned above, the paper cup is hygroscopic on its outer walls. The pores of its paper contain water. By applying a paraffin layer from the outside the cup is strongly heated so that the water tends to suddenly escape from the pores. However, measured on the amount of water, these pores are clogged by paraffin; the water tries to emerge inward but is hindered there by the inner synthetic plastic layer. Bubbles of steam here formed may tear up the synthetic plastic layer or produce small blisters which impart a rough condition to the whole synthetic plastic layer. In order to avoid this, it is necessary according to the teaching of this invention to completely dry the cup from the outside in order to remove the water which could cause the before described harmful effect. After the incomplete treatment with dry paraffin is accomplished, the cup which still remains somewhat hygroscopic, as stated above, will absorb again sufficient water from the air after the cup is cooled down, in order to prevent melting of the paraffin upon filling the cup with the hot beverage.

In using this process hot beverage cups can be manufactured from paperboard of smaller thickness. The expenses of the additional paraffin represent only a fraction of the expenses which can be saved by the reduction of the thickness of the paperboard. The reduction of the paper thickness is particularly advantageous in connection with cups for automatic slot machines for hot beverages. The cups have a conical shape in order to telescope them into each other in storage. Due to the relatively small conus angle of the cups—which is in the range between 4° and 7°—the consequence is that the walls of the cups lie tightly against each other so that it is difficult to separate the cups. On the other hand, it is necessary in automatic slot machines that the cups easily separate from each other. For this reason, the height of the bottom is so selected that it prevents clogging of the cups on their conical walls. It is clear that the thicker the walls are, the higher the bottoms of the cups must be. At an angle of 6°, the tangent of which amounts to about 0.1, the height of the bottom must amount to 10 times the wall thickness in order that the telescoped cups fall easily apart. Therefore, the height of the bottom can be reduced by ⅓, if the thickness of the cup wall is reduced by ⅓. A stack of e.g. 50 cups has a height which corresponds to 50 times of the bottom height and the height of a single cup. A stack height predetermined by the dimensions of an automatic dispenser may contain considerably more cups if the bottom height of the cups is low. Therefore, the dispenser has to be refilled with cups less frequently, because the bottom height is smaller, at a smaller thickness of the cup wall, because the cups are provided with an incomplete dry-waxing.

The appended drawings serve to illustrate, by way of example, the cups embodying the present invention and to more fully explain the process of their manufacture. In the drawings

FIG. 1 diagrammatically illustrates in sectional view the structure of a cup prepared according to the invention;

FIG. 1A shows a magnified view of the material used to form the cup body;

FIG. 2 shows in a similar view three cups according to the invention, telescoped into each other;

FIG. 3 is a partial sectional view on an enlarged scale of FIG. 2 and serves for showing the dimensions of the individual parts; and

FIG. 4 is a separate illustration of the triangle A–A'–B appearing in FIG. 3.

Referring now to the drawings in detail, the cup shown in FIG. 1 consists of a wall **1** and a bottom member **2**, which are connected by a flanged edge **3**. Reference symbol 4 denotes the paper material which is provided with a synthetic plastic foil **5** on the inner surface. The circle in FIG. 1 shows the picture which can be seen from observation of the cross-section of the cup material, on a magnified scale. It will be understood, however, that the dimensions shown in the drawing, particularly the proportions between the thickness of foil and paper, are not limited to those shown in the drawing. Normally, the thickness of the paper layer will be essentially higher in comparison to the foil, than shown in FIG. 1. At the mouth of the cup, the edge is bent to a flanged roll **6**.

FIGURE 2 illustrates three cups of equal shape and dimensions telescoped into each other. They are stacked in this manner in high numbers and inserted in automats. It can be seen from FIG. 2 that due to their conical shape having a conus angle α the cups easily become locked, unless their bottom is made sufficiently high for preventing further penetration than that possible in accordance with the purely geometrical conditions of their design. These geometrical conditions are determined by the thickness d of the paper material, and the thickness of the covering foil, the conus angle and the height h of the bottom. These demensions are shown in FIG. 3 on an enlarged scale.

The conus angle is the angle formed by the wall of the cup with a line parallel with the axis of the cup. d denotes the thickness of the material which the cup is made of. The height of the bottom extends from the undermost edge of the bottom bead up to the inner, upper surface of the cup bottom.

The geometrical relations between these values can be derived from the triangle, the corners of which are denoted A, A' and B in FIG. 3. The points A and A' are located one above the other. If a cup would be inserted in the upper cup shown in FIG. 3, the edge of the bottom of such inserted cup would be located at point A. Therefore, it corresponds to point A' insofar as A' denotes the edge of the bottom of the upper cup. A horizontal line connects point A in outward direction to point B and the length of this connecting line is equal to the thickness of the side wall of the cup.

In the triangle A–A'–B shown separately in FIG. 4, the distance AA' is equal to the height h of the bottom and forms a 90° angle with a horizontal line. The conus angle α is also shown in FIG. 4. The letters tg stand for tangent. As the conus angle α is small, the distance AB is practically equal to the thickness d. From this the relation

$$h=\frac{d}{\mathrm{tg}}$$

can be derived. The height of the bottom is always made at least of a value equal to

$$h=\frac{d}{\mathrm{tg}\ \alpha}$$

In this case no locking of the cups can occur. If this condition is met, the height of a stack formed by n cups is essentially determined in dependence of the height of the bottom of the cups, and is equal to H (which denotes the height of a cup) $+n$ times h (which is height of the bottom). As h must be proportional to the thickness of the cup material, the number of cups which are present

in a stack of predetermined length is determined substantially by the wall thickness *d* of the cups.

Thus, the reduction of *d* according to the present invention has advantages not only in connection with saving material, but also because it renders possible the insertion of considerably more cups in a stack of predetermined length in comparison with prior art cups under otherwise equal conditions.

Any desired synthetic plastic material can be used as a foil for coating the paper material for the cups, which can be applied according to conventional methods to the surface of a continuous sheet of paper material or applied to the surface of shaped cups, likewise by conventional methods. Examples of such plastic materials are: polyvinylchloride, polyvinylidene chloride, polyethylene, polypropylene and rubber derivatives.

The parts and percent mentioned herein are by weight if not otherwise stated.

What is claimed is:

1. Paper cup for hot beverages, having a bottom part and a side wall connected to the bottom part; having on the inner surface of the paper material a coating consisting of synthetic plastic material substantially insoluble in water, the pores of said paper material on the outer surface of the cup being incompletely filled with paraffin, without applying paraffin onto said outer surface proper.

2. Paper cup as claimed in claim 1, in which the height of the bottom part amounts to at least the value

$$\frac{d}{\text{tg } \alpha}$$

wherein *d* is the thickness of the paper wall of the cup and α is an angle formed by the surface of the wall and a line parallel with the longitudinal axis of the cup.

References Cited in the file of this patent

UNITED STATES PATENTS

1,489,691	Barbieri	Apr. 8, 1924
2,176,216	Fenner	Oct. 17, 1939
2,240,599	Amberg	May 6, 1941
2,357,161	Barbieri	Aug. 29, 1944
2,816,697	Amberg	Dec. 17, 1957
3,049,277	Shappell	Aug. 14, 1962