

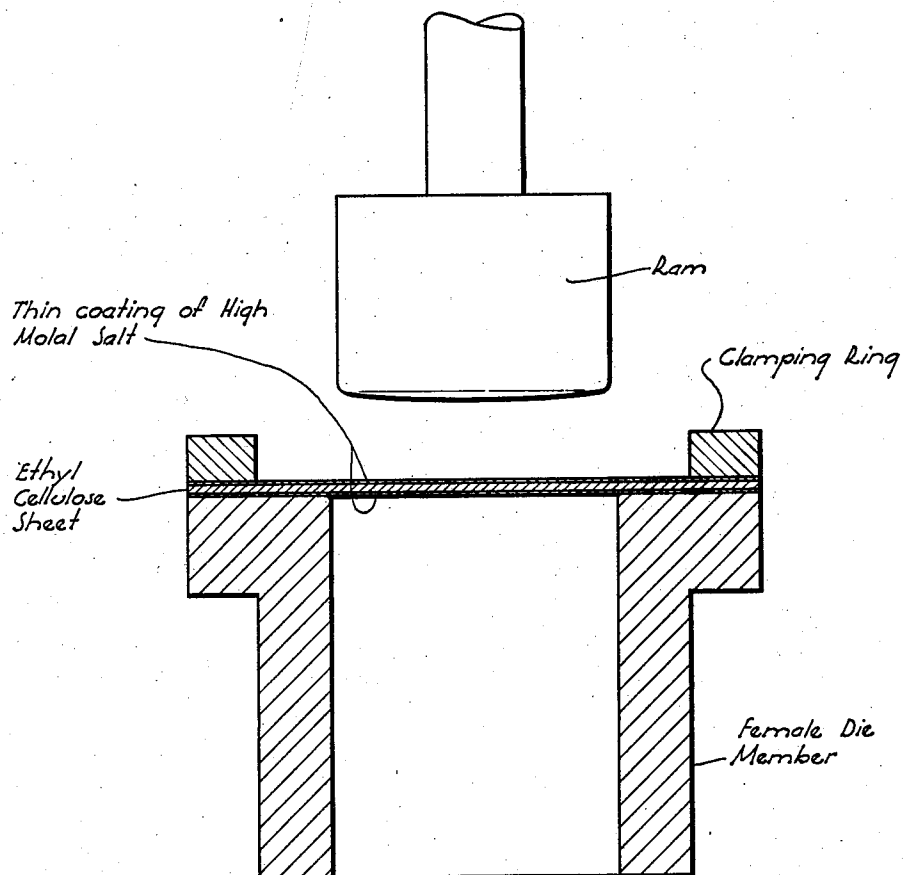
Sept. 22, 1942.

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2,296,723

METHOD OF DEEP-DRAWING ETHYL CELLULOSE FILMS

Filed June 8, 1940



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2,296,723

METHOD OF DEEP-DRAWING ETHYL
CELLULOSE FILMS

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Application June 8, 1940, Serial No. 339,492

8 Claims. (Cl. 18—56)

This invention relates to the making of hollow shapes from thermoplastic films by a process of drawing.

It is known that a hollow article may be made from a thermoplastic film by clamping the film over the opening of a heated die and pressing the film into the die by means of a suitably shaped ram. By this means the film is drawn so that it conforms to the shape of the die.

When using ethyl cellulose films it has heretofore been possible to make only comparatively shallow drawn articles such as, for example, caps for milk bottles. Attempts to make deep-drawn articles have resulted in the appearance of whitened areas extending from the edge of the clamp down the walls of the drawn article. This whitening appears to result from local overstrain of the film; it is unsightly and renders the drawn article useless. Whitening almost invariably occurs when articles having walls one inch or more high, for example, cylindrical cup-shaped articles, are drawn from untreated film blanks, and frequently occurs when drawing articles of lesser depth.

It is accordingly an object of this invention to make useful deep-drawn articles from ethyl cellulose.

A further object is to prevent whitening of ethyl cellulose film on drawing.

Another object is to prevent the sticking of ethyl cellulose film to the die during drawing operations.

The invention may be illustrated by reference to the accompanying drawing in which is shown in diagrammatic form a conventional deep-drawing apparatus, and in greatly exaggerated form a sheet of ethyl cellulose having on its surface a thin coating of a "high-molal salt."

According to our invention, the ethyl cellulose film, prior to drawing, is treated with a solution comprising an alkali metal salt of a sulfuric acid ester of a higher saturated fatty alcohol containing 10 or more carbon atoms. The film is then dried or allowed to dry, and is drawn to a hollow shape. For the purpose of the present invention, these salts are termed "high molal salts." Suitable "high molal salts" are: sodium lauryl sulfate, sodium stearyl sulfate, potassium cetyl sulfate, and sodium palmityl sulfate.

The solution comprising the "high molal salts" may also contain minor proportions (up to 50 per cent of the weight of the high molal salt) of colorless inorganic salts such as sodium sulfate.

Commercial products which may be dissolved in water to form solutions useful in carrying out

the instant invention include the household detergent known as "Dreft," the commercial wetting agent sold under the name Duponal W. A., and the emulsifying agent known as Duponal M. E. All of these products are composed largely of sodium lauryl sulfate.

Among the efforts to find an alternative and equally effective method of drawing ethyl cellulose film to that described in the present application there has been tried:

(1) The use of common lubricants such as mineral oil and soap on the ram, die and clamp ring of the drawing machine, or on the film surface.

(2) The treatment of the ethyl cellulose film prior to drawing with thin continuous coatings of each of the substances tabulated below:

	Commercial name	Believed to be—
1	Sapamine.....	A high molecular weight quaternary ammonium salt used as a wetting and emulsifying agent.
2	Aresklene 375....	Dibutyl phenylphenol sodium disulfonate.
3	Lux.....	Sodium stearate.
4	Aerosol OT.....	Octyl ester of sodium succinate.
5	Alkanol B.....	Sodium alkyl naphthalene sulfonate.
6	Triton S 18.....	A high molecular weight quaternary ammonium salt.
7	Alox 8000.....	Complex methyl esters of high molecular weight acids.

Neither class of treatment led to successful deep-drawing of ethyl cellulose films, as the film would seize and crack under the distorting influence of the drawing device.

It is necessary that the treatment of the ethyl cellulose films with the solution of "high molal salts" should be carried out so that on drying a thin, substantially continuous, yet invisible coating of the salt results. The coating should be as thin as possible on grounds of economy and in order to produce perfectly clear films. The treatment of the film may be carried out in any customary manner using a dilute solution of "high molal salt." Thus the film may be dipped in and out of the solution and excess liquid removed by means of a rubber squeegee blade or roller, or the solution may be spread on the film by means of brushes, a roller, a doctor blade, or by spraying. In our preferred method, we use an approximately 0.75 per cent by weight aqueous solution of "high molal salt" and apply a thin continuous coating of it to the film by means of a roll coating machine. We find that in all cases it is unnecessary to use a solution of concentration greater than about 3 per cent. After treat-

ment with the solution the films are dried in a current of warm air.

Ethyl cellulose films carrying a thin, continuous coating of "high molal salt" are sparkingly clear and have a hard slippery surface.

Ethyl cellulose films suitable for drawing include those made of all those types of ethyl cellulose which may be dissolved in organic solvents to give smooth, gel-free solutions suitable for film casting. There is on the market ethyl cellulose of ethoxy content as low as 44 per cent which is sufficiently uniformly substituted to yield smooth, flowable solutions suitable for film casting purposes. This material and ethyl celluloses of higher ethoxy contents are suitable for making films for drawing. However, it is preferred for most purposes to use ethyl cellulose of ethoxy content in the range from 44 to 46.5 per cent approximately as this material yields harder films of higher softening temperatures than do materials of the higher ethoxy range.

It is not necessary to incorporate plasticizers with ethyl cellulose when making films suitable for drawing, though up to 20 per cent of the film composition may consist of plasticizer. For most purposes it is preferred to use unplasticized ethyl cellulose film as it has a higher softening temperature than plasticized ethyl cellulose film and consequently has less tendency to stick to the die when drawing. Again, on account of its odorless and tasteless non-toxic nature, unplasticized ethyl cellulose film is particularly useful for making hollow shapes which are to be used for packaging foodstuffs. Films comprising plasticizer generally do not have this advantage; most plasticizers impart at least a slight taste and/or odor to foodstuffs when stored in contact with them.

The following example illustrates the practice of the invention, but it should not be construed as limiting its scope.

Example

Cylindrical cup shapes were prepared by deep-drawing operations performed on ethyl cellulose films which had been treated with the high molal salts previously mentioned. The drawing machine consisted essentially of a heated female die member having a cross section of 3.25 inches internal diameter. There was a cylindrical ram of about 3.23 inches diameter so adjusted and positioned that it could be driven to any predetermined depth into the heated die cavity. When the die and the ram were disengaged, there was an annular ledge about 7 inches in diameter surrounding the opening of the female die member and a clamp ring of like over-all diameter, adjustably tensioned, so as to seize and hold firmly the edges of the film blanks to be subjected to the drawing operation. A number of circular discs, 7 inches in diameter, were cut from both untreated ethyl cellulose film of 0.005 inch thickness and from ethyl cellulose film of the same thickness carrying a thin continuous surface coating of sodium lauryl sulfate. The discs were clamped in position over the opening of the female die member and were drawn by forcing the male ram down into the die opening. In the tests reported, the die was heated to a temperature of about 250° F. Cylindrical cups having smooth unblemished walls about 2.5 inches high could be made from the discs of treated ethyl cellulose when the film blank was retained under a pressure of about 10 pounds per square inch,

applied to the clamp ring around the periphery of the die opening. By way of contrast, attempts to make similar articles from the untreated film discs when using a corresponding die temperature and a corresponding pressure on the clamp ring resulted in breaking the untreated films. When, however, the pressure on the clamp ring about the die opening was reduced to about 5 pounds per square inch, deep-drawn cylindrical cups could be produced from the untreated film, but their appearance was marred by the occurrence of whitened areas, which extended downwards from the top edges of the cups nearly to the bottom. These whitened areas appear to be under considerable strain and the articles containing them are deemed unmarketable. When still lower pressures were employed to retain the untreated discs in a position over the die opening, the film slipped as the ram was driven home and the shaped article was badly wrinkled and worthless.

As an indication that the high molal salts exert solely a surface effect on the films, it might be pointed out that when film blanks which had once been treated with sodium higher alkyl sulfates were subsequently immersed in water prior to drawing and then dried, they exhibited the same mechanical difficulties and presented the same problem in the production of useful drawn shapes as did the films which had been given no prior surface treatment.

Although it may be believed, and it appears correctly so, that the efficacy of the high molal salts in producing smooth-walled, unblemished deep-drawn articles when operating as described herein depends upon some lubricating quality of the salts, it is quite obvious that the mere provision of a lubricant is not enough to achieve the desired result. This becomes apparent from the surprisingly large number of substances normally employed as surface lubricants other than the high molal salts, none of which were effective in producing satisfactory deep-drawn shapes from ethyl cellulose film. A partial list of such unsuccessful lubricants has been given hereinabove.

We claim:

1. The method which comprises coating a film, containing organo-soluble ethyl cellulose as the principal film-forming ingredient, with a thin surface layer composed substantially of an alkali metal salt of the acid sulfate of a saturated higher fatty alcohol containing at least 10 carbon atoms, drying the said coating, and drawing the film to make a hollow article.

2. The method which comprises coating a film consisting essentially of organo-soluble ethyl cellulose with a thin surface layer composed substantially of an alkali metal salt of the acid sulfate of a saturated higher fatty alcohol containing at least 10 carbon atoms, drying the said coating, and drawing the film to make a hollow article.

3. The method which comprises coating a film consisting essentially of organo-soluble ethyl cellulose and a plasticizer therefor in amount less than about 20 per cent of the weight of said film with a thin surface layer composed substantially of an alkali metal salt of the acid sulfate of a saturated higher fatty alcohol containing at least 10 carbon atoms, drying the said coating, and drawing the film to make a hollow article.

4. The method which comprises coating a film, containing as the principal film-forming ingredient, organo-soluble ethyl cellulose of from

about 44 to about 46.5 per cent ethoxy content, with a thin surface layer composed substantially of an alkali metal salt of the acid sulfate of a saturated higher fatty alcohol containing at least 10 carbon atoms, drying the said coating, 5 and drawing the film to make a hollow article.

5. The method which comprises coating a film, containing organo-soluble ethyl cellulose as the principal film-forming ingredient, with a thin surface layer composed substantially of sodium 10 lauryl sulfate, drying the said coating, and subjecting the film to a drawing operation to make a hollow article.

6. The method which comprises coating a film, containing organo-soluble ethyl cellulose as the principal film-forming ingredient, with a thin surface layer consisting essentially of sodium 15 lauryl sulfate and a minor proportion relative thereto of a colorless, water-soluble inorganic salt, drying the said coating, and subjecting the 20

film to a drawing operation to make a hollow article.

7. The method which comprises coating a film, containing organo-soluble ethyl cellulose as the principal film-forming ingredient, with a thin surface layer consisting essentially of sodium lauryl sulfate and a minor proportion relative thereto of sodium sulfate, drying the said coating, and subjecting the film to a drawing operation to make a hollow article.

8. The method which comprises making a hollow article by drawing a film containing organo-soluble ethyl cellulose as the principal film-forming ingredient, said film bearing a thin surface coating composed substantially of an alkali metal salt of a saturated higher fatty alcohol containing at least 10 carbon atoms.

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