FIG. 1

FIG. 2

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PLASTIC FILM MADE BY A FILM CASTING ARTICLE
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1 Claim

ABSTRACT OF THE DISCLOSURE

A method of making a film casting article having a casting surface capable of imparting to polymeric film cast thereon and stripped therefrom desirable optical and slit-roll forming characteristics. The cast surface of the film casting article is polished, blasted with grit, and stoned and polished again to impart critical "roughness" characteristics to such casting surface.

This is a division of application Ser. No. 881,370, filed Dec. 2, 1969, now abandoned.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention is a film casting article and, additionally, is a method of making a film casting article having a novel metallic casting surface on which polymeric material can be cast into film. The film casting surface is roughened, in a novel manner, whereby film cast thereon has imparted to it desirable surface physical properties.

(2) Description of the prior art

Roughened casting surfaces have long been known to the art. U.S. Pat. 2,866,717 to Bristol, which is exemplary of such prior art, shows a process for preparing a film casting surface having from 100 to 2000 microcrons of pits per square centimeter whose radii range from 1 to 10 microns which comprises coating a casting base with a cement comprising polyvinyl alcohol dissolved in a solvent.

U.S. Pat. 3,053,763 to Zobriskys shows a chromium bearing surface having a multitude of minute projections and depressions which correspond in size and shape to projections and depressions formed in a surface of solid un-secured chromium by blasting the surface with a high abrasive grit ranging in size from 60 to 150 mesh.

U.S. Pat. 3,177,558 to Gronholz et al. discloses a highly polished film casting surface having from $2 \times 10^4$ to $12 \times 10^6$ randomly spaced hemi-spherical indentations per square inch of surface with the indentations having diameters within the range of 30 to 1500 micromicrons.

U.S. Pat. 5,310,860 to Gronholz et al. shows a process for producing "nodular chill rolls" having a chromium plated surface having an over-all roughness of 4 to 20 micromicrons due to the presence of $2 \times 10^4$ to $12 \times 10^6$ hemi-spherical indentations per square inch of surface having diameters of 30 to 1500 micromicrons.

Canadian Pat. No. 536,619 to Bristol shows a process for manufacturing non-blocking film having uniformly distributed microscopic bumps on its surface by casting a film-forming solution onto a casting surface having 100 to 2000 microscopic pits per square centimeter with the radii of the pits generally ranging from about 1 to 10 microns.

Canadian Pat. No. 572,487 to Bristol shows a non-blocking thermosealable film web having about 100 to 2000 bumps per square centimeter whose radii generally range from about 1 to 10 microns and are uniformly distributed on both sides of the web.

None of these patents show or suggest the instant novel film casting surface and novel method of making it.

SUMMARY OF THE INVENTION

This invention is a film casting article and a method of making such article having a casting surface on which molten polymeric material can be cast to form a novel plastic film with good visual, wrapping and other properties. Briefly described, such method includes the steps of forming a metallic casting surface having normal minute surface pits therein, polishing the casting surface until the pits in the surface are less than 60 microns deep, blasting the polished casting surface with hard abrasive grit to form a multitude of new pits in the surface which are spaced an average of less than 0.004 inch apart and finishing the grit blasted surface until the pit depths are less than 60 microns and the nominal diameters of the pits are no more than 0.0005 inch.

In making thermoplastic polymeric film, generally a molten polymer or a polymeric solution is extruded through a long narrow die orifice onto a moving highly polished cooled metallic casting surface of a film casting article or member. The uniformity of the gauge across the cast film or web is determined largely by the setting of the two die lips which form the long narrow die orifice. The temperature of the cooled casting surface on which the extruded polymer is cast largely determines the quenching rate and the finish of such casting surface essentially controls the surface characteristics imparted to the film web cast thereon. The film casting member is usually in the form of a cylinder although certain film-making methods employ cooled metallic belts.

Many film uses, such as in cellulose acetate film windows in floral containers and in certain envelopes, require high transparency and clarity properties in the cast film. Such film characteristics are usually achieved by employing highly finished metallic casting surfaces. Super-finished casting surfaces, however, present problems, particularly relating to the winding of the web into roll form after it is slit into the desired web widths.

By practicing the method of this invention, this winding problem is controlled or alleviated by roughening the casting surface of a casting member so that the cast image of the film cast thereon has a controlled degree of surface roughness. This degree of roughness controls or determines the slip and anti-blocking or winding properties of the cast film; however, it may also adversely affect the clarity of the cast film.

Cellulose acetate and polyethylene terephthalate films made for use in the recording tape industry require high clarity of the film and other good optical properties. Further, good slit-roll formation properties of the film is critical since the one-side coated webs are slit into very narrow widths and wound onto narrow cores at high production rates. The desired combination of film properties for this use area points up the necessity for a film casting surface which will impart to chill-roll cast polymeric film excellent optical clarity with a surface roughness which is not noticeable to the human eye but is sufficient to insure good roll formation of re-slit rolls.

The metallic casting surface made by the method of this invention with its many critically formed pits or indentations produces a reverse-replica surface on polymeric film that is melt or solution cast thereon thereby forming a multitude of microscopic protrusions or projections on the film surface stripped from the casting surface. These protrusions cause the proper amount of field between wound film layers as the film web is wound to prevent blocking and also interlock sufficiently within.
the wound web layers to cause the alignment of the winding web to be maintained. The microscopic size of the protrusions, on the other hand, are such that the clarity of the cast film is not adversely affected or is maintained within acceptable limits.

**BRIEF DESCRIPTION OF THE DRAWING**

FIG. 1 is a fragmentary diagrammatic plan view of a film casting article made by the method of the present invention, the surface of which has been magnified approximately 250 times, and

FIG. 2 is a typical magnified sectional elevation, in diagrammatic form, of a film casting article embodying the invention.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

Referring to the drawing, a novel film casting article or member 10 of the invention consists of an article surface portion or part 11 having a “roughened” film casting surface 12, which surface portion 11 is affixed to or integral with or deposited upon an article base portion 13.

The casting surface 12 may be of chromium, stainless steel or nickel metals. A casting surface 12 of metallic nickel is preferred. This can be attained by using a nickel body or by using a metallic body such as finished steel on which is deposited a first layer of copper and a second layer of nickel.

The article surface portion 11 may be a layer of nickel which is deposited on a smoothly finished copper-covered surface, for example, of the article base portion 13 which, in turn, may be in the form of a cylindrical roll or a flat surface, such as the upper run of an endless metallic belt.

The film casting surface 12 is roughened in a novel manner and contains a multitude of pits or irregularly shaped indentations 14 which preferably have a depth, measured from peak to valley, ranging from 25 to 60 microinches, an average diameter of less than 0.0005 inch and an average spacing of less than 0.0045 inch. The pits 14 are highly irregular in cross-sectional shape and are randomly distributed across the casting surface 12. In addition to these pits 14, there is the unavoidable presence of microscopic scratches 15 remaining from the various machining operations. These are finished such that no individual scratch 15 exceeds more than 20 microinches in depth and all such scratches average no more than 6 microinches in depth.

**METHOD OF MAKING THE FILM CASTING MEMBER**

The preferred method for making the film casting member 10 with its novel film casting surface 12 includes the steps of depositing by electrolytic deposition up to 0.025 inch layer of nickel onto a previously finished metallic surface of the base portion 13 of the casting member 10 thereby to form the surface portion 11 of such casting member 10; stoning the nickel casting surface 12 of the surface portion 11 until the surface pits 14 in the nickel surface are less than 60 microinches deep, all accumulated scratches 15 on or in the surface 12 arithmetically average no more than 6 microinches in depth and no individual scratch 15 exceeds more than 20 microinches in depth; blasting the finished nickel casting surface 12 using hard abrasive grit to form a multitude of new pits 14 on the metallic nickel surface 12 which are spaced an average of less than 0.004 inch apart and finish honing of the preferred previously enumerated final roll surface characteristics were achieved. Examples 1 and 8 were usable surfaces but required an excessive amount of stone time to achieve the final desired surface characteristics. The pit spacings of Examples 2, 4, 5 and 6 were too close for rolls having final optimum finishing.

The final casting surfaces which resulted from honing the rolls of Examples 3, 7 and 9 had pit depths of from 50 to 60 microinches, pit spacing of less than 0.004 inch and average pit sizes of 500 microinches or less.
Cellulose acetate polymer was directly solvent cast onto these surfaces and the film so cast was examined for surface characteristics and for slit-roll winding characteristics. It was found in all cases that the films cast on these surfaces had acceptable clarity together with excellent slit-roll formation properties.

What is claimed is:

1. A plastic film made by casting polymeric material onto a film casting surface of a film casting article made by a method including the steps of:
   - depositing a layer of nickel of from 0.005 inch to 0.025 inch thickness onto an article base portion whereby to form a smooth metallic film casting surface having normal minute surface pits and scratches therein;
   - polishing the casting surface until the depths of the surface pits are less than 60 microinches, all scratches average no more than 6 microinches in depth and no individual scratch exceeds more than 20 microinches in depth;
   - blasting the polished casting surface with hard abrasive grit to form a multitude of pits on the metallic surface, which pits are spaced an average of less than 0.004 inch apart;

2. Stoning and polishing the grit-blasted casting surface until the pit depths are from 30 to 60 microinches and the nominal diameters of the pits are substantially no more than 0.0005 inch; and casting such polymeric material upon the surface of said casting article to thereby form a plastic film having the surface reproduction of said article.

References Cited

UNITED STATES PATENTS
2,866,717 12/1958 Bristol 117—41 X
3,063,763 11/1962 Zubrisky 308—241
3,310,860 3/1967 Gronholz 29—148.4 D
3,412,479 11/1968 Markovic 29—148.4 D

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