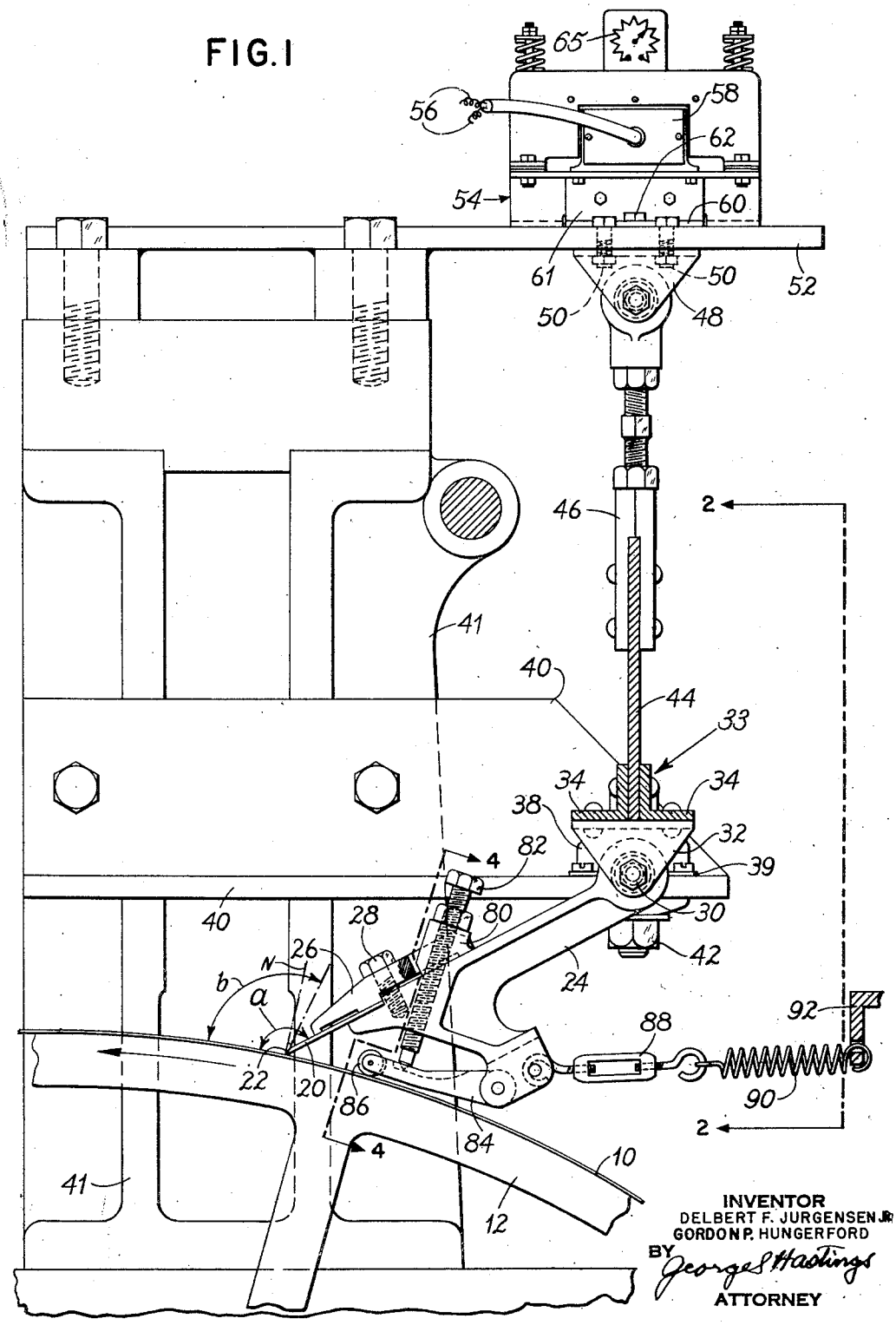
March 27, 1951 D. F. JURGENSEN, JR., ET AL 2,546,342

FILM CASTING KNIFE AND PROCESS

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FIG. 1



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FILM CASTING KNIFE AND PROCESS

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FIG. 2

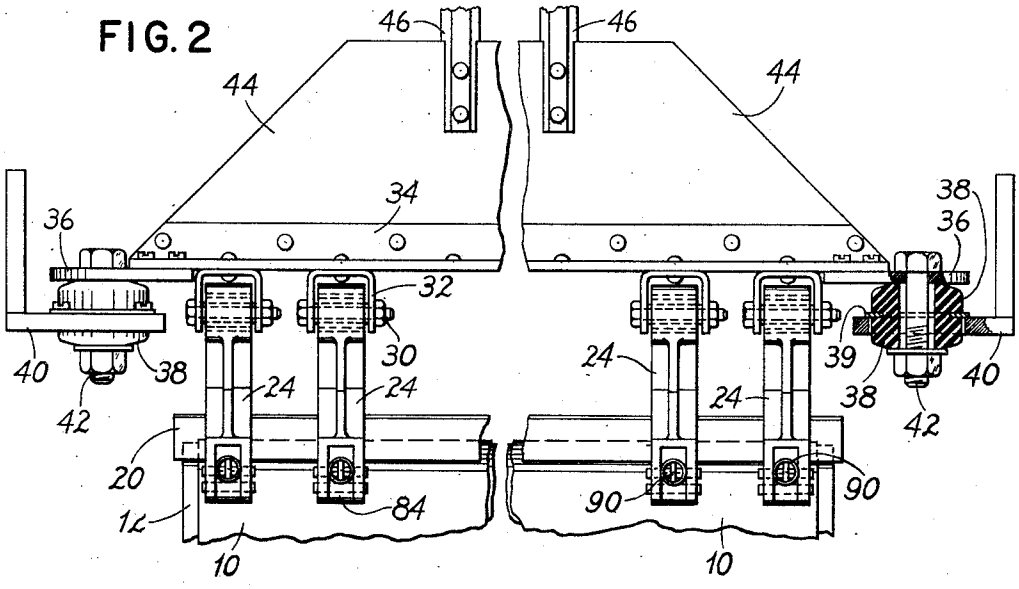


FIG. 3

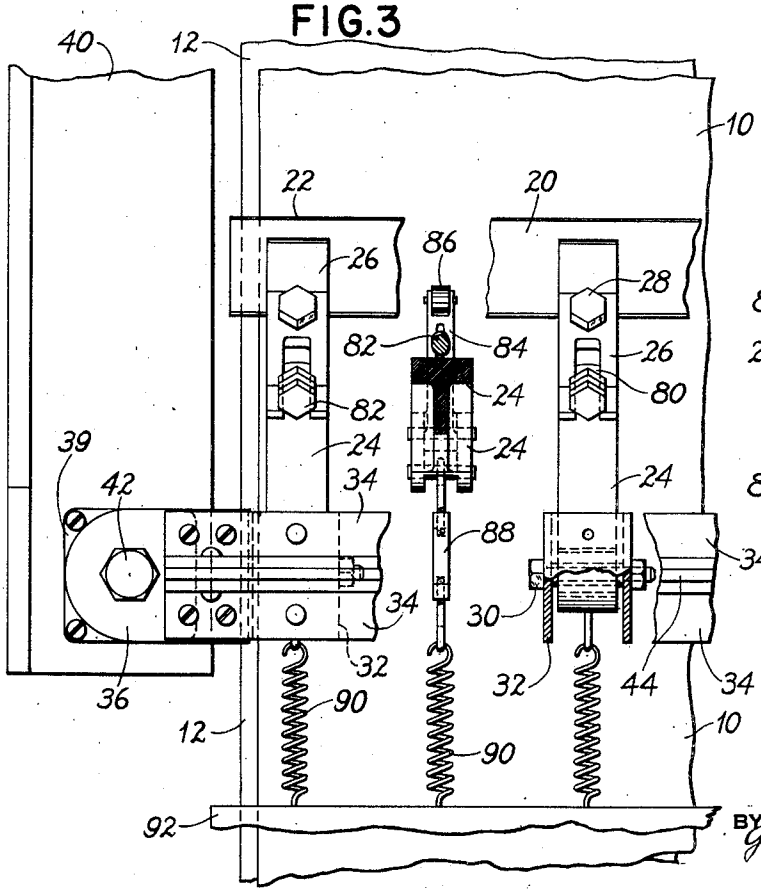
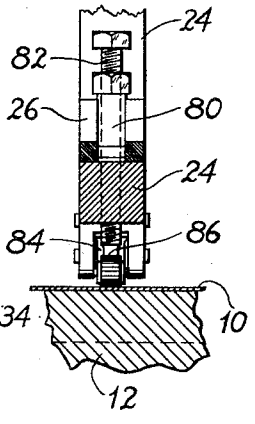


FIG. 4



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FILM CASTING KNIFE AND PROCESS

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FIG. 5

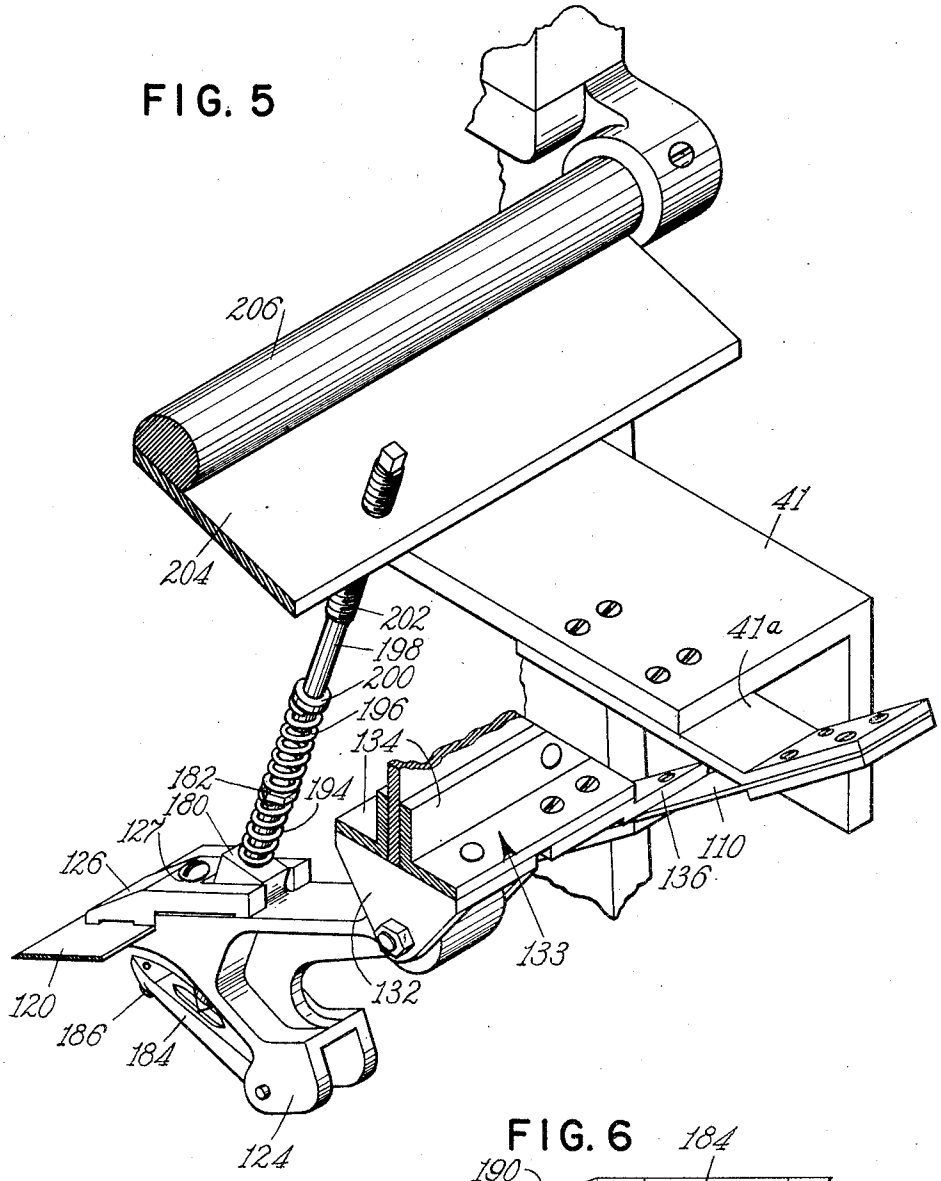
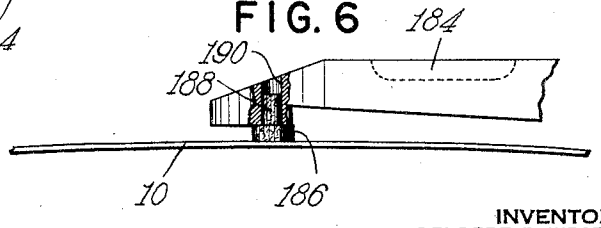


FIG. 6



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UNITED STATES PATENT OFFICE

2,546,342

FILM CASTING KNIFE AND PROCESS

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Application September 18, 1948, Serial No. 49,968

12 Claims. (Cl. 18—15)

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This invention relates to the manufacture of films or sheets by spreading the film forming material in a liquid or plastic state, either in solution or in suspension, on a surface, after which it may be solidified either by evaporation of the solvent or dispersant, or by other means, such as polymerization, lowering the temperature thereof, or coagulation.

One of the main objects of the invention is to spread the film forming material deposited on said surface in a manner whereby a layer (hereinafter called "web") of uniform thickness will be obtained from which a finished film of uniform thickness and appearance can be obtained by the above mentioned methods.

A further object is to avoid the formation of mottling or pockets on the surface of webs made from certain types of film forming materials, which results when presently commercially available web forming devices are used.

A still further object of the invention is to allow the formation of smooth webs from fibrous or other heterogeneous dispersions without the use of the excessive amounts of liquid dispersant necessary when presently known web forming devices are used.

These and other not specifically mentioned objects may be obtained with the method and apparatus selected to illustrate an embodiment of the invention and hereinafter described and defined in the appended claims.

In the accompanying drawings which form a part of this specification:

Fig. 1 is a side elevation of suitable mechanism embodying this invention for supporting and vibrating the casting knife, a portion of the drier belt with which it coacts also being shown; and

Fig. 2 is an end elevation of the same taken from the line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary plan view of the same; and

Fig. 4 is a detail view of the same taken on the line 4—4 of Fig. 1;

Fig. 5 is a detail view of a modified construction for supporting the casting knife; and

Fig. 6 is a detail view of a modified construction of one of the fingers forming a part of the mechanism for supporting the casting knife.

Referring to Fig. 1 of the drawings, it will be seen that an endless drier belt 10 which is supported on the drum 12 fragmentarily shown therein and another drum (not shown), travels in the direction of the arrow. The film forming material, which may be a fibrous dispersion

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such as tobacco slurry formed in the manner described in the Wells, et al., Patent 2,433,877, is deposited on a portion of the belt 10 overlying drum 12.

The tobacco slurry or other film forming material which may be deposited on belt 10 by any suitable spreading or feeding mechanism, is advanced underneath a web forming or casting knife 20 which preferably has a sharp edge and is arranged with its upper face at a suitable angle a to the belt 10. The web forming knife 20 is preferably formed of any suitable material, such as stainless steel, or other metal, so that it may be flexed in the manner hereinafter described, and will maintain a uniform clearance above belt 10 when vibrated. The preferred thickness of knife 20 is approximately 30–70 thousandths of an inch. This thickness of the knife assures the formation of webs of uniform thickness. The sharp edge on knife 20 may be formed by a bevel 22. The beveled side of knife 20 may be arranged facing either towards the belt or away from it (as shown), but in any case the upper surface of the knife should make an obtuse angle with the receding surface of belt 10, preferably greater than 110° as indicated by the a arrow in Fig. 1.

Reference is made to the upper surface of the knife forming an obtuse angle with the receding surface of belt 10, but it is apparent that the upper surface of the edge or bevel 22 of the knife is an operative surface. As shown in Fig. 1, the angle b of the surface of this bevel 22 with the receding surface of belt 10 is obtuse. If the knife be inverted then the cutting surface and the surface of the body of the knife being continuous would each form the angle a with the receding belt.

In the position shown in Fig. 1, the angle of the body of the knife prevents build-up of fibers on the upstream side while the still obtusely angled beveled edge 22 prevents mottling on the downstream side.

Heretofore, the casting knife was arranged approximately at right angles to the drier belt, and the slurry tended to adhere thereto on the downstream side thereof and cause mottling (non-uniform thickness) of the web and consequently of the film obtained by drying the material on belt 10. Due to the surface tension of the water therein, the slurry tends to climb up the right angle face of the knife on the downstream side thereof and thereby pull off drops of material from the top face of the slurry. This results in the formation of pock-marks, or mottling of the

slurry, thereby producing a non-uniform thickness thereof. Moreover, when using fibrous dispersions with an ordinary commercially available casting knife formed of heavy plate and arranged at approximately right angles to the drier belt, the fibers tended to agglomerate and collect behind the knife on the upstream side thereof and interfere with the feeding of the slurry thereunder. When the knife was elevated to relieve this condition and permit passage of the film forming material, the latter was then fed at an excessive rate which gave a dried sheet of a thickness greater than desired. By arranging our casting knife 20 at a suitable obtuse angle relative to the receding section of belt 10, these unfavorable conditions will be avoided. Furthermore, the slurry is thereby caused to circulate behind the knife in rolling fashion and thus minimize settling, stratification and agglomeration.

It will be observed that the knife 20 is clamped against a series of arms 24 by blocks 26 secured on each of the arms 24 by screws 28. The inner ends of arms 24 are pivotally supported by suitable members such as bolts 30 carried by yokes 32 which are secured to a support 33 comprising a pair of angle irons 34 extending across belt 10. The angle irons 34 are secured to plates 36 mounted on rubber cushions 38 having collars 39 embedded therein and supported by angle irons 40 secured to the main frame 41. The plates 36 are retained on cushions 38 by bolts 42.

A strap 44 connects the angle irons 34 to a pair of connecting rods 46 which are rigidly connected to yokes 48 by suitable bolts, the yokes being secured by screws 50 to the bottom of a pair of flexible metal strips 52. The strips 52 may be suitably secured to the top of frame 41 and constitute cantilever beams which are flexed by an electrical vibrator unit 54 to rapidly vibrate the support 33 and thereby vibrate the arms 24 with the casting knife 20. The vibrator unit 54 may be of any suitable type provided with a controller having a thermionic valve (not shown) which converts alternating electric current into pulsating waves which are supplied by wires 56 to the coil of the electromagnet or stator 58 which vibrates an armature connected to the casting 60. The flanges 61 of the casting 60 are secured to the strips 52 by screws 62. Thus the strips 52 will be rapidly vibrated to produce the desired vibration of the casting knife 20. The controller also includes a rheostat 65 which may be manually regulated to vary the amperage of the current flowing into the electromagnet 58. By setting rheostat 65 to vary the current flowing through the electromagnet 58 the vibration of knife 20 may be regulated to obtain a predetermined thickness of the web of film forming material.

The inner ends of blocks 26 are bifurcated and extend to either side of bosses 80 formed on the upper face of each arm 24. A stop screw 82 is threaded into a hole extending through the boss 80 and the underlying portion of arm 24. The lower end of stop screw 82 engages a finger 84 pivoted on arm 24 and carrying a roller 86 resting on the film forming material advanced on the belt 10. Instead of the roller 86 it is preferred to mount in a manner hereinafter described a disk 186 (Fig. 6) formed of Micarta or other suitable material on each of the fingers to slide on the film forming material advanced on belt 10.

For better results, the roller 86 should be located closer to knife 20 than is indicated in Fig. 1. Turnbuckles 88 connect the arms 24 to tension springs 90 anchored on a stationary member 92 whereby the arm 24 is swung downwardly to maintain the roller 86 in engagement with the belt 10. Instead of the tension springs 90, weighted levers connected to the turnbuckles 88 may be used. Accordingly, the arms 24 will be swung up and down by variations in the thickness of belt 10. Therefore, a predetermined clearance will be maintained between the sharp edge of knife 20 and belt 10 despite variations in the thickness of the latter. By individually adjusting the stop screws 82 the various sections of the casting knife 20 along its entire length may be flexed by different amounts to obtain a uniform clearance along the lower edge thereof across the entire width of belt 10.

In Fig. 5 is illustrated a preferred construction for mounting resiliently the support 133 which corresponds to the support 33. To the plates 136 secured on each end of the support 133, which comprises the pair of angle irons 134, may be secured one end of a pair of leaf springs 110 (only one leaf spring being shown in Fig. 5) which are anchored at their other ends to extension 41*a* of the main frame 41. The knife 120 is formed of flexible material and supported from support 133 in the same manner, as described above, upon a series of arms 124 pivoted on yokes 132 secured to the bottom of support 133. The knife 120 is retained on the arms 124 by blocks 126 which are secured to the arms by screws 127. The inner ends of blocks 126 are bifurcated and extend to either side of bosses 180 provided on each arm 124. Stop screws 182 are threaded into holes extending through each boss 180 and the underlying portion of each arm 124 to engage a finger 184 pivoted on each arm 124. A disk 186 (Fig. 6) formed of Micarta or other suitable material has a stem 188 secured in a hole 190 formed in each finger 184 and rests on the film forming material advanced on belt 10. A compression spring 194 interposed between the boss 180 and the head of stop screw 182 prevents accidental turning thereof. Each arm 124 is swung downwardly to maintain the knife 120 in engagement with the film forming material on belt 10 by a compression spring 196 mounted on the lower end of a stop screw 198 and seated against a flange 200 thereon. The lower end of spring 196 engages the head of stop screw 182 and stop screw 198 has a threaded portion 202 threaded into a plate 204. Plate 204 is secured to a bar 206 which is fastened at its ends to frame 41. By individually adjusting the stop screws 182 the casting knife 120 may be flexed along its entire length to obtain a uniform clearance along the lower edge thereof across the entire width of the belt 10.

With the construction shown in Fig. 5 more uniform thicknesses of the web of film forming material will be formed on belt 10 when support 133 is vibrated by a vibrator unit (not shown) similar to the vibrator unit 54 described above and connected to a strap 144 secured to the angle iron 134. Furthermore, with the construction of Fig. 5 the vibration will be damped less than with the construction of Fig. 1.

As previously mentioned, due to the relatively large or obtuse angle a of the upper face of knife 20 or knife 120 with the receding portion of belt 10 excessive agglomeration of the fibers of the tobacco slurry or other fibrous dispersion deposited on the belt is prevented. There is thus avoided the interference with the feeding of the slurry which results with casting knives presently available and having lower edges of various de-

signs arranged to engage the upper surface of the film forming material on the belt and disposed at an angle of about 90° thereto. With our arrangement of the knife 20 or knife 120 at a suitable obtuse angle to the receding section of the belt 10 further advantages, which were previously mentioned, are obtained in avoidance of mottling of the film forming material and minimizing settling, stratification and agglomeration. Thus the solid materials are kept in suspension and more uniform slurries are obtained.

The effect of the vibration of knife 20 or knife 120 is:

(1) To produce smoother films and webs than can otherwise be formed.

(2) To allow the formation of webs containing more fibrous materials than heretofore possible, with the use of less dispersant (water) than heretofore possible.

The vertical vibration of knife 20 or knife 120 allows large agglomerates of fibers or other constituents of the film forming material deposited on belt 10 to pass under the knife and in doing so to be patted down to form a smooth surface. Furthermore, we have some evidence that vibration of the knife provides a certain degree of pumping action, in much the same manner as a vibratory feeder works on dry materials. This effect would help to explain why the vibration of the knife permits the casting of slurries of much lower water content than was hitherto necessary.

In the operation of the particular apparatus exemplifying the invention, the tobacco slurry, or other film forming material in solution or in suspension, is deposited on the belt in any suitable manner or by any suitable apparatus. The slurry, or other film forming material deposited, is spread upon the belt 10 by the vibration of knife 20 or knife 120 to form a continuous web of uniform thickness. The stop screws 82 or 182 are adjusted to provide the amount of clearance beneath knife 20 required by the character of the slurry and the thickness thereof desired. By adjusting the rheostat 65 of the vibrator unit the vibration of the knife 20 or knife 120 may be regulated to obtain the desired thickness of the web of film forming material.

The web may then be solidified to form a finished film of uniform thickness and appearance by evaporation of the solvent or dispersant, or by other means such as polymerization, lowering the temperature thereof, or coagulation, etc.

While the invention has been exemplified in a particular apparatus suitable for performing a novel method embodying our invention, it will be understood that other constructions and methods within the scope of the appended claims may be utilized.

What is claimed is:

1. The combination with a conveyor adapted to advance film forming material deposited thereon, of a member adapted to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, and a device for supporting and rapidly vertically vibrating said member to assure formation of a web of film forming material of uniform thickness.

2. The combination with a conveyor adapted to advance a fibrous dispersion deposited thereon, of a member adapted to engage and spread the fibrous dispersion advanced on said conveyor to form a continuous fibrous web, and a device for supporting and rapidly vertically vibrating said member to assure formation of a fibrous web of uniform thickness, said member being arranged at an obtuse angle to the surface of said conveyor to prevent mottling of said web and permit passage of the fibers in said fibrous dispersion under said member whereby the same are prevented from agglomerating by the vertical vibration of said member to form a smooth surface on said web.

3. The combination with a conveyor adapted to advance film forming material deposited thereon, of a member adapted to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, a support to which said member is pivotally connected, yielding means for resiliently maintaining said member against the film forming material on said conveyor, and a vibrator connected to said support and adapted to vibrate the support with said member to assure formation of a web of film forming material of uniform thickness, and a plurality of leaf springs which are anchored at one end and fastened at their other end to said support to permit the support to be vibrated by said vibrator.

4. The combination with a conveyor adapted to advance film forming material deposited thereon, of a member adapted to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, a support to which said member is pivotally connected, yielding means for resiliently maintaining said member against the film forming material on said conveyor, and a vibrator connected to said support and adapted to vibrate the support with said member to assure formation of a web of film forming material of uniform thickness, and a plurality of cushions underlying and supporting the ends of said support to permit the latter to be vibrated by said member.

5. The combination with an endless conveyor having a run adapted to advance film forming material deposited thereon, of a knife having a sharp edge arranged to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, said knife being disposed with its upper face at an obtuse angle to said conveyor run, and a device for supporting and rapidly vibrating said knife to assure formation of a web of film forming material of uniform thickness, said device including a support, a plurality of members pivoted on said support, means for retaining said knife on said members, and instrumentalities for continuous automatic individual adjustment of said members relative to the surface of said endless conveyor to transversely flex said knife to maintain a uniform clearance along the lower edge thereof across the width of said endless conveyor.

6. The combination with a casting knife having a sharp edge arranged to engage and spread a continuously advancing layer of film forming material to form a continuous web of film forming material, said knife being disposed at an obtuse angle greater than 110° to the receding section of the layer of film forming material to prevent mottling of said web and permit passage of agglomerates under said knife, of a device for supporting and rapidly vibrating said knife in a generally vertical direction whereby agglomerates are prevented from agglomerating by the vibration of said knife and thereby to form a smooth surface on the web.

7. The combination with a conveyor adapted to advance film forming material deposited thereon, of a flexible member extending across said conveyor and adapted to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, a support, a series of arms pivoted on said support, a device for clamping said member against said arms, and means for individually adjusting said arms relatively to said conveyor to transversely flex said member by different amounts along its length to obtain a uniform clearance beneath said member across the entire width of said conveyor.

8. The combination with a flexible member having one edge thereof arranged to engage and spread a continuously advancing slurry, of a support, a series of arms pivoted on said support, means for clamping said member against said arms, a device for maintaining said member yieldingly against said slurry, and means for individually adjusting said arms relatively to said slurry to transversely flex said member and maintain a uniform clearance beneath the operative edge thereof.

9. A process for making films or sheets comprising depositing fibrous film forming material upon a continuously advancing surface extending in a generally horizontal direction, and spreading the film forming material on said surface to form a continuous web of film forming material with a knife arranged at an obtuse angle relative to said surface great enough to prevent mottling of said web and permit passage under said knife of agglomerates of the fibers of the film forming material, and vibrating said knife in a generally vertical direction to prevent agglomeration of the fibrous constituents of the film forming material and thereby form a fibrous web having a smooth surface.

10. A process for making films or webs comprising depositing film forming material having solid constituents upon a surface extending in a generally horizontal direction to form a continuous web of film forming material, spreading the film forming material upon said surface with the sharpened edge of a knife arranged at an obtuse angle greater than 110° to said surface to prevent mottling of said web and permit passage of agglomerates of said solid constituents under said sharpened edge, and vibrating said knife in a generally vertical direction to prevent agglomeration of said solid constituents and thereby form a web having a smooth surface.

11. A process for making films or sheets comprising depositing fibrous film forming material upon a continuously advancing surface extending in a generally horizontal direction, and spreading the film forming material on said surface to form a continuous web of film forming material with a knife arranged at an obtuse angle relative to said surface great enough to prevent mottling of said web and permit passage under said knife of agglomerates of the fibers of the film forming material, and vibrating said knife in a generally vertical direction to prevent agglomeration of the fibrous constituents of the film forming material and thereby form a fibrous web having a smooth surface, and governing the clearance between the operative edge of said knife and said advancing surface, and thereby regulating the extent of downward vibration of said knife to produce a web of film forming material having a predetermined thickness.

12. The combination with an endless conveyor having a run adapted to advance film forming material deposited thereon, of a knife having a sharp bevel edge arranged to engage and spread the film forming material advanced on said conveyor to form a continuous web of film forming material, said knife being disposed with the upper face of its bevel edge at an obtuse angle to said conveyor run, and a device for supporting and rapidly vibrating said knife to assure formation of a web of film forming material of uniform thickness, said device including a support, a plurality of members pivoted on said support, means for retaining said knife on said members, and instrumentalities for continuous automatic individual adjustment of said members relative to the surface of said endless conveyor to transversely flex said knife to maintain a uniform clearance along the lower edge thereof across the width of said endless conveyor.

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