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H. E. VAN DERHOEF

2,226,186

FILM CASTING ELEMENT

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FIG. 1

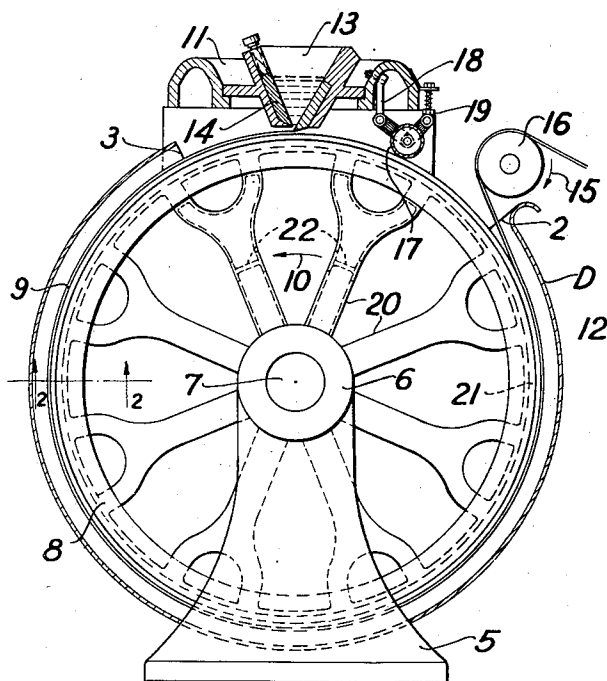


FIG. 2

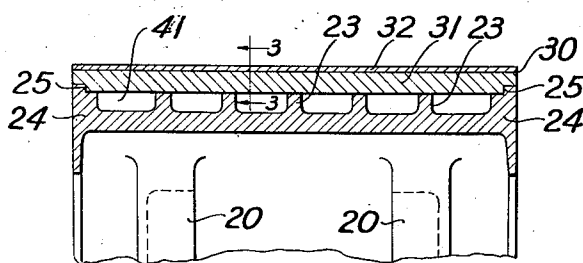
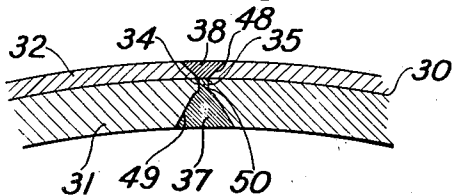


FIG. 3



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FILM CASTING ELEMENT

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8 Claims. (Cl. 18—15)

The present invention relates to apparatus for making sheets or film support from viscous compositions, known in the art as dope, containing derivatives of cellulose, polyvinyl resins and solvents therefor, and particularly to the casting element upon which said dopes are cast into film support.

As is well known to the art, film or sheeting is formed by spreading a thin coating of dope onto an appropriate surface and permitting or causing the solvents to evaporate therefrom. The method generally employed consists in feeding the solution or dope from an appropriate device, such as a V-shaped hopper, onto a polished metallic surface of a slowly rotating wheel or drum. The solvents evaporate from the film more or less progressively as the wheel turns until (in less than one complete revolution) sufficient solvent has been removed to admit of the film being removed therefrom and conveyed to a wind-up or carried over other rolls for further treatment.

For aiding the evaporation of the solvent from the dope, it has been common practice to either apply heat to the inside of the coating wheel wherein the heat is transferred through the casting surface to the "dope" thereon, or to circulate heated air through a chamber surrounding the casting surface of the wheel in such a manner that the heat passes through the partly cured support into the metal of the casting surface, where due to the mass of metal, it is stored up and eventually delivered to the fresh dope as it is spread upon the surface. With either method or with a combination of both, it is essential that the casting surface permit a uniform transmission of heat, because without a uniform transmission of heat through the casting surface to the dope, a uniformly cured film will not be obtained. Film dope, including cellulose or resinous compositions, possesses intense and peculiar deterioration forces which tend to attack the metallic casting surfaces, and to overcome this tendency the material from which the casting surface is made must be carefully selected to resist such deteriorating action or corrosion.

Casting wheels heretofore have been made by shrinking a comparatively thin band of corrosion-resisting metal onto the rim of the coating wheel to form a casting surface, or have applied a plurality of layers of corrosion-resisting metal, such as copper, silver, nickel, and chromium, directly to the rim of the wheel by electro-plating. I have found that casting surfaces made by shrinking a band of metal onto the rim of a coating wheel does not give a uniform transfer of heat to the dope, because it is impossible to get a uniform intimate heat conducting contact between the band and the rim of the wheel. A coating wheel having a casting surface formed by superposing, by electro-plating, a plurality of metals directly

onto the rim of the coating wheel, is satisfactory from the standpoint of giving a uniform heat transfer, but is unsatisfactory in that the electro-deposited surfaces, being necessarily thin to avoid imperfection, must be replated from time to time due to deterioration of the thin layers.

My invention accordingly has for its principal object, to overcome the above-mentioned difficulties found in the casting surfaces of known coating wheels. Another object is to provide a film casting element comprising a substantially thick layer of ferrous metal and a substantially thick layer of metal highly corrosion-resistant to attack by the film dope in intimate heat conductive contact, to insure a uniform heat transfer. And still another object is to provide a casting element in which the layer of metal forming the casting surface is of substantial thickness so that it will have a longer life than the casting surfaces formed by electro-plating, and can be refinished cheaper and quicker than said electro-plated casting surfaces. And yet another object is to provide a film casting element which will in effect form the rim of the coating wheel and will be heavy enough to bear the weight of the wheel in lifting it during the finishing operation without becoming deformed. A further object is to provide a film casting element in which the layer of metal forming the casting surface is one which will be hard and smooth, and at the same time highly resistant to wear, even when exposed to prolonged wearing contact with the sheet material.

The casting element which I have invented is formed from a two-layer strip of metal which is fabricated by taking a sheet of ferrous metal of substantial thickness, placing a substantially thick sheet of metal highly resistant to corrosion by film dope, such as nickel, chromium-nickel alloy, or iron-chromium-nickel alloy, in surface contact therewith, and hot working the two together so as to form an intimate heat conductive contact between the two sheets. The two layer strip of metal is then rolled around the rim of the coating wheel and expanded by heat to bring the two ends close together. While the casting element is hot the adjacent ends of the ferrous layer are welded by a ferrous metal and the adjacent ends of the corrosion resistant metal are welded by a metal of the same composition as said metal so that a casting element is formed having two separate layers of metal throughout its circumference. The casting element after welding is allowed to cool whereby it is shrunk onto the wheel and held firmly in place. Instead of forming the casting element directly on the wheel, it could be made into a circular band of the proper diameter separate from the wheel, and placed on said wheel thereafter by expanding it with heat and allowing it to shrink into place

upon cooling. It will be readily understood that instead of forming the circular casting element from a single sheet connected by one weld that it could be formed from a plurality of arcuately formed sheets which when abutted one to the other would form a complete casting element.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing in which,

Fig. 1 is a side elevation, partly in section and on a reduced scale, of a typical film making apparatus including one form of coating wheel on which my novel casting element is mounted,

Fig. 2 is a section taken on line 2—2 of Fig. 1, and

Fig. 3 is a section taken on line 3—3 of Fig. 2, and exaggerated to clearly show the method of welding the ends of the casting element.

Like reference characters refer to corresponding parts throughout the drawing.

Referring now to the accompanying drawing, a description in detail will be given of an illustrative embodiment of my invention, but the latter, is of course, not restricted to this embodiment or details.

In Fig. 1, a base 5 supports a bearing 6 for the shaft 7 of a wheel generally indicated as 8. The cylindrical peripheral casting surface 9 of the wheel moves during rotation in the direction of the arrow 10 from a dope applying station 11 to a film stripping or removing station 12, and then back to station 11 past a cleaning station.

At the dope applying station is a V-shaped trough 13 having the usual adjustable gate 14 for regulating the thickness of the dope layer that is deposited on the casting surface 9. Heat may be applied to the dope on the wheel for evaporating the solvents therefrom by either of the well-known methods, one being that of applying heat to the inside of the casting surface allowing it to be transferred therethrough to the dope, the other being to pass heated air over the dope through duct D surrounding the casting surface. In the latter case, heated air is forced into end 2 of the duct D near the point on the wheel where the film support is stripped therefrom, and moves in a direction opposite to the direction of rotation of the wheel to be exhausted at point 3.

It will be readily understood by those skilled in the art that when the film support approaches the station where it is stripped from the wheel it is partly cured, and the heated air entering at this point is not cooled by evaporating the solvents from the support but passes through the partly cured support into the metal of the casting surface, where it is stored up, and is eventually delivered to the fresh dope as it is spread in the casting surface. In order to be able to store up and release this heat in the desired manner, the casting element must permit a uniform transfer of heat. The film being drawn under tension from the casting surface 9, as indicated by arrow 15, passes over rollers 16. The cleaning pad or roll 17 is carried in a swinging support 18 that is pressed toward the wheel 8 by a spring pressed plunger 19. All of these details are well known in the art and further explanation is, therefore, unnecessary. They illustrate

the relation of my invention to the rest of a typical apparatus and process.

It may be well to point out here that these coating wheels sometimes are 18 feet in diameter, have a width of 5 feet, and weigh around 37 tons so that the problem of fabricating the same can be more readily appreciated.

The wheel body, which may be fabricated in any suitable manner, although a single casting of cast iron is preferred, includes spokes 20 extending outwardly from a central bearing, not shown, surrounding shaft 7 to support the rim 21. Inasmuch as the rim 21 is comparatively wide I have found it desirable to mount the spokes 20 in pairs spaced transversely of the rim, see Fig. 2, connecting each transverse pair of spokes by means of a cross brace indicated at 22 in Fig. 1. The spokes are made in the form of channels, as indicated in Fig. 1, in order to reduce the weight of the casting without sacrificing strength. The outer surface of the rim 21 is provided with a plurality of ribs 23 which are spaced transversely of the rim relative to one another and which extend radially from the rim. Each of these ribs 23 extend completely around the circumference of the rim 21 and serve to support the casting element as will be hereinafter described. The extreme edges or flanges 24 of the rim 21 are notched as indicated at 25 to position the film casting element and hold it against transverse movement relative to the rim as will also be hereinafter described.

The cylindrical peripheral casting surface 9 of the wheel 8, as shown in Fig. 1, comprises a circular film casting element, see Figs. 2 and 3, made up of a layer of ferrous metal 31 and a layer of metal highly corrosion-resistant to attack by the film dope, for example, nickel, chromium-nickel alloy, or iron-chromium-nickel alloy. So that the two layers of metal which go to make up the casting element will be in intimate heat conductive contact, the casting element is formed by laying a sheet of nickel, chromium-nickel alloy, or stainless steel upon a supporting sheet of ferrous metal and hot rolling the two sheets together after they have been heated to a malleable condition. This method of making a two-layer casting element gives an intimate heat conductive contact between the two sheets of metal, and is generally known as cladding one metal with another. When two sheets are made into one in this manner the thinner sheet is referred to as the clad metal while the heavier or supporting sheet is referred to as the metal which is clad. In the case of the present casting element, the supporting sheet of ferrous metal 31, which is the thicker of the two, would be the metal which was clad, while the sheet of metal highly resistant to corrosion would be the cladding metal, and the composite sheet would be known as the clad strip or clad section. A composite sheet of metal made up of a layer of steel and a layer of nickel formed in the above-described manner would be known as a nickel clad steel, while one using a chrome-nickel alloy, known by the tradename "Inconel," would be called "Inconel" clad steel, and one using stainless steel would be called steel clad with stainless steel. Therefore, in the remainder of this specification when I refer to the casting element being a steel clad with one of the three noted corrosion resisting metals it will be inferred that the two layers of metal are bonded by the above-described hot working method. Also when a metal is referred to as being the clad

metal it will be the thinner layer of the two, or the corrosion-resistant metal.

The circular casting element 30 can be formed by rolling a sheet of clad steel, the clad being nickel, "Inconel," or stainless steel, into a circle then welding the adjacent ends, or it can be formed from a plurality of clad sheets each being arcuately formed so that when they are abutted end to end they will form a circle of the desired diameter. In order to provide a casting element which will be strong enough to bear the weight of the wheel in lifting the same during finishing operation, and which will have a casting surface heavy enough to stand repeated finishing operations, I have found it desirable to have the supporting ferrous layers 31 between $\frac{1}{2}$ and 1 inch in thickness, and the cladding layer of corrosion resisting metal of a thickness between $\frac{1}{8}$ and $\frac{1}{4}$ inch. It should be understood that if the ferrous layer is $\frac{1}{2}$ inch thick the cladding layer will be $\frac{1}{8}$ inch thick, etc.

The casting element 31 is wide enough to extend to the sides of the rim 21, and is of such a length that when it is pulled and drawn tightly around the rim the ends 34 and 35 of the elements will lack by a fraction of an inch of touching each other. If the casting element is formed from a plurality of arcuately shaped clad strips, all of the abutting ends will be welded except one, which is left open, whereby a band is formed as described. When the casting element is on the wheel, it is preferably heated to expand sufficiently for the ends 34 and 35 to come almost together, whereupon the ends are welded together while the element is hot, as will be hereinafter described, the welds being indicated at 37 and 38. When the casting element cools after welding it will be shrunk in place on the rim 21, and the contraction of the element is sufficient to fix it firmly on the rim and hold it against movement circumferentially thereof. The edges of the ferrous supporting layer 31 are notched to engage the notches 25 in the outer edge of each flange 24 of the rim 21 so as to correctly position the casting element on the rim and prevent relative transverse movement between the two, see Fig. 2. If it should be found impractical to form the casting element directly on the wheel as described, it will be readily understood that it can be formed into a complete circular casting element of a given size, from a single strip with one weld, or from a plurality of arcuate strips with several welds, exclusive of the wheel. This circular casting element could then be heated in a large tank of liquid and slipped over the rim of the wheel while still hot and allowed to shrink into position while cooling.

Referring to Fig. 2, it will be noticed that the casting element will be supported atop the ribs 23 and the flanges 24 on the rim 21 whereby ducts 41 are provided around the periphery of the wheel through which hot water, steam, or any other heating element may be admitted if it should prove desirable to administer heat to the dope by transmitting it through the casting element first as is sometimes the case.

The ends of the clad casting element 30 are welded, as will be hereinafter described, so that the composition of the cladding metal, nickel, "Inconel," or stainless steel, will be maintained throughout the circumference of the casting element. Referring now to Fig. 3, each end of the casting element has the cladding layer beveled and the ferrous supporting layer cut out as shown so that when the ends are brought together for

welding, a V-shaped groove 48 is provided for the weld whose composition is to be the same as that of the cladding metal, and a U-shaped recess 49 is provided for the ferrous weld, there being the usual breather duct 50 between the two. The weld is first made in the U-shaped recess 49 with a ferrous welding rod filling up that portion thereof, and then the V-shaped groove 48 is welded with a rod which is of the same composition as the cladding metal whereby the two layer characteristic of the casting element is carried through the welded joints to give a circular casting element of which the cladding metal is uniform throughout the circumference.

I at first had difficulty in making a pure nickel weld in the V-groove 48 due to the fact that when using a nickel welding rod some ferrous metal tended to boil up through the breather duct 50 and alloy with the nickel to give a ferrous-nickel alloy. I found that I could overcome this difficulty by first grinding and polishing off the ferrous metal at the top of the breather duct 50, and flowing a thin layer of nickel over this polished surface with an atomic hydrogen weld. This layer of nickel apparently is sufficient to overcome the tendency of the ferrous metal to boil up into the V-shaped groove 48, and a pure nickel weld can be made therein after said preparation. This difficulty does not arise when the "Inconel" cladding metal is used, because "Inconel" is actually an alloy of 80 per cent nickel, 14 per cent chromium, 6 per cent iron, and the percentage of iron in the welding rod can be cut down to account for the small amount which might boil up through the breather duct 50 in the welding operation. This difficulty would also be of no consequence where a stainless steel cladding material was used, because stainless steel is an alloy of iron, chromium, and nickel in varying percentages, and the percentage of iron in the welding rod could be controlled to account for that added to the alloy by boiling up through the breather duct 50.

Film casting surfaces must be absolutely smooth and free from all blemishes such as scratches and pit marks, because even though such blemishes be invisible to the naked eye they will cause a defect or bubble in the cast film which when projected on a screen at high magnification will be very noticeable. Therefore, I have found it desirable in welding the cladding metal to use an atomic hydrogen weld or a carbon arc weld instead of the usual electric arc weld, because the first two give welds free from porosity while the latter weld has a tendency to be porous. If a porous weld were used to join the ends of the cladding metal, when the surface of said cladding metal was finished to provide the film casting surface the porosity of the weld would be very likely to yield pit marks in the casting surface which would render it useless. While carbon arc welds have the advantage of being free from porosity, it is desirable to avoid the use of carbon arc welding in welding stainless steel, due to the fact that stainless steel, or alloys, formed in stainless steel, combine with the carbon to form a more inferior composition of stainless steel than the original low carbon sheet.

It will be understood that my novel casting element can be made to fit and be applied to any type of coating wheel having a rim on which it could be supported, and is not restricted to use with a wheel fabricated as the one shown and described. The cladding metal, nickel, "Inconel," or stainless steel, has its peripheral surface fin-

ished in any known manner to render it suitable for casting film thereon, and is relatively thick so that it can be refinished from time to time thus lengthening its usefulness. Making the
 5 casting element by clading the sheet of corrosion resistant metal of substantial thickness to a supporting layer of ferrous metal gives an element having heat transferring qualities equivalent to that of a strip of a single metal having the same
 10 thickness, and lends rigidity to the element which is necessary when the wheel is handled in finishing operations. As the final weld is made so that the composition of clading metal is maintained therethrough, a casting surface is provided which will have the same corrosion resistance, wearing, and heat transferring qualities throughout its entirety.

Although I have shown and described certain specific embodiments of my invention, I am
 20 fully aware that many modifications thereof are possible.

Having thus described my invention, what I declare as new and desire to secure by Letters Patent of the United States is:

25 1. A film casting wheel for receiving a film of dope including a cellulose derivative or a polyvinyl resin and a solvent therefor, comprising a wheel body, and a casting element attached to the periphery of said wheel body, said casting element
 30 being composed of a supporting layer of ferrous metal of substantial thickness, and an outer layer of chromium-nickel alloy of substantial thickness having one surface hot worked into an intimate bond with one surface of the supporting layer, and having its outer surface forming a casting face which is highly resistant to attack by said dope.

2. A film casting wheel for receiving a film of dope including a cellulose derivative or a
 40 polyvinyl resin and a solvent therefor, comprising a wheel body, and a casting element attached to the periphery of said wheel body, said casting element being composed of a supporting layer of ferrous metal of substantial thickness, and an
 45 outer layer of stainless steel of substantial thickness having one surface hot worked into an intimate bond with one surface of the supporting layer, and having its outer surface forming a casting face which is highly resistant to attack
 50 by said dope.

3. A casting wheel for receiving a film of dope including a cellulose derivative or a polyvinyl resin and a solvent therefor, comprising a wheel
 55 body, and a casting element attached to the periphery of said wheel body, said casting element being composed of a supporting sheet of ferrous metal of substantial thickness, a sheet of chrome-nickel alloy of substantial thickness having one surface hot worked into an intimate bond with
 60 one surface of the ferrous supporting sheet to form a clad section, said clad section rolled into a ring with its ends in abutment and with the chrome-nickel alloy sheet on the outside to form a circular film casting element, a ferrous weld
 65 connecting the abutting ends of the ferrous supporting sheet, and a chrome-nickel alloy weld connecting the abutting ends of the chrome-nickel alloy sheet.

4. A casting wheel for receiving a film of dope
 70 including a cellulose derivative or a polyvinyl resin and a solvent therefor, comprising a wheel body, and a casting element attached to the periphery of said wheel body, said casting element being composed of a supporting sheet of ferrous

metal of substantial thickness, a sheet of stainless steel of substantial thickness having one surface hot worked into an intimate bond with one surface of the ferrous supporting sheet to form a clad section, said clad section rolled into
 5 a ring with its ends in abutment and with the stainless steel sheet on the outside to form a circular film casting element, a ferrous weld connecting the abutting ends of the ferrous supporting sheet, and a stainless steel weld connecting the abutting ends of the stainless steel sheet.

5. A film casting wheel for receiving a film of dope including a cellulose derivative or a polyvinyl resin and a solvent therefor comprising a wheel body, and a casting element attached to
 15 the periphery of said wheel body, said casting element being composed of a supporting layer of ferrous metal of substantial thickness, and an outer layer of corrosion-resisting metal of substantial thickness having one surface hot worked
 20 into an intimate bond with said supporting layer and having the outer surface forming a casting face which is highly resistant to attack by said dope.

6. A film casting wheel for receiving a film of
 25 dope including a cellulose derivative or a polyvinyl resin and a solvent therefor comprising a wheel body, and a casting element attached to the periphery of said wheel body, said casting element being composed of a supporting layer of ferrous
 30 metal of substantial thickness, and an outer layer of nickel of substantial thickness having one surface hot worked into an intimate bond with one surface of the supporting layer, and having its outer surface forming a casting face which is
 35 highly resistant to attack by said dope.

7. In a film casting wheel for receiving a film of dope including a cellulose derivative or a polyvinyl resin and a solvent therefor, the combination with a wheel body the rim of which is provided
 40 with a circumferential groove, of a casting element attached to the periphery of said rim in spaced relation with the bottom of said groove to form a conduit through which a heating medium may be passed, said casting element
 45 comprising a supporting layer of ferrous metal of substantial thickness, and an outer layer of corrosion-resistant metal of substantial thickness having one surface hot worked into an intimate bond with said supporting layer, and having the
 50 outer surface forming a casting face which is highly resistant to attack by said dope.

8. In a film casting wheel for receiving a film of dope including a cellulose derivative or a polyvinyl resin and a solvent therefor, the combination with a wheel body the rim of which is
 55 provided with a plurality of grooves extending circumferentially of said rim and spaced laterally of one another to extend substantially across the entire face of said rim, of a casting element
 60 mechanically attached to the periphery of said rim in covering relation with each of said grooves and spaced from the bottom of each thereof to provide conduits through which a heating medium may be passed, said casting element comprising a supporting layer of ferrous metal of
 65 substantial thickness, and an outer layer of nickel of substantial thickness having one surface hot worked into an intimate bond with one surface of the supporting layer, and having its
 70 outer surface forming a casting face which is highly resistant to attack by said dope.

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