This application is a continuation-in-part of my copending application Ser. No. 205,086, filed June 18, 1962, now abandoned.

My invention, broadly speaking, is directed to the production of a uniformly calipered paper web that is subsequently moved to the suction boxes of a paper-making machine of the Fourdriner type, to the preservation of the normal form of the straight-edge-ungrooved forming boards and foils for long periods of time in such a manner as to avoid the tendency of the wires to wear the wire-contacting surface of the forming boards and of the foils, and to the prolongation of wire life.

As is well known in the production of the paper web in a Fourdriner machine, the wood chips are processed to form pulp that is fed to the Fourdriner section of the machine. The pulp usually contains about one percent wood fiber, 99 percent water and amounts of foreign material such as abrasive grit, silicon, clay filler and many other foreign substances when it reaches the Fourdriner wire.

This stock is forcefully projected at a relatively high velocity from a head box which extends transversely of and substantially coextensive with the width of the Fourdriner screen. To project this stock onto the screen at the breast roll, the outlet of the head box is provided with a "sleeve," which is, in effect, a transversely extending slot from which the stock issues. The adjustment of this slot controls the flow of the stock to the screen by regulating the velocity and amount of stock issuing from the slot at various points in its length.

In actual practice in the industry, the stock is jetted through the slot from the head box to the screen at a greater speed than that of the screen.

Beneath the lower surface of the upper reach of the Fourdriner screen between the breast roll and the couch roll are located a forming board, foils, suction boxes and table rolls.

The forming boards used commercially in the industry take several forms, two of which are illustrated in the drawings. The forward edge of the forming board, that is to say the edge adjacent the breast roll, is slightly spaced from the roll, making it possible for the portion of the upper reach of the Fourdriner wire above the forming board to dip downwardly into the said space as the upper reach of the Fourdriner wire is drawn across the forming board under the weight of the stock or slurry. As the wire passes over the rear or trailing edge of the forming board it will also dip.

The force required to pull the upper reach of the wire across the forming board will be increased by this dipping of the wire. The effect of this and of the weight of the slurry will subject the wire and the surface and the edges of the forming board to a great amount of wear.

The result will be that the leading edge of the forming board as now constituted, adjacent the breast roll, will become worn and notched. The wearing of the leading edge of the forming board results in the changing of its normally straight edge form into a transversely grooved or notched form from which trough-like channels extend longitudinally of the machine in the upper surface of the forming board as a result of the progressive wearing away of the face of the forming board. This wear permits the slurry to be thicker (and thus contain more pulp) at the trough-like locations than it is in between these locations across the face of the forming board. This uneven distribution of the slurry causes the production of a web which is uneven in thickness or caliper transversely. A similar wearing of the trailing edge and the adjacent face portion of the forming board takes place as a result of the wire dipping over the trailing edges.

The wearing of the forward edge of the forming board and the formation of trough-like channels in the wire bearing face of the forming board has been a source of great concern not only because of replacement cost, but, importantly, because of the production of the uneven caliper of the web and subsequently formed paper. Many efforts have been made to eliminate these undesirable conditions or to introduce means for compensating for them, as, for example, so constructing the slice that its output openings may be individually or in groups adjusted to feed more or less pulp at given locations across the wire, as has already been pointed out.

As is well known in the industry, two distinct conditions prevail in the formation of Fourdriner paper, one at the forming board location and the other at the suction box locations. At the forming board, the surface and trailing edges of the board are subjected to the wearing action of the wires caused by the weight and velocity of the great mass of water, foreign material and pulp that are projected, jet-like, from the head box onto the wire, and to the change of direction of the wire from a straight line to an undulating line as it dips at the edges of the forming board and the edge of the foils.

On the other hand, when the web reaches the location of the suction boxes, the slurry has been transformed into a self-sustaining web of oriented fibres, much of the water having already been extracted at the forming board, at the table rolls, and at the foils. Because the web of paper has already been formed by the time it reaches the suction boxes, the covers of the boxes are subjected to a relatively less downward force which is that created by the weight and speed of the upper reach of the Fourdriner screen and the weight of the paper web and the suction. The result is that the covers of the suction boxes are subjected to less wear and a different character of wear than are the forming boards.

Because the web is, in effect, a formed, self-sustaining paper strip carrying less water than the water-carried mass of oriented fibres from which it is formed, it is of lesser weight per unit area and therefore the web has less tendency to dip over the edges of the forming board. The covers are, therefore, not subjected to the same destructive conditions as are the forming boards.

My invention contemplates, particularly, the prolongation of the useful life of forming boards so that they will resist the transformation of their straight edges into undulated or grooved edges and the transformation of the upper surfaces from a plane into one which has longitudinal channels that tend to produce a paper web of uneven thickness or caliper transversely.

It contemplates, also, the creation of forming boards that are of such nature that, for long periods of time, the mat or partially formed web which passes from the forming boards over the foils and the table rolls, will be of substantially uniform thickness, the unit areas of which will be of substantially the same density and will, in this condition, be presented to the suction boxes.

It contemplates also the provision of suction box covers and foils constructed in such a manner that they will not tend rapidly to wear the wire or to themselves become worn.

I have found that, in the preferred form of my invention, a greatly improved surface for forming boards and foils can be provided by making use of a hard, wear-resistant refractory oxide material which, in some instances is somewhat porous. Such a surface can be made
by flame spraying such a material onto wear surfaces as taught in the patent to Wheeldon 2,707,691. By using this spraying technique a suitable refractory oxide-bearing wear-retarding layer can be placed on the surface to be exposed against the underside of the Fourdrinier wire. Such a coating is hard, preferably at least 7 on Mohs' scale, and has excellent wear resistance characteristics. The coating is also somewhat porous as it is formed, and in one form of my invention the coating and spraying procedure is selected to develop these pores which, in service, become filled with water flowing from the pulp to form a lubricated surface whereby to minimize the friction between the moving wire and the stationary surface at certain locations. In another form of my invention, the porous surface may be filled with an epoxy resin to provide an imperious surface. In both forms the surface may be finished to have a very smooth and substantially friction-free characteristic. The coefficient of friction between the wire and such a surface is quite low, and excellent results are obtained by providing such a surface on the above-mentioned forming board and foils and other relatively fixed elements, such as suction box covers, of a Fourdrinier machine. Preferably my invention contemplates an inert base such as a stainless steel or brass, etc. element which is coated with a nickel chrome alloy layer sprayed on the surface which faces toward the wire. An outer sprayed metal oxide layer is then coated over the nickel chrome alloy with a flame spray means as taught in the Wheeldon patent noted above. The metal oxide surface formed by this freezing of molten droplets in situ on the surface is somewhat porous and has a very hard wear-resistant characteristic. To obtain the proper finish it may be ground and polished to have a high degree of surface smoothness to further minimize the possibility of wear resulting from the rubbing contact against the under surface of the moving wire.

In the drawings:

FIGURE 1 is a diagrammatic side elevation of a Fourdrinier wire section of a paper making machine showing, conventionally, some of the elements associated therewith;

FIGURE 2 is an enlarged diagrammatic side elevation of an associated head box, breast roll, forming board, and Fourdrinier wire;

FIGURE 3 is a fragmentary view showing a path of travel of the Fourdrinier wire from the breast roll over the forming board and foils;

FIGURE 4 is a sectional view showing one form of a forming board;

FIGURE 5 is a sectional view showing a foil;

FIGURE 6 is a fragmentary sectional view showing one form of a suction box cover;

FIGURE 7 is a fragmentary sectional view of a modified form of foil structure; and

FIGURE 8 is a sectional view showing a suction box.

At the head box end of the Fourdrinier machine, the wire 10 is supported on a free wheeling breast roller 11. The stock flows or is jetted onto the generally horizontally directed upper run of the wire 10 just past the tangent point formed between the roller 11 and the wire as at 10A. At this point the wire has started on its paper-web forming generally horizontal run. As the wire leaves roll 11 with the stock flowing from the head box, the under surface of the wire is supported by a stationary forming board 12.

A forming board structure used in the industry as shown in FIG. 4 may take the form of a dough roll 13 having a curved side wall 14 for closely following the curve of the periphery of roll 11. This forming board has a flat upper bearing surface 15 which engages directly against the underside of the wire, as the wire leaves the head box, to prevent water from flowing too easily through the screen until fibers in the stock can get oriented thereon. The remaining portion of the upper surface or top of the forming board has a series of slots formed in it that permit water, which thereafter drains through the wire, to flow from the underside of the wire into the box 13 for removal. The slots are faced with lip elements 16 which may, if desired, be curved and are configured to act as scraper means to remove the water droplets clinging to the underside of the wire. The action of the lip elements may be designed to retard or encourage water passage through the screen whereby to assist in controlling the felting of the fibres as formation of the paper bat progresses.

A series of table rolls 20 may be provided to carry the top run of the wire to the end of the horizontal paper web or sheet forming run in so far as web is completed on the Fourdrinier wire.

The wire turns on the last of their rollers 20 to angle downwardly to pass around the couch roll 22. The paper web leaves the wire just above the couch roll for delivery to the first part of the Fourdrinier machine. At this point, the couch roll to return to the head box end of its run by passing over the set of support and tensioning rollers 23 and 24 and roller 25. The couch roll is driven in the usual manner to provide the sole driving contact with the wire.

Between several of the table rollers 20 which engage the underside of the generally horizontal upper run of the wire, various relatively fixed elements may be disposed such as foils 30 and suction boxes 31. Enlarged foil elements are shown in FIGS. 5 and 7. These foil elements serve as a further scraper means which acts like the forming board 12 to control the removal of water draining through to the underside of the wire. The foil elements may have a drain box 32 for conveying the water away from the wire but usually the water drains from the foil into the sink. The upper surface of each foil is slotted so that the water can pass from the underside of the wire into the box 32 or pit. Each slot has a lip 33 for engaging against the underside of the screen to control water flow through the screen and collect water from the underside thereof. The flat surface 34 on the foil engages under the wire at the rear end of the foil and controls or slows the water flow through the wire and supports the wire on its travel toward the adjacent table roll 20 to limit the wrap angle of the forming wire around this table roll 20. The deflector surface 34 may be independent of the foil elements and may be positioned between table rolls 20 if desired. The foil element as shown in FIG. 7 has differently shaped scraper or lip elements 33 thereon for removing the water from the underside of the screen in such manner that suction is produced by the configuration of the trailing edge. Some suction effect is inherent in the operation of the form of lip 33 shown in FIG. 5.

Each suction box element 31, such as the one shown in more detail in FIG. 8 which receives the pre-formed web of paper, includes a chest 32 where air is captured, be evacuated and is therefore sealed on all sides except the top. The suction box has perforated, slotted or other patterned openings in the top cover 36 for engaging against the underside of the wire to suck water through the screen to aid in completion of the pulp or paper web formation.

It is apparent that the very weight of the wire itself plus the added weight of the stock carried on the wire and the effect of the jetting of the stock onto the wire cause the underside of the wire to have a significant frictional contact with the relatively stationary surfaces of the forming board and the foils, especially where it engages the edges of the same. Even the engagement of the wire with the table rolls 20 produces some frictional resistance and the interplay of all the forces encountered in driving and supporting the wire produces conditions that are not consistent with a long life for the wire screen, the forming boards, the foils and the
suction box covers. Added to this is the strain imposed on the wire by the heavy drag produced on the wire when the several elements engaging the underside thereof are being wound.

Under ideal conditions a copper alloy wire being run on a conventional high speed high production Fourdrinier machine such as is used for newsprint paper, may operate for a relatively short period of continuous operation. When conditions are not ideal and a tear or unusual wear of the surface of the article being coated which is produced in a shorter time, expenses mount up because not only must the expensive wire be discarded, but the entire paper-making plant is put out of operation until the Fourdrinier machine can be fitted with a new wire. This entails loss of production and the cost of the expensive skilled labor which must be used to handle the wire.

As I have pointed out, my invention is intended to provide an improved surface structure for those stationary element of such a machine which engage the moving wire and I herein provide an improved construction for minimizing the wear of the forming boards, soils, suction box covers and consequent down time whereby much more efficient paper making results.

I accomplish my purpose by coating the wire bearing surfaces of such elements as the forming board, the lips of the soaks, and the suction box covers, as heretofore stated, with a hard, wear resistant refractory oxide material. I have found that this not only incidentally prolongs the life of these elements themselves more or less indefinitely but, in my preferred form, this construction, also minimizes the frictional engagement between these rubbing parts. While attaining these advantages, I have also found that the coating construction I specify does not permit gritty objects to lodge upon and become imbedded in a surface whereby another source of damage inherent in present day Fourdrinier structure is eliminated.

In following my preferred teaching the elements such as the forming boards and soaks are covered with a bearing surface for minimizing frictional engagement with the underside of the wire. These elements are preferably formed as a base member of inert or corrosion resistant materials such as a bronze or stainless steel which makes the best base member for use in a paper making machine. The base member is prepared for reception of the bearing coating of my invention by any suitable cleaning method, but I prefer to use a grit blasting procedure with abrasive grain such as fused aluminum oxide of about 16 to 24 mesh.

As far as my invention is applicable to suction box covers, a perforated stainless steel base member for a suction box cover 36 formed of 304 stainless steel is a typical structure to which my invention has been applied and I have blasted it with aluminum oxide grit of 24 mesh carried in an air stream at a pressure of 40 pounds per square inch air pressure and sprayed at the rate of about 10 to 30 square inches per minute to condition the base member for the application of a flame-sprayed nickel chrome metal undercoat 52 as shown in FIG. 6. The nickel chrome alloy is composed of approximately 80% nickel and 20% chromium and may be sprayed to the suction box cover by a conventional molten metal spray technique known as metallizing. A layer of nickel chrome approximately .003" thick will be found to be the optimum as an intermediate layer for receiving the bearing layer 41 of my invention. A range in thickness, however, of from .002" to .006" has been found to be useful as an intermediate layer for the type of refractory metal oxide here described and undercoatings as thick as .013" have been used. The forming boards and foils may be similarly prepared.

The bearing layer I prefer is flame-sprayed onto the nickel chrome undercoat as taught in the Whelton Patent 2,707,691 mentioned above. Any of the refractory oxides there disclosed will be found to be more or less satisfactory, but to date I have found chromium oxide to be best for my purposes. Alumina and zirconia silicate are useful and in some instances zirconia silicate, which has a particularly low coefficient of friction for this purpose, is used.

The molten droplets of chromia or other refractory metal oxide sprayed onto the surface to be coated, freeze in situ upon landing on the surface and flatten out as they solidify to form a rather laminated-like porous coating. They form platelets in a layer preferably .040" thick that is not in general parallel with the plane surface of the article being coated which structure produces a hard wear resistant coating that has an unexpected degree of flexibility. This surface layer may be from .010" to .070" thick. Such a surface formed of chromia will have about 2% open and interconnected pores and a total porosity of 4% and is extremely hard. While chromia is used to produce my preferred coating because of its hardness and ability to be finished to take a high polish, the aluminas and zirconia or zirconia silicate coatings, for example, may be more easily applied and have different porosity characteristics. Alumina and zirconia silicate for example, have about 8% to 12% porosity with 4% of the porosity in the form of open and interconnected pores.

After deposition of my preferred coating, the chromium oxide surface is finished to have a surface polish in the range of 7 to 50 RMS microinches and preferably I try to stay at the low end of the scale. This is accomplished by grinding the sprayed chromia layer with a diamond wheel and otherwise polishing the surface in a known manner such as by lapping the final surface with fine grit diamond or boron carbide. A finish within this range is preferred to provide the best wire supporting surface consistent with the porosity of the sprayed chromia, to trap droplets of water in the grooves on the surface for a reservoir for liquid lubricant for the surface on which the wire rides. Such trapped water lubricates the wire as it moves over certain of the stationary surfaces to minimize friction, especially at the suction box locations, as has been pointed out.

In the instance of coating a suction box cover element, the perforations through which the water from the wire passes on its flow to the suction box must be ground and polished to produce a rounded shoulder surrounding the inlet to the perforation, as best seen in FIG. 6. Due to the surface tension of the molten liquid deposited on the surface by the described spray procedure, a somewhat rounded condition is inherently produced as the coating solidifies. Nonetheless, I prefer to further polish these corner surfaces to eliminate any and all surfaces of possible wear or damage to the wire. As more will be said later, if introduced in the several boxes 35, the flexible wire and the partially formed paper web on its surface are caused to bow down somewhat into the mouth of each of the perforations. If the corners or edges were not adequately rounded and polished, they would produce an undue wear on the wire by causing it to have a sharp bending action each time the wire passed over the front and rear walls on each perforation in the suction box cover. The wear this bending action tends to produce on the wire can be greatly minimized by providing a proper rounded configuration at the top edges of the suction box openings. In the cases of forming boards and soaks, because of the wear producing factors heretofore pointed out, the smoothly rounded finish is produced on the leading edge of each of the lips of the forming boards and foil elements.

The coating of this invention has been found to be somewhat flexible and this is important to the success of these elements of a Fourdrinier machine. For example, occasionally the wires vibrate and develop a fluttering condition in use. The wear resistant characteristics together with the significant flexibility thereof permit my coatings to continue to be operative under severe conditions which have been found to be intolerable for more brittle substances. This property is also utilized to overcome slight warpage and twisting thereof which may be expected in fitting elongated elements such as foils, form-
ing boards and suction box covers to existing Fourdrinier structures and of course is of incidental value during shipping in commerce.

It may be sometimes happen that a portion of the coated surface made in following this invention will become worn unevenly in use. The laminated surface structure I have described can be reground once or several times, depending upon the thickness of the final coating of the refractory metal oxide deposited on the base member. In other instances the coating may be damaged by a hard blow that will crack or spall a localized area of the coating. Such a flaw can be remedied easily in following my teaching by simply removing all of the loose and damage coating from that area and applying a new sprayed on surface to cover that area only. After the localized area has been coated with a final layer of refractory metal oxide to a depth slightly thicker than the depth of the previous finish on the element, the patch may be ground down and the surface refinishing to bring it with the rest of the surface. Also when the finished coating has been worn down so that it cannot be reground to fit it for further use, the working surface can be rebuilt on the base element. Since the coating procedure may be repeated an indefinite number of times, it is obvious that the relatively expensive base element coating and finished as I have suggested, and finished in a relatively inexpensive manner and can be made to last the life of the machine with which it is used.

As I have stated, the coated surface may in some instances be further treated by applying a resin thereto. Porous refractory metal oxide coating which have been flame sprayed from a solid rod onto a surface, have been filled with either phenolic, epoxy or silicone resins. The resins can be thinned and painted on the sprayed surface with a paint brush and cured in a known manner. Resin penetration by capillary action fills the open and interconnected pores and by applying the resin in several applications, penetrations 0.005” deep have been attained in aluminia coatings. A resin layer may be left to cover the entire surface of the coated element, but I prefer to polish the resin away so that the refractory metal oxide layer is exposed with the resin filling only the pores.

In FIGURE 3 of the drawing, which illustrates, conventionally, a head box with the slice, a breast roll, a forming board and a section of the Fourdrinier wire, a path of travel of the upper reach of the wire is indicated. As the wire passes from the head box 42 to the adjacent breast roll, such as at 11, it dips downwardly as at 44 and must be drawn upward to some degree over and in forceful contact with the leading edge of the forming board, as at 46. If the forming board is of the type that includes slots 48 the wire dips into the slots and will be drawn over the leading and trailing edges of the forming board elements.

The continuous movement of the wire over the edges of the forming board their surfaces tends to wear the edges from straight form to broken or notched form, as I have heretofore pointed out. The notches across the machine may be of different depths and different forms. As the wire is drawn over these edges, supporting the weight of the pulp and the water and foreign material, these notches gradually extend over the surface of the forming board longitudinally of the machine forming channels or depressions with higher lands intervening.

Recognizing the detrimental effect of these notches and channels, the industry has attempted to overcome such effects by providing the adjacent edges. My invention is intended to counteract the cause at least to the extent that the initial condition of the forming boards or foils will be maintained for longer periods of time than was possible before my invention.

In FIGURE 6 of the drawing I have shown the hard smooth and polished ceramic surfaced 50 on the undercoat 52 on the suction box cover and have shown the edges of the suction boxes as protected by the ceramic at 54.

In FIGURE 4 the ceramic facing 56 laps over the leading and trailing edges of the forming board element at 58 and 60. Thus the wearing of the wire contacting surfaces of the forming board will resist the wearing of notches and channels heretofore referred to with the result that long periods of time the mat that is formed by the draining off of the water and the matting or felting of the fibres will be of reasonably even caliper transversely.

In FIGURES 5 and 7 this ceramic surfacing 62 is of the same general form as that on the forming board with its edge protecting portions.

Many modifications of my invention can be conceived. It is not always essential that the undercoat layer be used, but since this layer serves to more strongly adhere the refractory metal oxide layer to the base element while simultaneously cooperating with the outer layer to form a somewhat more impervious composite layer, the undercoating with a nickel chrome layer is used in my preferred construction. Where a completely impervious coating is needed, as suggested above, the complete undercoat and metal oxide layering may be fully impregnated with an epoxy resin which is to be substituted in the pores to become integrated with the coating applied to the base member. The epoxy resin seals the metal oxide layer by flowing into the open and interconnected pores and curing in place. The exposed surface may then be finished to have the desired polish to minimize wear and friction on the wire. All these and possibly other modifications of this invention may occur to those skilled in the art which will fall within the scope of the following claims.

What I claim is:

1. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and transversely extending plates arranged longitudinally and contacting said screen to control the drainage of water from said pulp, the improvement wherein said plates have a smooth, hard, porous ceramic screen contacting face portion.

2. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and transversely extending plates arranged longitudinally and contacting said screen to control the drainage of water from said pulp, the improvement wherein said plates have a smooth, hard, porous ceramic screen contacting face portion and a filler in certain of said pores.

3. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and transversely extending plates arranged longitudinally and contacting said screen to control the drainage of water from said pulp, the improvement wherein said plates have a smooth, hard, porous ceramic screen contacting face portion and a filler in certain of said pores.

4. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom, and a foil arranged transversely thereof and contacting said screen to control the drainage of water from said pulp, the improvement wherein said fill has a smooth, hard, porous ceramic screen contacting face portion.

5. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom, and a suction box cover transversely thereof and contacting said screen to control the drainage of water from said pulp, the improvement wherein said suction box cover has a smooth, hard, porous ceramic screen contacting face portion.

6. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water...
water therefrom, and a forming board arranged transversely thereof and contacting said screen to control the drainage of water from said pulp, the improvement wherein said forming board has a smooth, hard, porous ceramic screen contacting face portion.

7. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and a foil extending transversely of and contacting said screen to control the drainage of water from said pulp, the improvement wherein said foil has a smooth, hard, porous ceramic screen contacting face portion, and a filler in certain of said pores.

8. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and a suction box cover extending transversely of and contacting said screen to control the drainage of water from said pulp, the improvement wherein said suction box cover has a smooth, hard, porous ceramic screen contacting face portion, and a filler in certain of said pores.

9. In a paper-making machine having a traveling screen for supporting water-wet pulp during the drainage of water therefrom and a forming board extending transversely of and contacting said screen to control the drainage of water from said pulp, the improvement wherein said forming board has a smooth, hard porous ceramic screen contacting face portion, and a filler in certain of said pores.

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