March 30, 1965 R. J. SMALLIAN 3,175,792

WEAR RESISTANT WIRE SCREEN

Filed Sept. 13, 1961 2 Sheets-Sheet 1

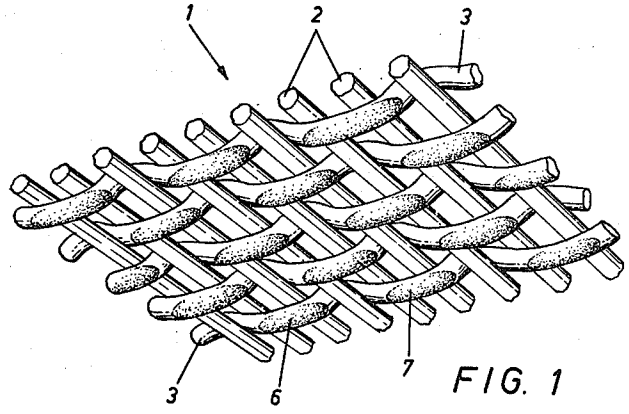


FIG. 1

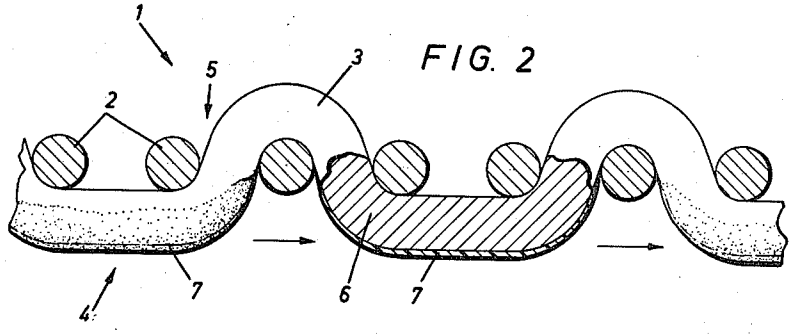


FIG. 2

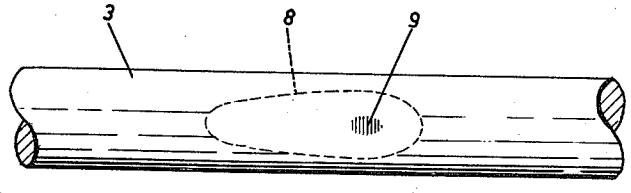


FIG. 3

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WEAR RESISTANT WIRE SCREEN

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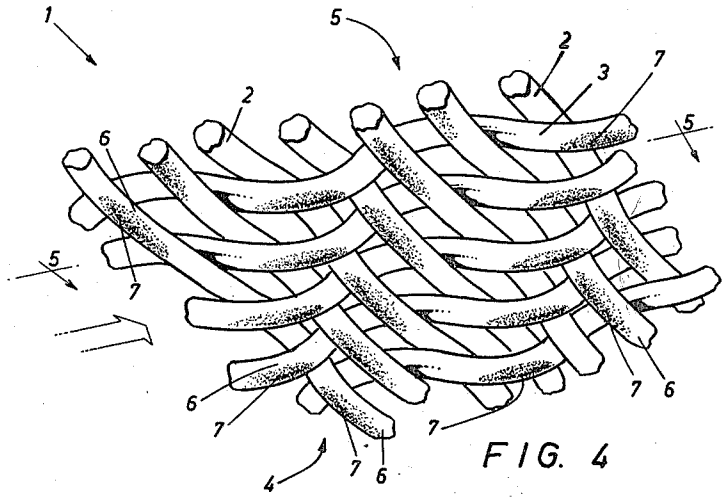


FIG. 4

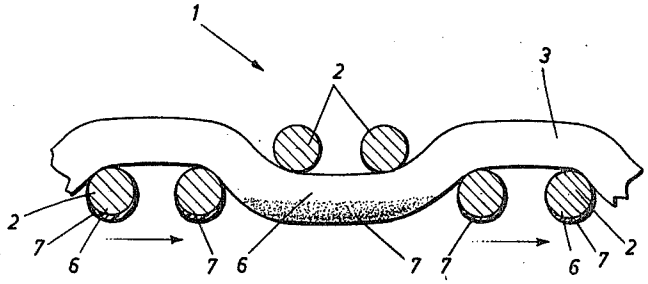


FIG. 5

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# WEAR RESISTANT WIRE SCREEN

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7 Claims. (Cl. 245—8)

This application is a continuation-in-part of application, Serial No. 37,769, filed June 21, 1960, now abandoned.

This invention relates to a wear resistant wire screen. More particularly, this invention relates to a wear resistant wire screen having interwoven warp and shute wires, and a coating applied on the wearing side of the wire screen to only the knuckle portions of the warp wires, or if the shute wires have knuckle portions on the wearing side, to only the knuckle portions of the warp and shute wires, the wire being especially suitable for use with a paper making machine.

While wear resistant wire screens embodying my invention are particularly useful with paper making machines, as will be explained in more detail hereinafter, and while wear resistant screen embodying my invention will be specifically described hereinafter as paper making machine wire screens, it should be noted that wear resistant wire screens constructed in accordance with my invention may have numerous other uses, and it is not my intention that my invention be limited to wear resistant wire screens useful only with paper making machines. In general it can be said that a wear resistant wire screen constructed in accordance with my invention may be used with any apparatus where there is frictional engagement between the screen and the apparatus, the frictional engagement being under wet rather than dry conditions.

A conventional Fourdrinier paper making machine has what is known as a wet end and a dry end. The basic operation of a paper making machine may be described as follows. The pulp from which the paper is to be made is mixed with a large excess of aqueous carrier and is evenly spread from the head-box of the paper making machine onto a moving wire screen which has a very fine mesh. The wire screen passes over table rolls and suction boxes, the latter of which are hollow, rectangularly shaped boxes having apertures in the top thereof. The suction boxes are connected to vacuum pumps. When the wire screen passes over the suction boxes, the aqueous carrier is separated from the pulp and drawn through the screen by means of the suction established in the suction boxes, and a mat of evenly distributed pulp is left on top of the moving wire screen. After passing through various types of rollers, the pulp leaves the wet end of the paper making machine and is transferred from the screen to what is known as a dryer felt. The pulp then passes through a series of dryer rolls, which are usually steam heated, and emerges from the dry end of the paper making machine as uncalendered paper. This paper may be passed through suitable calender rolls and wound on reels.

The wire screen on which the pulp and aqueous carrier are deposited at the wet end of the paper making machine is a very critical part of the paper making machine and must be manufactured to very close tolerances so as to provide the required amount of porosity to permit adequate drainage of the aqueous carrier through the wire screen, and the wire screen must be woven in such a manner that it does not leave impressions in the pulp fibres supported thereon. Such wire screens, because of the close tolerances required in their manufacture, are relatively expensive, and while the cost of wire screens varies considerably, $3,000 is not an unusual price. In use, paper making machine wire screens frictionally engage the suction box covers, table rolls and drive mechanism for the wire screen. As a result of this frictional engagement, the wire screen wears away quite rapidly, and it is not unusual for the life expectancy of a wire screen on a Fourdrinier paper making machine to be from between five to twelve days. It will be apparent from a consideration of the cost and life expectancy of wire screens for paper making machines that they add considerable expense to the process of manufacturing paper. This expense is further increased, of course, by the fact that in order to replace a wire screen the paper making machine must be shut down. This entails both loss of production and labour cost.



Attempts have been made in the past to increase the life expectancy of wire screens for paper making machines. For example, it has been attempted to increase the life expectancy of such screens by coating both the warp and shute wires of the screen prior to interweaving the same into a screen. This approach has obvious disadvantages inasmuch as it requires that each wire be individually coated. Furthermore, this approach has the disadvantage that much more coating material than is actually necessary is employed, because the non-wearing surface of the wire screen need not be protected, and, as will become apparent, not even all of the wearing side of the wire screen need be protected.

Accordingly, it is an object of my invention to provide a wear resistant wire screen.

It is another object of my invention to provide a wear resistant wire screen using a minimum amount of coating material.

It is a further object of my invention to provide a wear resistant wire screen which has a high porosity and permits adequate drainage.

Yet another object of my invention is to provide a wear resistant wire screen, only the knuckles on the wearing side of the screen having coating material thereon.

A further object of my invention is to provide a wear resistant wire screen suitable for use with paper making machines.

Still another object of my invention is to provide a wear resistant wire screen that is simple and inexpensive to manufacture.

In brief a wear resistant wire screen embodying my invention comprises interwoven warp and shute wires. The wire screen has a wearing side, and the warp wires have knuckle portions on the wearing side which overlap the shute wires. Depending on the weave, the shute wires may have knuckle portions on the wearing side which overlap the warp wires. A stable coating is firmly adhered on the wearing side to only the knuckle portions to provide caps thereon, the screen having a life ratio greater than one and a high porosity.

Before proceeding with a detailed description of a wear resistant wire screen embodying my invention, I wish to define what is meant by the terms "stable," "firmly adhered," "life ratio," and "high porosity."

The life ratio is the ratio of the length of time required to wear down a coated wire screen embodying my invention to a predetermined thickness to the length of time required to wear down an identical uncoated wire screen to the same thickness, both the coated and uncoated wire screens being worn down under identical conditions.

Firmly adhered means that the caps of coating material on the knuckles cling to the knuckles with sufficient tenacity that when the wire screen is in use in its intended manner with the wearing side frictionally engaging a surface or surfaces, at least a large majority of the caps as whole parts will not be dislodged by the frictional engagement, but rather will gradually wear down.

Stable means that if the intended use of a coated wire screen embodying my invention is such that the screen is to be operated under acidic, basic or other corrosive conditions, at least a large majority of the caps of coating material on the knuckles will remain firmly adhered thereto and as whole parts will not be dislodged as a result of chemical action or combined chemical action and frictional engagement.

High porosity means that the width of the caps on the knuckles should not substantially reduce the size of the screen openings to an extent such that adequate drainage is not obtained when the screen is used in its intended manner, the width of the caps for paper making machine wire screen therefore being preferably the same as the diameter of the knuckle, or only slightly greater.

Other features, objects and advantages of wear resistant wire screens embodying my invention will become apparent from the following detailed description taken in conjunction with the drawings in which:

FIGURE 1 is a perspective view of a wear resistant wire screen constructed in accordance with my invention;

FIGURE 2 is a cross-sectional view taken along line 2—2 in FIGURE 1;

FIGURE 3 is a portion of a worn warp wire showing a comparison between the amount of wearing of the metal of a conventional warp wire and the amount of wearing of the metal of a warp wire coated in accordance with my invention;

FIGURE 4 is a view similar to FIGURE 1 of another embodiment of my invention; and

FIGURE 5 is a cross-section taken along line 5—5 in FIGURE 4.

Referring to FIGURES 1 and 2, I have shown a wear resistant wire screen 1 which is particularly suitable for use with a paper making machine. Wire screen 1 comprises interwoven shute wires 2 and warp wires 3. As best seen in FIGURE 2, warp wires 3 pass over one shute wire 2 and under the next two adjacent shute wires 2, this sequence being repeated. Shute wires 2 pass over two adjacent warp wires 3 and under the next adjacent one warp wire, this sequence being repeated, as best seen in FIGURE 1. This type of weave is referred to in the art as twill weave. Generally, with twill weave, the warp wires of a paper making machine screen are 8% Phosphor bronze, while the shute wires are usually brass or bronze. The wires may be of other materials, of course. Wire screen 1 has a wearing side 4 and an upper side 5 which serves to support the pulp and aqueous carrier. Warp wires 3 in passing under adjacent shute wires 2 provide knuckle portions 6. As best shown in FIGURE 2, only the knuckle portions 6 have a coating 7 applied thereto. Coating 7 may be of any material which is stable and firmly adherent to warp wires 3, and which will result in wire screen 1 having a life ratio greater than one and a high porosity. Preferably the width of coating 7 is the same as the diameter of knuckle 6, but the width of coating 7 may be slightly greater than the diameter of knuckle 6 without decreasing the porosity of the screen or affecting drainage therethrough to an appreciable extent.

When wire screen 1 is placed on a paper making machine, its direction of travel is the same as the direction of warp wires 3. It will be apparent from a consideration of FIGURE 2, that since the suction boxes, table rolls and driving mechanism for the wire screen contact the wearing side 4 of the wire, coating 7 will receive all the abrasion until such time as the coating is worn down to knuckles 6, at which time knuckles 6 will start to be worn away by the frictional engagement between the screen and the suction boxes, table rolls and screen driving mechanism. It will be apparent, however, that because coating 7 must be abraded before knuckles 6 can begin to start wearing, a wire embodying my invention will have a longer life than an uncoated wire i.e. the life ratio of wires embodying my invention will be greater than one. This is best understood from a consideration of FIGURE 3 wherein the dotted outline 8 indicates the boundary of wearing of a conventional warp wire 3 after having been employed for a certain length of time on a wear testing machine, the area within outline 8 being flatt. On the other hand, the solid outline 9 indicates the amount of wearing of warp wire 3 after having been coated in accordance with my invention and employed on the same wear testing machine for the same length of time. Neither coating 7 nor the amount of wear thereof is shown in FIGURE 3.



My invention also is applicable to a wire screen woven in what is known as a full twill weave. Full twill weave wire screens are woven such that knuckle portions are provided on the wearing side of the screen by both the warp and shute wires. A full twill weave wire screen 1 is shown in FIGURES 4 and 5. In such a screen warp wires 3 are woven in the repeated sequence of under two adjacent shute wires 2 and over the next two adjacent shute wires. Shute wires 2 are woven in the repeated sequence of over two adjacent warp wires 3 and under the next adjacent two warp wires. It will be seen that on wearing side 4 of screen 1 both the warp and shute wires have knuckle portions 6. In accordance with my invention, coating 7 is applied on the wearing side of screen 1 to only knuckle portions 6 of warp and shute wires 3 and 2 respectively.

In connection with full twill weave it should be noted that on wearing side 4 of screen 1, the shute wire knuckle portions and the warp wire knuckle portions preferably lie in the same plane. On the side 5 of the screen which supports the paper stock, the shute and warp wire knuckle portions may be of the same height, or the shute wire knuckles may be elevated above the warp wire knuckle portions, especially for tissue manufacture. Preferably shute wires 2 are of smaller gauge than warp wires 3, although this is not essential. Whereas conventional twill weave has openings ranging from square to rectangular in a longitudinal direction, full twill weave has openings which ordinarily vary from square to rectangular in a transverse direction. With a full twill weave the screen is substantially symmetrical in all respects.

It is most important to note that the essence of my invention lies in coating on the wearing side of a screen only the knuckles with a coating material which is stable and firmly adherent to the knuckle portions so as to provide a wire screen having a life ratio greater than one. As long as the coating material has three properties, the type of coating material which is employed in practising my invention may vary. Therefore, while, by way of example only, I will describe two types of plastic coatings which have been found suitable in practising my invention insofar as paper making machine wire screens are concerned, it is not my intention that I should be in any way limited thereto.

## EXAMPLES

### (A) *Two types of suitable coating materials*

One suitable coating material useful in practising my invention is as follows:

COATING H—UREA-FORMALDEHYDE-EPOXY

| | Parts by weight |
|---|---|
| Epon 1007 | 32.0 |
| Cellosolve acetate | 12.4 |
| Methyl isobutyl ketone | 5.2 |
| Toluene | 13.6 |
| Isophorone | 13.9 |
| p–196–60 | 22.9 |
| | 100.0 |

In preparing this coating material, the epon resin was dissolved in the solvents, and the p–196–60 urea-formaldehyde solution was then mixed in. This coating has a quoted pot life of one to two months.

Commercial grades of solvents were used.

Another coating found to be suitable in practising my invention is as follows:

COATING I—PHENOL-FORMALDEHYDE-EPOXY

| | Parts by weight |
|---|---|
| Epon 1007 | 33.3 |
| Cellosolve acetate | 19.6 |
| Toluene | 21.4 |
| Isophorone | 13.9 |
| Methylon 75108 | 11.1 |
| Phosphoric acid, 85% | 0.7 |
| | 100.0 |

In preparing this coating material, the epon resin was dissolved in the solvents, the phenol-formaldehyde was stirred in, and then the phosphoric acid was added and well blended. The pot life of this coating is not known. Again commercial grades of solvents were employed.

Epon 1007 is an epoxy-resin which is sold by the Shell Chemical Corporation, a Division of the Shell Oil Company of Canada. P–196–60 is a 60% solution of urea-formaldehyde resin in butanol-ethanol and is sold by Reichhold Chemicals Incorporated, Toronto, Canada. Methylon 75108 is a phenolformaldehyde resin which is marketed by the Chemical Materials Department of the Canadian General Electric Company Ltd., Toronto, Canada.

(B) *Application of coating materials*

It was desired to apply various coatings to an endless belt of conventional twill weave wire screen of the type employed with paper making machines, the screen being Number 68 mesh, the belt being 5 inches wide and 49 inches long. In order to effect this, one half of the wearing surface of the band was lightly abraded lengthwise of the band (three or four strokes in a given area with the paper being hand-held) by a 5/0, 180, 3M aluminum oxide paper (a product of the Minnesota Mining and Manufacturing of Canada Limited). The whole of the wearing surface of the band was then cleaned with a cotton cloth soaked in toluene. Starting at the seam in the band and on the non-abraded half, coatings of plastic three inches wide were applied in strips using mixtures H and I alternatively. This was achieved by applying a film of the wet coating (coating H or I) to be applied to the wire screen onto a flat stainless steel plate eight inches square with a Baker applicator. This made a wet film drawdown of six inches long, three inches wide and any preset desired thickness up to 0.007 to 0.008 inch.

After a selected drying time at room conditions to increase the viscosity and the solids content of the film by solvent evaporation, the wearing surface of the band of wire screen was placed onto the wet film, and a steel plate eight inches square and weighing approximately eight and a half pounds was laid on the wire screen. After a few seconds the weight and screen were removed carefully. The flat plate was used to ensure fairly uniform contact of the wire screen and the wet film of the plastic solution.

A second strip was then coated using a fresh portion of the belt of wire screen immediately adjacent to the strip which had just been coated and employing the same draw-down of wet film which had just been used. Thus each drawn-down of coating was used to make two coated strips on the band of wire screen side by side.

When two or four strips had been coated on the wire screen in the manner previously described, the band of wire screen was supported such that the freshly coated strips were facing down and the coatings allowed to air dry.

The above process for coating the wire band was repeated until there were fourteen strips on the inside of the band of wire screen.

After all the strips of coated wire screen had been prepared, the band of wire screen was subjected to the



following drying and baking schedule (*a*) overnight at room temperature, followed by (*b*) 1 hour at 75° C. in a standard oven, then (*c*) 20 minutes at 170° C. and (*d*) 40 minutes at 174° C. Steps (*c*) and (*d*) were in a forced draught oven.

The following table lists some of the data regarding the application of the strips onto the wire screen:

| Strip | Coating | Plastic type | Baker Applicator Setting | Wet Film Drying Time, Minutes [1] |
|---|---|---|---|---|
| 1 | H | Urea-formaldehyde epoxy | 8½ | 10 |
| 2 | H | do | 8½ | 12 |
| 3 | I | Phenol-formaldehyde epoxy | 8½ | 11 |
| 4 | I | do | 8½ | 13½ |
| 5 | H | Urea-formaldehyde epoxy | 8½ | 11 |
| 6 | H | do | 8½ | 13½ |
| 7 | I | Phenol-formaldehyde epoxy | 8 | 11 |
| 8 | I | do | 8 | 13 |
| 9 | H | Urea-formaldehyde epoxy | 8 | 11 |
| 10 | H | do | 8 | 13 |
| 11 | I | Phenol-formaldehyde epoxy | 8 | 11 |
| 12 | I | do | 8 | 13 |
| 13 | H | Urea-formaldehyde epoxy | 8 | 11 |
| 14 | H | do | 8 | 13 |
| 15 | I | Phenol-formaldehyde epoxy | 8 | 11 |
| 16 | I | do | 8 | 13 |

[1] This is the drying time at room conditions of the wet film of the coating which had been cast on the steel plate before the belt of wire screen was laid on it.

The setting of the Baker applicator for making the film on the steel plate was decreased slightly for strips 7 to 14 because it was found that the thicker film obtained with the 8½ setting caused too many of the apertures in the screen to be filled. It was found that the 8½ setting gave a wet film on the steel plate of thickness 0.0055 inch whereas the setting of 8 gave a film thickness of 0.0050 inch (both measured immediately after the film was made).

(C) *Testing machine and results*

The belt of coated wire screen was placed over two six-inch diameter rolls with the coated surface of the wire screen in engagement with the rolls. One of the rolls was driven by an electric motor. The coated surface of the wire screen was drawn over a simulated suction box cover made of end grain maple, three inches wide and having a top surface with a five-inch radius of curvature. The tension in the wire was set at thirty pounds per linear inch while the normal pressure at the wearing surface (the suction box cover) was six pounds per square inch. Shower water at a temperature of 100° F., and brought to a pH of 4.5 with aluminum sulphate was directed at the wearing surface to form an eight-inch wide shower, the water being recirculated. No abrasive was added to the water as it was found that the recirculating water became rusty very rapidly and the rust itself acted as an abrasive. The wire screen belt was driven by the driving roll at a speed of two thousand feet per minute.

(D) *Results of test*

After eleven hours of continuous running on the wear tester, the band of wire screen was removed and examined under a binocular microscope. The original diameter of the warp wire was eight and a quarter thousands of an inch (thou.). After the wear test the uncoated test areas showed knuckle wear of approximately two thou. In some areas of the coated strips (where the caps on the knuckles were thicker) no metal had been worn off the knuckles. In other areas (where the caps were thinner) some metal had been lost. The thickness of the coating applied to the knuckles was estimated as between one and two thou., and it was concluded as a result of the foregoing tests that coatings of this thickness would increase the life expectancy of the particular wire screen tested under the preceding conditions by at least about 25%, and under certain conditions by appreciably greater than 25%.

## GENERAL

While for the purposes of experiment, coating 7 was applied to knuckles 6 by the pressing technique previously described, this technique or any other suitable technique may be employed to commercially produce wire screen embodying my invention. Such wire screen, for example, may be coated by passing it in contact with a rotating roll which dips into a coating material and carries the same on its surface.

It is essential to note that wire screens embodying my invention are suitable for use as paper making machine wire screens, or for use with other apparatus where frictional engagement of the wire screen with the apparatus occurs under wet rather than dry conditions. A great deal of harm could be done by dry running a wire screen embodying my invention while it was frictionally engaging a surface.

It will be apparent from the foregoing that I have provided new and improved wire screens which are particularly suitable for use with Fourdrinier paper making machines. A wire screen embodying my invention has a life ratio greater than one, which means that it will have to be replaced less frequently than a conventional wire screen, with resultant savings in capital expenditure, labour cost and lost production losses. At the same time the precision and accuracy with which a wire screen is made is not lost by coating the wire screen in accordance with my invention, and wire screens constructed in accordance with my invention possess the required porosity to permit adequate drainage of a liquid therethrough.

It is to be clearly understood that while my invention resides in a wear resistant wire screen having interwoven warp and shute wires, the knuckle portions only of the warp wires or the warp and shute wires on the wearing side of the screen being coated with a suitable material, during the coating process coating material may accidentally be applied to portions of the shute wires and to portions of the warp wires other than the knuckles. Therefore the terminology "a stable coating firmly adhered on said wearing side to only said knuckle portions" is intended to cover wires having coatings accidentally applied to portions of the shute wires and/or portions of the warp wires other than the knuckles.

While I have described a preferred embodiment of my invention, it will be apparent that many other embodiments may be constructed without departing from the spirit and scope of my invention as defined in the appended claims.

What I claim as my invention is:

1. A wear resistant wire screen comprising interwoven warp and shute wires, said screen having a wearing side, said warp wires having warp wire knuckle portions on said wearing side overlapping said shute wires, and a stable coating firmly adhered on said wearing side to only said warp wire knuckle portions to form caps on said warp wire knuckle portions, said caps having a width up to the diameter of said warp wire knuckle portions, said wire screen having a life ratio greater than one and a high porosity.



2. A wear resistant wire screen according to claim 1 wherein said coating is a plastic material.

3. The invention according to claim 2 wherein said wire screen is a paper making machine screen.

4. The invention according to claim 3 wherein said coating is selected from the class consisting of urea-formaldehyde converted epoxy resins and phenol-formaldehyde converted epoxy resins.

5. A wear resistant wire screen comprising interwoven warp and shute wires, said screen having a wearing side, said warp wires having warp wire knuckle portions on said wearing side overlapping said shute wires, said shute wires having shute wire knuckle portions on said wearing side overlapping said warp wires, and a stable coating firmly adhered on said wearing side to only said warp wire and shute wire knuckle portions to form caps on said warp wire and shute wire knuckle portions, said caps having a width up to the diameter of said warp wire and shute wire knuckle portions respectively, said wire screen having a life ratio greater than one and a high porosity.

6. A wear resistant wire screen according to claim 5 wherein said screen is a paper making machine screen.

7. A wear resistant wire screen according to claim 6 wherein said coating is selected from the class consisting of urea-formaldehyde converted epoxy resins and phenol-formaldehyde converted epoxy resins.


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