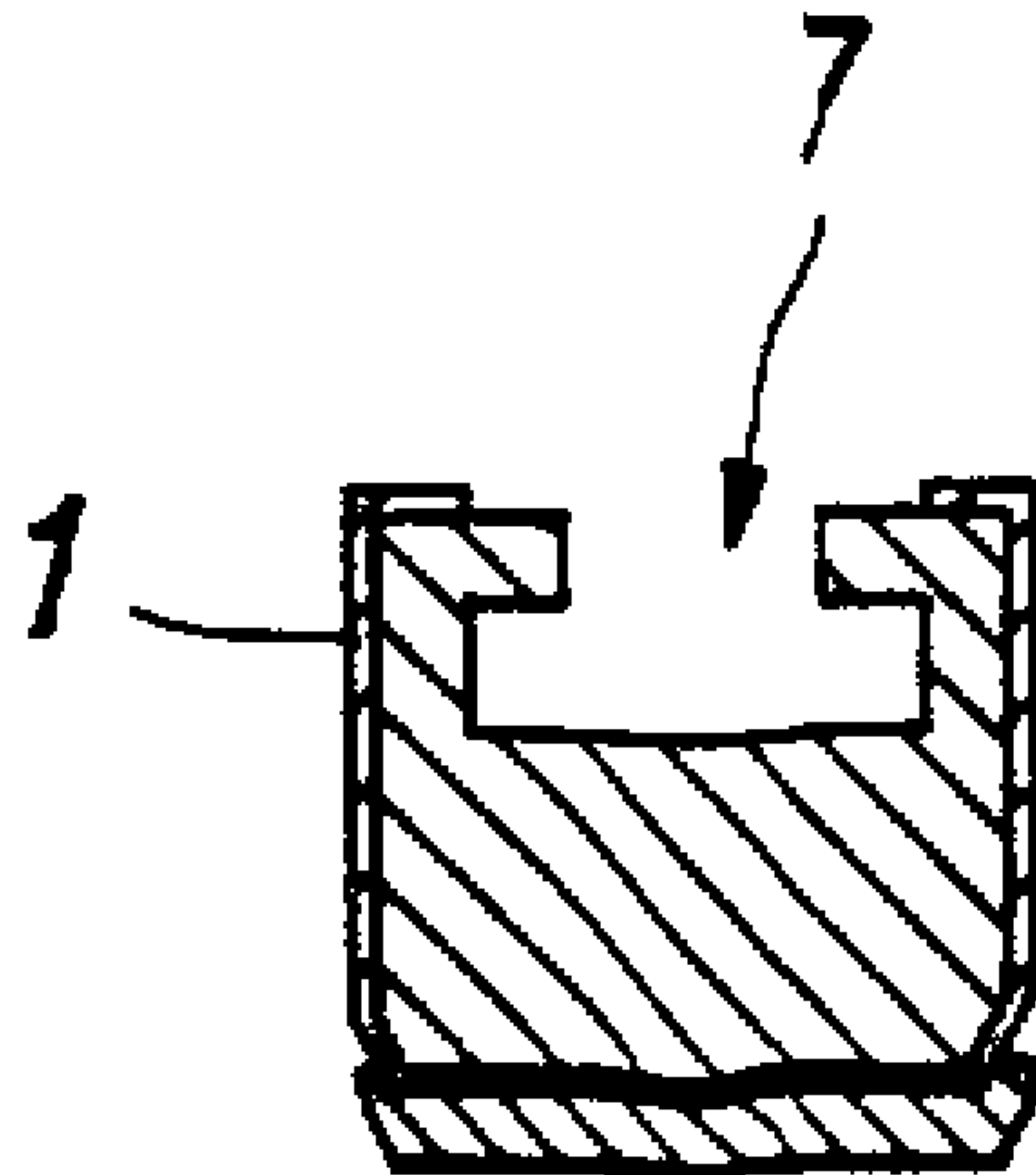




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(54) Titre : ELEMENT D'ELIMINATION DE L'EAU POUR MACHINE A PAPIER, ET SON PROCEDE DE FABRICATION
 (54) Title: WATER REMOVAL ELEMENT IN A PAPER MACHINE AND METHOD OF MANUFACTURING SUCH AN ELEMENT



(57) **Abrégé/Abstract:**

Paper and board machines require the use of fixed water removal elements adapted to squeegee the wire or press felt of the machine from the side opposite to the sheet side of the wire/felt, whereby water is removed from the wire/felt. The present invention relates to a water removal element comprising a body (1, 6) and a ceramic wear-resisting coat (5). The body (1, 6) comprises an elongated continuous section forming a bounded space into which a thermoset plastic compound fill (6) can be cast, and at least one surface suited to accommodate the adherence of said wear-resisting coat (5). The bounded interior space of the continuous section body is at least partially filled with said thermoset plastic compound fill (6) and said ceramic wear-resisting coat (5) is formed by a ceramic coat (5) applied by thermal spray-coating onto a surface of the continuous section body (1).



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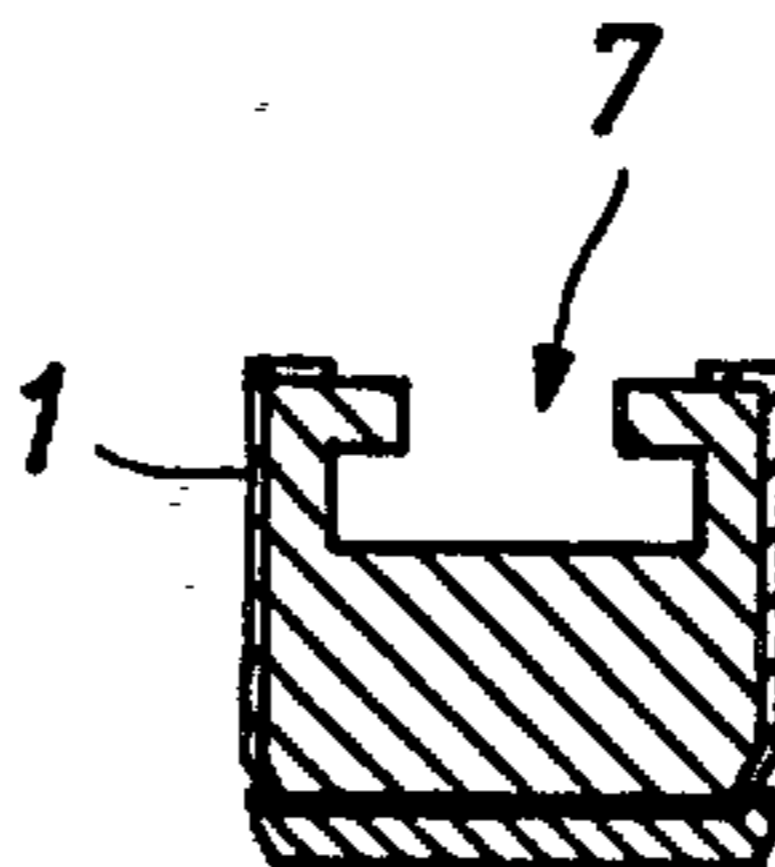
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(54) Title: WATER REMOVAL ELEMENT IN A PAPER MACHINE AND METHOD OF MANUFACTURING SUCH AN ELEMENT

(57) Abstract

Paper and board machines require the use of fixed water removal elements adapted to squeegee the wire or press felt of the machine from the side opposite to the sheet side of the wire/felt, whereby water is removed from the wire/felt. The present invention relates to a water removal element comprising a body (1, 6) and a ceramic wear-resisting coat (5).

The body (1, 6) comprises an elongated continuous section forming a bounded space into which a thermoset plastic compound fill (6) can be cast, and at least one surface suited to accommodate the adherence of said wear-resisting coat (5). The bounded interior space of the continuous section body is at least partially filled with said thermoset plastic compound fill (6) and said ceramic wear-resisting coat (5) is formed by a ceramic coat (5) applied by thermal spray-coating onto a surface of the continuous section body (1).



Water removal element in a paper machine and method of manufacturing such an element

5 The invention relates to a fixed water removal element according to the preamble of claim 1 in a paper or board machine, said element being adapted to squeegee the wire or press felt of the machine from the side opposite to the sheet side of the wire/felt.

10 The invention also concerns a method of manufacturing such a water removal element.

15 Water removal elements are subjected to high wearing stresses. As web speeds in modern paper machines are today in the range 1000 - 1500 m/min, a wire or felt travelling over the surface of the water removal element hurls past the element at a substantial velocity. The wear is increased by the fillers used in papermaking such as clay, talc and chalk, and by unwanted impurities of
20 the papermaking process. Fixed water removal elements are located at the wet end of the paper machine along its wire section and press section. Passing over the water removal element in the wire section is a wire woven from polymer monofilament, whereby the wire permits drainage
25 of water from the paper sheet of high moisture content at this stage. The water removal elements squeegee water off the wire or impose a vacuum or pressure shocks on the wire. In the press section water is removed from the felt by suction.

30 Different types of water removal elements are required in varying applications. The simplest of such elements are planar slices extending over the width of the web aligned so as to support and squeegee the wire. If the trailing
35 edge of the slice relative to the machine direction is chamfered, a slice is obtained capable of imposing a pressure shock on the moving web. Suction boxes are used

to remove water from the wire by a vacuum, and the box cover resting against the wire may comprise slice-like elements or a drilled surface. Besides these, sliding shoes can be adapted about the wire so as to opposedly support and press the wire(s). Such sliding shoes may also be employed to deflect the web and subject it to pressure shocks. The sliding surface of such shoe elements must be manufactured to close tolerances with a design which is most durable under the wear imposed by the moving wire or felt and which simultaneously is very gentle to the wire or felt. Ceramic materials have been found optimally compatible with these requirements.

Conventionally, ceramic water removal elements are fabricated by assembling a long slice comprising adjoining ceramic pieces. The length of the slice is determined by the web width of the machine. The slice may be prepared from pieces machined to exact dimension that are mounted onto a precision pedestal, whereby a relatively smooth surface of the slice results. However, a better end result is achieved by means of a structure in which the ceramic pieces are adjacently glued to each other and the ready-assembled slice is ground to correct shape, whereby no height differences remain between the pieces. The most common materials for the pieces are aluminium oxide, silicon carbides and zirconium oxide.

However, a slice structure assembled from ceramic pieces has several shortcomings. Even if the water removal element is assembled from pieces, the pieces become relatively massive and thus rather vulnerable to thermal shocks. Temperature variations in a piece pressed against a web moving at a high speed may be substantially rapid at, e.g., loss of water film lubrication between the piece and the web. Such thermal shocks cause local fractures of the pieces and erosion of the piece surfaces which increases the wear rate of the wire massively. A

slice assembled from pieces may become deformed due to wear or displacement of the pieces. Shape defects of the slices cause disturbances in water removal and can ruin the sheet being manufactured.

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Yet, the greatest problems plaguing water removal elements made from ceramic pieces are associated with the inferior chemical and thermal resistance of adhesives used for joining the pieces. The adhesive applied to the joint has insufficient resistance to the wide temperature variations and strong chemicals occurring in a paper machine. The heaviest thermal loads occur when the wire travels without lubrication, that is, the machine is running dry. In this case the heat of friction can elevate the surface temperature of the ceramic piece in a few minutes by 120 - 200 °C. Since the thermal expansion coefficients of the ceramic material, the adhesive and the glass-fiber reinforced plastic body are different and the temperature profile of the slice is not homogeneous, substantial thermal stresses will develop in the slice that may detach the ceramic pieces from each other or totally separate them from the slice body.

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Adhesives employed for bonding the ceramic pieces are not sufficiently resistant to the warm waters of the paper machine which are chiefly detached from the web being dried. The degrading effect of the waters is amplified by the residual chemicals of the papermaking process contained in the waters. Experimental tests on the strength of an adhesive-bonded joint indicated that already after 200 hours of aging the bond strength of almost all adhesives was lowered by tens of percent and in some adhesive grades even below half of their initial strength during this aging period. Because the strength impairment of the adhesive bond may result in the detachment of the ceramic pieces, such a drastic loss of bond strength is not acceptable. The ceramic pieces may

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also rise above the slice surface which results in a so-called keyboard effect. Then, the elevated pieces mark the web with detrimental streaks. Hence, a water removal element requiring no adhesive bonds in its manufacture
5 would be desirable.

It is an object of the present invention to achieve a cost-efficient and easy-to-manufacture water removal element having a continuous ceramic sliding surface.
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The goal of the invention is accomplished by manufacturing the water removal element from a continuous section of metal having its one side covered with a ceramic coat applied by thermal spray-coating and its interior filled
15 with a cast thermoset plastic compound.

More specifically, the water removal element according to the invention is characterized by what is stated in the characterizing part of claim 1.
20

Furthermore, the manufacturing method according to the invention is characterized by what is stated in the characterizing part of claim 7.

25 The invention offers significant benefits.

The invention is capable of entirely avoiding the use of an adhesive in the manufacture of a water removal element with a ceramic surface. The vulnerability of the element
30 to damage is reduced as no piece can become detached therefrom under use. The thin, ceramic surface of the water removal element is most resistant to thermal shocks, this making it less sensitive to damage under rapid variations of the element temperature as compared
35 with conventional ceramic elements. By means of spray-coating, a continuous surface is obtained, whereby the keyboard effect is avoided which plagues water removal

elements assembled from ceramic pieces. The element has a relatively good inherent stiffness, because the metallic continuous section forms a shell structure with good resistance to stresses about the thermoset plastic compound core. Hence, the bodies of the water removal elements can have a relatively lightweight construction and dispose of the need for a separate plastic body for ceramic pieces. Due to the corrosion resistance requirement imposed on a water removal element, stainless steel or other corrosion-resistant material must be employed in its manufacture. The element structure according to the invention is capable of minimizing the use of required expensive, stainless material to a very small amount, whereby a cost-efficient construction results. Hence, the present type of water removal element may be used in applications where conventional embodiments made from ceramic pieces have been too costly. The porous coat made by thermal coating is sealed, whereby good wear resistance and advantageous friction properties are obtained.

In the following, the invention will be examined in more detail with reference to the attached drawings, in which:

Figure 1 is the cross section of a water removal element according to the invention after its first manufacturing step;

Figure 2 is the cross section of the element illustrated in Fig. 1 after its second manufacturing step; and

Figure 3 is the cross section of the element illustrated in Figs. 1 and 2 after its third manufacturing step;

Referring to the diagrams, a complete water removal element comprises a U-shaped continuous section 1 having,

e.g., a ceramic coat 5 applied onto the base part 3 of the U-shaped continuous section so as to form a wear-resistant surface, and a thermoset plastic compound core 6 cast into the continuous section 1. A T-slot is
5 machined into the thermoset plastic compound core 6, in the area between the legs of the U-shape, for mounting the water removal element.

In the embodiment illustrated herein, the continuous
10 section of the water removal element body is made from stainless steel having its cross section comprising a base part 3 of the U-shaped continuous section forming a plane to which the legs 2 of the continuous section are joined extending orthogonally upward from the base part
15 3. The joining edge between the base part 3 and the legs 2 is provided with a chamfer 8, and the legs 2 end at inward bent flanges 4. The entire interior of the continuous section is filled by a thermoset plastic compound core 6.

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A water removal element with the above-described structure is manufactured in the following manner. A ceramic coat 5 is applied onto the base part 3 of the continuous section 1 cut to a suitable length by means of thermal
25 spray-coating. Next, the coat is sealed by impregnating the coat with a low-viscosity material having a high penetration capability into the coat. Subsequent to the sealing step, the interior of the continuous section is filled by casting it full of a thermoset plastic compound
30 which is cured, whereby it adheres to the interior walls of the continuous section 1 thus stiffening the continuous section 1. To assure good adherence of the plastic compound 6, the interior walls of the continuous section 1 may be sand-blasted or cleaned by any other suitable
35 method. After the curing of the plastic compound 6, a mounting slot 7 is machined into the cast compound for mounting the water removal element at the desired place

in the paper machine by means of a support frame. Finally, the outer surface of the coat is precision ground to correct shape.

5 The water removal element according to the invention may be made from a variety of different materials. While the optimal material for the base part continuous section 1 is stainless steel, also aluminium, brass, duplex steel and other corrosion-resistant materials may be employed.

10 The ceramic coat can be made from the following materials or mixtures thereof: Al_2O_3 , Cr_2O_3 , ZrO_3 , TiB_2 , SiO_2 , TiO_2 , WC and Cr_2C_3 . However, when applied by thermal spray-coating, these materials remain more porous and softer than ceramic pieces made by sintering. Such a porous coat

15 may wear down paper machine wires by the cutting action of the edges of the pores and the abrading action imposed on the wire by the filler particles and impurities lodging in the pores. To avoid such undesirable effects and improve the wear resistance of the coat, the pores may be

20 sealed with a suitable auxiliary material. Suitable materials are, e.g., organic resins and inorganic compounds. Of organic materials, the most suitable are low-viscosity epoxy resins which can be made to impregnate almost the entire porous volume of the coat. Moreover, such a sealing treatment improves the durability of the coat. Of

25 inorganic materials can be used, e.g., phosphate compounds which are impregnated into the coat from aluminium hydroxide and phosphoric acid solutions. These compounds are then converted into crystalline form by a heat treatment. Also these compounds are capable of improving the

30 wear resistance of the coat and their friction properties may further be enhanced by complementing the sealing treatment by auxiliary compounds with fluorinated resins. The selection of suitable sealing compounds is wide and

35 at least phenolic resins, fluorinated resins, epoxy resins, phosphate compounds and methacrylate resins are well suited for use as sealing compounds.

Thermal spray-coating can be used for applying coats on metallic surfaces only. Since the body of a water removal element must be of a non-rusting material, it would become excessively expensive with respect to competing solutions when made on, e.g. a solid stainless steel beam. According to the invention, this problem is overcome by manufacturing the body from a thin-walled continuous section which is stiffened by filling it with a thermoset plastic compound. In this manner the element can be made both stiff, lightweight and cost-efficient. Several different types of thermoset plastics are suitable for use as the fill material of the continuous section including epoxy resins, methacrylate resins, polyester resins, vinyl ester resins, phenolic resins and mixtures thereof. To improve the stiffness of the fill material and lower its thermal expansion coefficient, the resin may be reinforced with, e.g., chopped glass fiber or ceramic particles.

The above-described type of water removal element is suited for use as a water removal element squeegeeing a wire or felt. Naturally, the invention may also be applied to other water removal elements of a paper machine that are in contact with a moving wire or felt. Then obviously the shape of the element must be modified to suit the application. As a person versed in the art can readily fabricate elements of different shape for varied applications on the basis of the foregoing exemplary description, detailed illustration of such modified shapes will be omitted herein. Also the shape of the continuous section can be widely varied and, for instance, the use of a continuous section with a closed perimeter is possible. Then, the outer surface of the section may be contoured so as to provide the mounting facility of the water removal element.

CLAIMS

1. A water removal element in a paper or board machine, comprising:

an elongated shell structure, forming a bounded space therein, said shell structure having a surface extending along a length of the shell structure;

a plastic compound at least partially filling the bounded space in said shell structure, the plastic compound stiffening said shell structure along the length of said shell structure, the plastic compound filling the bounded space and adhering to the shell structure such that the shell structure is stiffened by the plastic compound along its length; and

a ceramic wear-resisting coating formed onto the surface of said body, said ceramic coating having been applied to the surface of said body by thermal spray-coating.

2. A water removal element as defined in claim 1, wherein said continuous section constituting the casting mould has an open cross-sectional shape, approximating a U-shape having its interior at least partially filled with a thermoset plastic compound and having said ceramic coat adhered to its base part.

3. A water removal element as defined in any one of claims 1 and 2, wherein a slot machined into the thermoset plastic compound fill for mounting the element to a support frame.

4. A water removal element as defined in any one of claims 1 to 3, wherein having the coat made from one of the following compounds: Al_2O_3 , Cr_2O_3 , ZrO_3 , TiB_2 , SiO_2 , TiO_2 , WC and Cr_2C_3 , or a mixture thereof.

5. A water removal element as defined in any one of claims 1 to 4, wherein having the coat sealed by impregnation with a compound selected from the group of the following compounds: phenolic, resins, fluorinated resins, epoxy resins, phosphate compounds and methacrylate resins.

6. A water removal element as defined in any one of claims 1 to 5, wherein having the fill compound of the continuous section selected from one of the following groups of compounds: epoxy resins, methacrylate resins, polyester resins, vinyl ester resins and phenolic resins.

7. A method of making a water removal element, comprising the steps of:

forming an elongated shell structure with a bounded space therein, said shell structure having a surface extending along a length of the shell structure;

applying a ceramic coating to the surface of the shell structure extending along the length of the shell structure, said ceramic coating being applied by thermal spray-coating;

at least partially filling the bounded space within the shell structure with thermoset plastic compound; and

thermosetting the plastic compound after the bounded space of the shell structure has been at least partially filled with the plastic compound, the thermoset plastic compound adhering to the shell structure and stiffening the shell structure along its length.

