

[54] EXTENDED-LIFE DOCTORING APPARATUS

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[52] U.S. Cl. 15/256.51, 34/110, 118/126

[51] Int. Cl. D21g 3/04

[58] Field of Search 15/256.5, 256.51; 162/281,
162/282; 34/110; 68/270; 100/174; 101/154,
155, 167; 118/126; 165/91; 134/6, 9, 15

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UNITED STATES PATENTS

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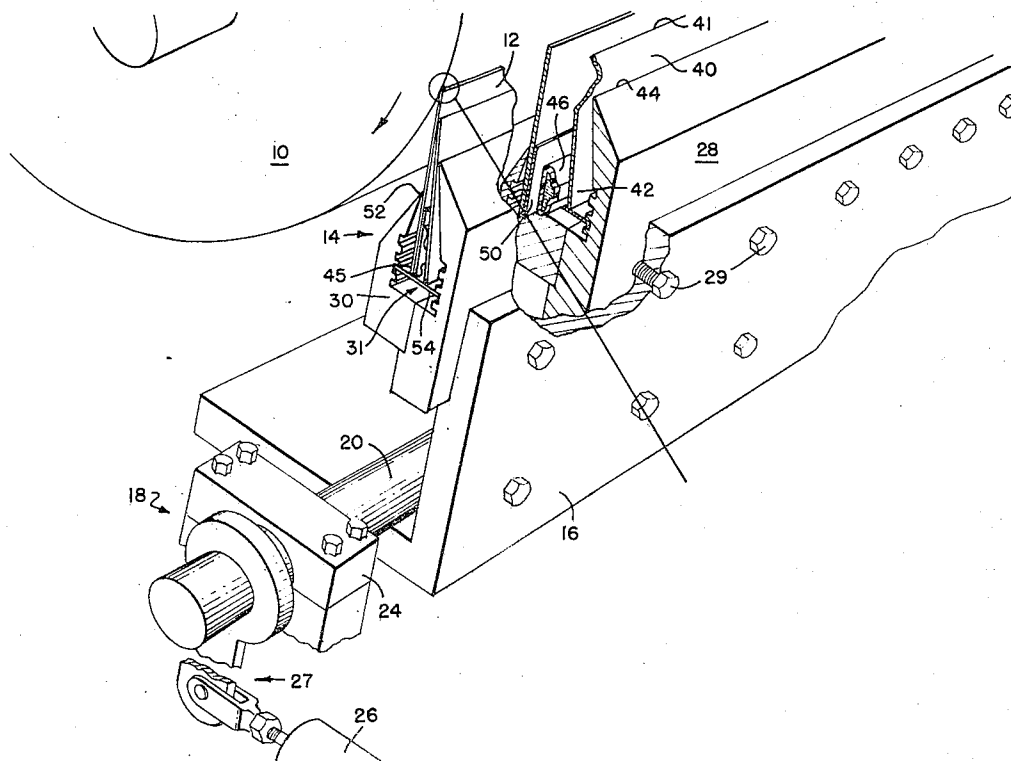
978,988 11/1963 Great Britain.....15/256.51

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[57] ABSTRACT

Doctoring apparatus for doctoring a moving work surface is disclosed as including novel extended-life blade structures and combined therewith blade holding apparatus for supporting a blade for engagement with the work surface including means acting on the blade differentially along the length thereof to cause the blade to conform to deviations in the work surface. Blade holding apparatus is disclosed which minimizes the width-wise deflection of a supported blade and thus maximizes its length-wise flexibility. Extended-life blade embodiments are disclosed which include means defining on an end surface of a tip portion of the blade a narrow relatively wear-susceptible land having along one side thereof a leading edge for making initial line contact with a work surface, and a relatively wear-resistant structure adjacent the land on the side thereof opposite the leading edge. Upon contacting a work surface, the land wear relatively rapidly to break in the blade before contact is made between the wear-resistant structure and the work surface, the wear-resistant structure wearing thereafter relatively slowly.

13 Claims, 16 Drawing Figures



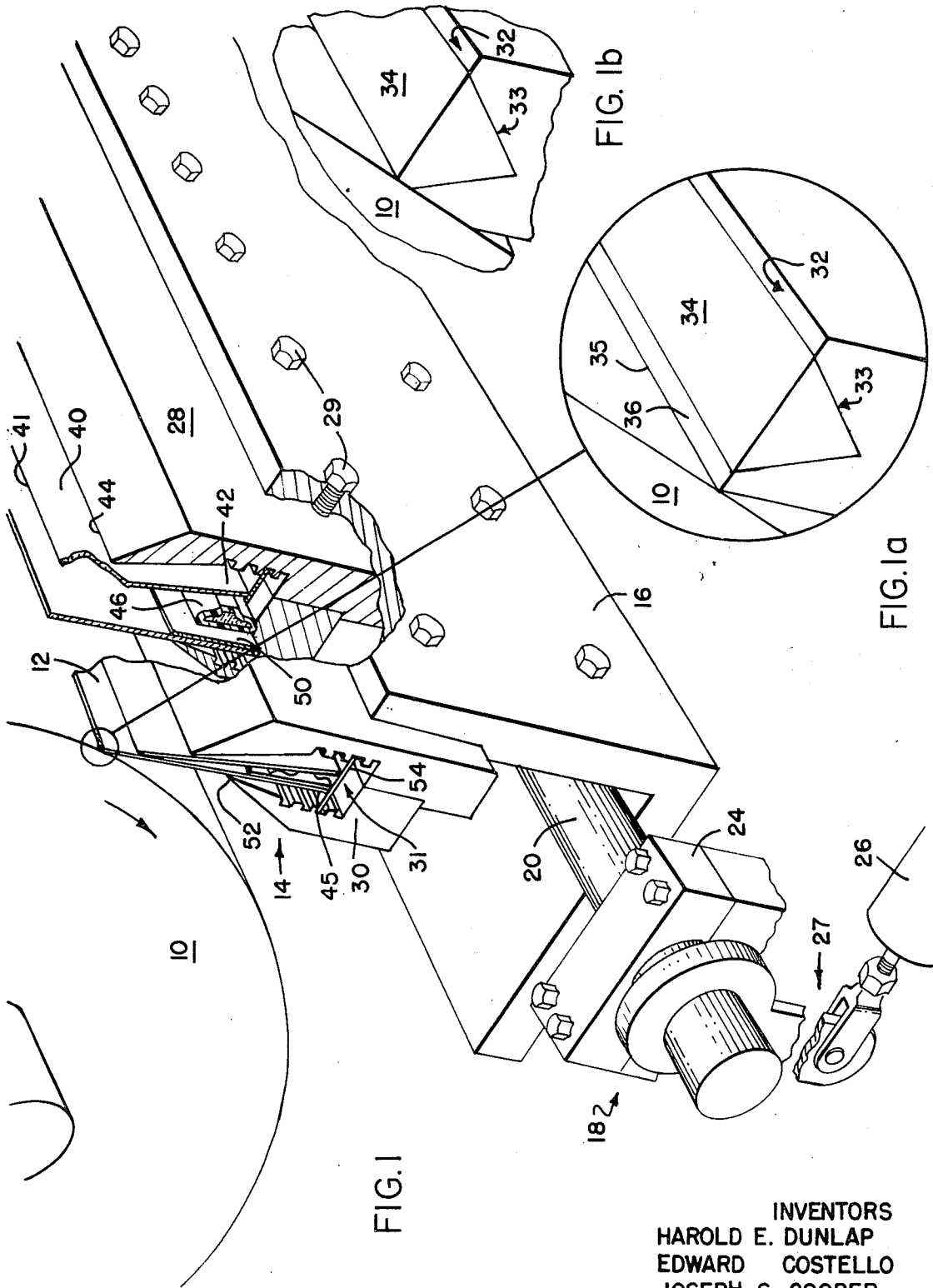


FIG. 1

FIG. 1b

FIG. 1a

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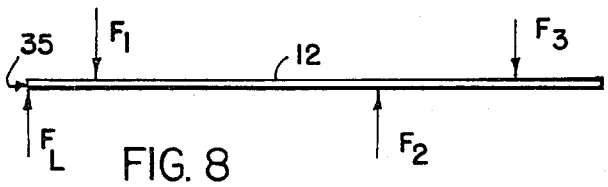


FIG. 8

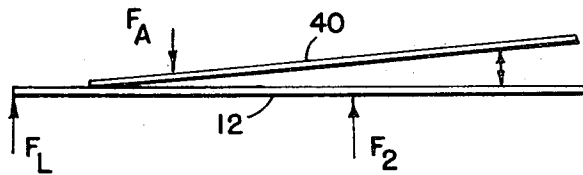


FIG. 9

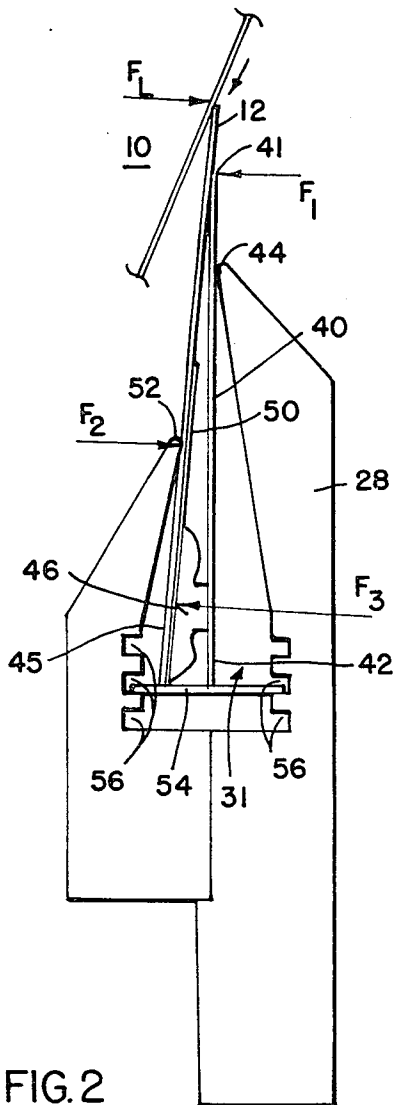


FIG. 2

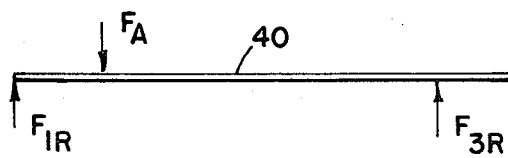


FIG. 10

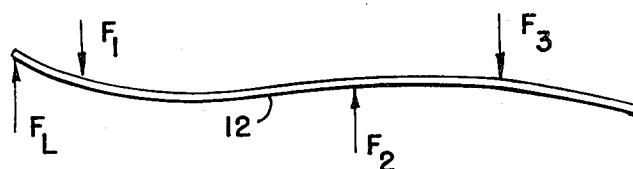


FIG. 11

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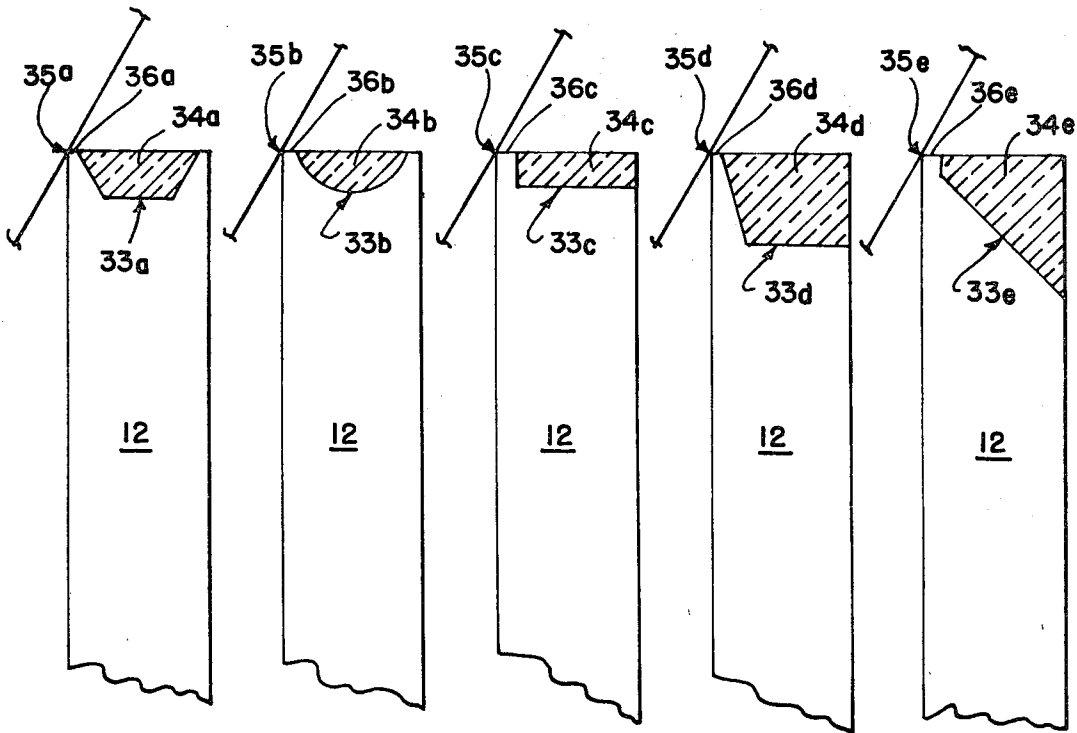


FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

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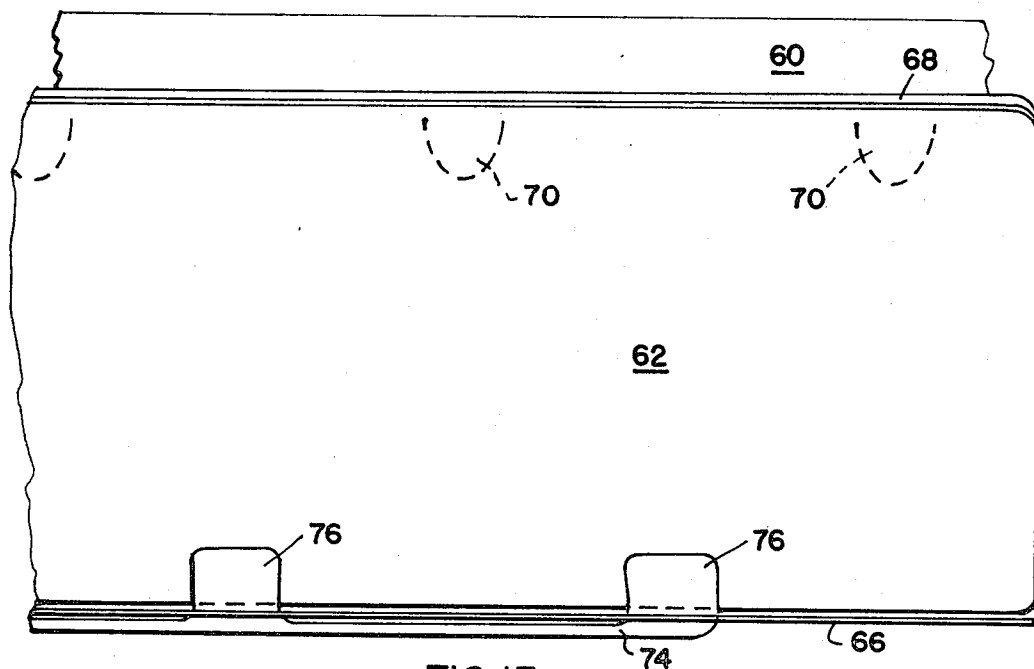


FIG. 13

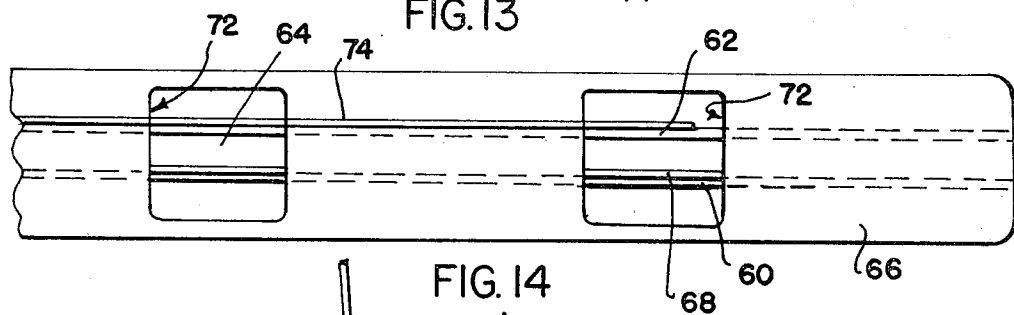


FIG. 14

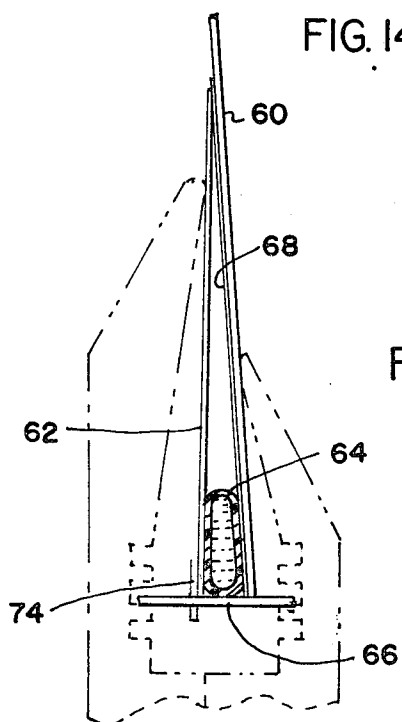


FIG. 12

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EXTENDED-LIFE DOCTORING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to co-pending applications Ser. No. 793,950 filed Jan. 27, 1969, now Pat. No. 3,529,315, Ser. No. 27,201 filed Apr. 7, 1970, and Ser. No. 55,421 filed July 16, 1970, all assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

Due principally to the very substantial costs involved in shutting down a complex processing operation such as is involved in the manufacture of paper stock, there has long been recognized a great need for doctoring apparatus capable of being run continuously for a long period of time before blade changing becomes necessary.

One approach to meeting this need has involved attempting to modify the blades themselves so as to prolong their useful life, e.g., by placing a wear-resistant coating or tip on the blades, as disclosed in Great Britain Pat. No. 978,988. This method has not been successful for a number of reasons. First, the very hard blade tip will not "Break in" and conform to deviations in the doctored surface (or in the blade supporting apparatus), with resulting poor doctoring effectiveness. Because the blade leading edge will not break in, high spots on the work surface are apt to be scored and overheated. Secondly, a blade as described in this British Patent is plagued by chipping of the wear-resistant tip or coating from the blade.

The above-referenced co-pending patent application Ser. No. 55,421 (LD-90), is directed to the very serious problems of blade break-in and chipping which attend the use of a hard, brittle wear-resistant structure. That application teaches for the first time that these problems can, to a very great extent, be overcome by the use of a break-in structure composed of a relatively soft, wear-susceptible material which is so disposed on the blade as to make initial contact with the work surface. The wear-resistant structure does not engage the work surface until after the blade has broken-in, thus maximizing doctoring effectiveness and minimizing chipping of the wear-resistant material. Chipping is further suppressed by the support provided therefor by the break-in structure. One aspect of this invention involves an extension of the teachings in that application.

Wear-resistant inserts have been set in wear-susceptible structures in unrelated arts; e.g., see U. S. Pat. No. 3,446,702 - Buchanan relating to wear inserts for drainage foils and No. 3,404,066 - Francois relating to wear inserts for suction box covers. However, such teachings as may be found in these patents are inapplicable and of little or no value in solving the doctor blade wear problem.

Another approach has involved attempting to design the blade holding apparatus to support the blade in such a way as to cause uniform blade wear and thereby extend blade life. This approach is followed in the first two of above-noted co-pending applications and, while being very successful in prolonging blade life, is only a partial answer because of the inherently limited life of conventional blade structures.

OBJECTS OF THE INVENTION

It is an object of this invention to provide doctoring apparatus having very long blade life compared with prior doctoring apparatus; it is thus an object to substantially reduce the frequency of operation shutdowns necessitated by doctor blade wear.

It is another object of this invention to provide long-life doctor blade structures which have a useful blade life many times that of conventional blades, and yet which minimize risk of damage to the doctored surface. It is an object to provide a long-life doctor blade having a wear-resistant structure constructed and arranged on the blade as to be extremely resistant to chipping and extremely resistant in creping applications to cavitation (hollowing) of the blade end surface by paper abrasion.

It is yet another object to provide blade holding apparatus which when combined with such novel blades acts positively to maximize the length-wise flexibility of a blade and to cause the blade to conform to deviations in the work surface and compensate for deviations in the blade supporting apparatus thereby promoting uniformity of blade loading with resultant substantial protraction of the blade life and minimization of risk of damage to the blade or work surface.

Further objects and advantages of the invention will in part be obvious and will in part become apparent as the following description proceeds. The features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view, partly broken away, of blade holding apparatus embodying the teachings of this invention;

FIG. 1A is an enlarged fragmentary view of the tip of a working blade shown making initial contact with a roll to be doctored;

FIG. 1B is a view corresponding to FIG. 1A, but showing the blade tip as it would appear in normal operation after an initial "break-in" period;

FIG. 2 is a side elevational view of a portion of the apparatus shown in FIG. 1;

FIGS. 3-7 are sectional views of alternative embodiments of working blades which may be constructed to carry out the principles of this invention;

FIGS. 8-10 are diagrams of forces developed by the blade holding apparatus shown in FIGS. 1 and 2;

FIG. 11 is a schematic and exaggerated representation of a working blade as it might appear in its deflected operative state; and

FIGS. 12-14 are end, side, and bottom views of an embodiment showing elements of the blade holding apparatus shown in FIGS. 1 and 2 assembled to form a cartridge.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings depict a preferred implementation of the principles of this invention. In FIGS. 1-2 novel ap-

paratus for doctoring a moving surface 10, here shown as a dryer roll, is illustrated as comprising a novel working blade 12 held by blade holding apparatus 14. The working blade 12 implements a very important aspect of this invention; a detailed discussion of the blade 12 will be engaged after a brief description of the general apparatus for supporting the blade 12.

The blade holding apparatus 14 is supported upon a doctor back 16. The doctor back 16 is supported by a pair of trunnions, one of which is shown at 18. The trunnion 18 includes a shaft 20 which is bolted to the back 16 and mounted for rotation in a bearing 24. A loading device 26, which may be of any suitable type, is coupled to the shaft 20 through an articulated linkage 27 and is employed to place a predetermined loading of the blade 12 against the roll 10.

A blade holder is shown as comprising a top plate 28 secured to the doctor back 16 by means of bolts 29. A bottom plate 30 affixed to the top plate 28 cooperates with the top plate 28 to define an open-ended slot 31 which receives the blade 12 and other blade holding means, to be discussed in detail after a description of the structure of the novel blade 12.

It is a stated object of this invention to provide doctoring apparatus having an extremely long life. In accordance with one aspect of this invention the working blade 12 includes means defining on an end surface of a tip portion of the blade a narrow relatively wear-susceptible land having along one side thereof a leading edge for making initial line contact with a work surface. The blade includes means defining a relatively wear-resistant structure adjacent the land on the side thereof opposite the leading edge, whereby upon contacting a work surface the land wears relatively rapidly to break in the blade before contact is made between the wear-resistant structure and the work surface, the wear-resistant structure wearing thereafter relatively slowly.

The drawings, particularly FIGS. 1A and 1B, illustrate a preferred working blade structure; in these figures the aforementioned end surface is designated 32. Incised in the end surface 32 is a groove 33 running along the full length of the blade. A novel wear-resistant structure is disposed in the groove 33. The wear-resistant structure 34 is spaced from a leading edge 35 of the blade 12 by a relatively wear-susceptible break-in structure or land 36. In the illustrated embodiment the land 36 constitutes an integral part of the blade 12, however, such is not crucial to the operation of a blade according to this invention. It is important, however, that the land be relatively soft in comparison with the wear-resistant structure in order to provide a break-in structure which conforms to the work surface before contact is made between the work surface and the wear-resistant structure.

The wear-resistant structure may be composed of any of a great variety of wear-resistant materials. Following are a number of typical wear-resistant materials which may be employed: aluminum oxide, chromium oxide, silicon carbide, and tungsten carbide.

The blade 12 is typically 0.025 - 0.050 inch thick and may be composed of such materials as K-monel, phosphor bronze, stainless steel, carbon steel, or other common blade materials, or may be of phenolic plastics or other suitable but less common materials.

Fabrication of a blade such as is shown in FIG. 1A may be achieved by milling, planing, or roll forming the groove 33 in the end surface 32 of a blade. This step is followed by application of a coating of wear-resistant material on the end surface 32 of the blade. The coating may be deposited by detonation gun, plasma, or oxy-acetylene methods, or by any other suitable commercial coating methods. The blade is then ground square to remove the wear-resistant material disposed outside the groove 33.

One extremely satisfactory blade was constructed according to the following specifications. The blade was .050 inch thick, the groove angle (the angle between the sides of the groove 33) was 90°, the groove depth 0.015 inch, and the groove width 0.030 inch, leaving a 0.010 inch land on the leading surface 32 on each side of the wear-resistant structure 34. A blade 12 constructed as described, having a wear-resistant structure of chromium oxide and supported in blade holding apparatus as described below was run in tests closely simulating operational conditions as a Yankee creping doctor for 91 hours and after such time exhibited very little wear. Compare this life statistic with that of a conventional doctor blade under similar operating conditions — typically in the order of 16 hours.

FIG. 1A shows a blade according to this invention as it might appear upon initial contact with a work surface; FIG. 1B illustrates the blade after it has been run for a period of time sufficient to wear away the wear land 36 and a small part of the wear-resistant structure 34.

A long-life blade 12 according to this invention having a wear-resistant structure on the blade end surface is extremely resistant to cavitation — a phenomenon occurring during creping in which the wet paper web as it is removed from a dryer roll by a creping blade abrades the blade end surface to form a hollow or cavity therein.

Further, in a blade 12 constructed as described with the wear-resistant structure 34 disposed in the leading end surface 32 thereof, there is little tendency of the wear-resistant structure 34 to chip. One reason for this is clearly evident from an inspection of FIG. 1B. It can be seen that in a blade constructed according to this invention, firm support for the structure is provided at all points along the blade and at all times during the operation of the blade. The direction of motion of the work surface 10 relative to the blade tip is such as to force the wear-resistant structure 34 into the groove 33; since the structure 34 is under compression in the groove 33, there is no tendency of the work surface 10 to oppose the bonding forces holding the wear-resistant structure 34 on the blade 12. The provision of a wear land for "breaking in" the blade prevents shocking of the blade, thus minimizing chipping of the wear-resistant structure 34, and prevents the formation of localized "hot spots" or high pressure points which might score and overheat the work surface and damage the blade.

Another important factor in the prevention of chipping of the wear-resistant structure 34 centers on the provision of blade holding apparatus capable of conforming the tip of the blade to deviations in the work surface. Conformation of the blade tip to the work surface promotes uniform blade pressure and

wear, and minimizes shocking of the blade, which is apt to induce chipping. The structure and operation of the blade holding apparatus for accomplishing the described blade conformation will be discussed in detail below.

FIG. 3-7 illustrate a number of alternative blade structures which implement the principles of this invention.

In the FIG. 3 embodiment, the groove 33a and wear-resistant structure 34a have a generally inverted trapezoidal configuration. The wear-resistant structure 34a is spaced from the blade leading edge 35a by a wear land 36a.

The FIG. 4 embodiment shows a groove 33b and wear-resistant structure 34b which have a cross-section generally in the configuration of a segment of a circle. A wear land and leading edge are designated 36b and 35b, respectively.

FIG. 5 shows an embodiment in which a wear-resistant structure 34c filling a recess 33c in the end surface of the blade defines all of the leading surface of the blade except for a wear land 36c.

The FIG. 6 embodiment is quite similar to the FIG. 5 embodiment except that the recess 33d and wear-resistant structure 34d have a generally inverted trapezoidal cross-sectional configuration. A wear land is shown at 36d.

FIG. 7 shows yet another of the many possible structures which may be fabricated to carry out this invention — the FIG. 7 version is again similar to the FIGS. 5 and 6 structures, however, the generally cross-sectional configuration of the recess 33e and wear-resistant structure 34e differ in being generally triangular. A wear land in the FIG. 7 embodiment is shown at 36e.

As is well known, the most commonly employed wear-resistant materials are extremely hard and brittle. Their hardness makes them ideally suited to minimize wear; however, unless the pressure distribution along the length of blades incorporating such materials is substantially uniform, serious problems are apt to arise. Non-uniform pressure distribution along the blade is apt to cause shocking of the blade, with possible resultant chipping of the wear-resistant structure. Further, because of the extreme hardness of the wear-resistant material relative to the work surface, typically an iron roll, a localized high pressure point on the blade can result in scoring of the roll and severe overheating of the blade and roll at the pressure point. Overheating of the roll may result in serious damage thereto; overheating of the blade may cause the bond between the wear-resistant material and the blade to fail and may otherwise result in structural damage to the blade or blade holder. It is therefore desirable if a long-life blade according to this invention is to be fully exploited, that the blade be held such that its tip conforms to deviation in the work surface, thereby producing a uniform pressure between the blade and the work surface with consequent even blade wear and minimal chipping.

To this end and in accordance with another aspect of this invention, blade holding apparatus is provided for supporting the blade for engagement with the work surface which includes profiling means operating on the blade to cause the tip portion thereof to conform to (take the profile of) deviations in the work surface. The illustrated profiling means is shown as employing a plia-

ble but substantially inelastic closed tube containing a substantially incompressible fluid which operates on the base of the blade, and holder means to support the tube and working blade so as to minimize the loading on the tube and further to minimize the width-wise deflection of the blade to thus enhance the length-wise flexibility thereof. The blade holding apparatus will be described generally first, followed by a discussion of the tube which accomplishes the conformation of the blade tip to deviations in the work surface.

As will be explained in detail below, preferred blade holding apparatus comprises first, second, and third force-applying means for respectively applying to the blade 12 first, second, and third forces in alternately reversing directions along lines which are, respectively, parallel to and spaced increasing distances from the blade end surface 32. See FIG. 8.

In the illustrated embodiment (see particularly FIGS. 1 and 2), the means for applying the described first force on the blade 12 includes a rocker plate 40 having a forward edge 41 and a rearward portion 42. The forward edge 41 bears upon the blade 12, applying a force F_1 along a line parallel to and spaced from the end surface 32 of the blade 12. Reference may be had in connection with this discussion to FIGS. 8-10 showing, respectively, diagrams of the forces acting substantially normal to the blade 12 per se, to the blade 12 and rocker plate 40 as an assembly, and to the rocker plate 40 alone. The force F_1 is in opposition to the normal component F_L of the loading force applied by the work surface to the blade leading edge 35.

An oppositely directed reaction force F_A is applied to the rocker plate 40 by a lip 44 on top plate 28. The rocker plate 40 acts as a first class lever pivoted about the lip 44 on top plate 28. The rocker plate 40 transmits a proportional part of the force F_1 to separating means 46 to thus establish the described third force F_3 along a line on the base portion 45 of the blade 12 parallel to the blade end surface 32. In FIG. 10 which represents the force diagram on rocker plate 40, force F_{1R} is a reaction force equal and opposite to force F_1 ; force F_{3R} is a reaction force equal and opposite to force F_3 .

The described second force F_2 is applied to the blade 12 by a lip 52 on bottom plate 30 which engages the blade 12 along a line between forces F_1 and F_3 . F_2 is oppositely directed from the forces F_1 and F_3 .

As shown in exaggerated dimensions in FIG. 11, the alternately reversing forces F_L , F_1 , F_2 , and F_3 in composite cause the working blade 12 to assume a gently curving S-shaped configuration having a relatively low width-wise deflection and moment of inertia about a neutral axis parallel to the length of the blade 12. Minimization of width-wise blade deflection by the force pattern created by this novel blade holding apparatus effects a maximization of the length-wise flexibility of the blade and thus of its ability to conform to or "fit" the surface being doctored.

The rocker plate 40, acting as a first class lever, functions to transmit a proportional part of the blade loading force to the separating means 46. Thus, the tendency of the width-wise deflection of the blade to increase with increasing blade loading is counteracted by the proportional increase in force F_3 acting on the base portion 45 of the blade 12, the low moment of inertia

configuration of the blade cross section being thereby maintained.

Further, minimization of the width-wise deflection of the working blade as a function of the blade loading reduces the variations in blade angle with changes in blade loading.

The separating means 46 may be solid or may take any of a variety of forms but is preferably constructed as here shown, consisting of a pliable but substantially inelastic tube (silicon or polyurethane, for example) charged with a suitable substantially incompressible fluid 48 such as glycerine or certain hydraulic fluids. The separating means 46, which operates on a volumetric displacement principle, is fully described and claimed in the above-referenced copending application Ser. No. 793,950 now Pat. No. 3,529,315, and functions to conform the profile of the blade tip to the doctored surface. Such a separating means 46 is capable of compensating for a crown on the roll, or for heat-induced distortions or other deviations in the work surface.

As suggested above, blade holding apparatus constructed according to an aspect of this invention enhances the usefulness of a filled tube separator as described for the reasons to follow. It is desirable that such a separator be relatively pliable in order to maximize its sensitivity to blade loading variations along the length of the blade. Thus the walls of the tube are preferably made as thin as possible. However, a thin-walled tube has definite loading limitations. Due to the nature of the rocker plate acting as a first class lever with a mechanical advantage of less than one, the tube experiences loading forces which are but a predetermined fraction of the blade loading forces. The magnitude of this fraction can be selectively varied by adjusting the width of the blade 12 or the effective lever arm lengths of the rocker plate 40. The lever arm lengths of the rocker plate 40 may be altered by varying the width of the rocker plate 40 and/or the location of the line along which the force F_A is applied relative to the forward and rear edges of the rocker plate 40. By this arrangement, then, a highly sensitive deformable separating means, as described, can be used in heavy-duty doctoring applications.

A buffer plate 50 disposed between the separating means 46 and the blade 12 prevents damage to the separating means 46 when the blade 12 is removed for replacement, and facilitates removal thereof.

A base strip 54 slideably received in a selected one pair of a plurality of pairs of grooves 56 formed in the top and bottom plates 30, 34 determines the magnitude of the extension of the blade 12 and associated rocker plate 40 beyond the top plate 28. The use of an adjustable base strip 54 enables a worn blade to be reground and used again; the base strip 54 is moved forwardly with each reconditioning of the blade to successive groove pairs in order to maintain the blade extension constant.

FIGS. 12-14 illustrate an embodiment wherein the rocker plate, separating means, and base strip are packaged as a cartridge to facilitate insertion and removal of these elements as a unit from the slot 36 in the blade holder and to maintain their desired relative positions. FIGS. 12-14 show a working blade 60, a rocker plate 62, separating means 64, and a base strip

66, all performing the same functions as described above with respect to the FIGS. 1-2 embodiment. A buffer plate 68 has been modified to perform plural functions — first, to protect the separating means 64, as described above, and second to provide means for retaining and positioning the separating means 64 between the rocker plate 62 and the working blade 60.

Referring particularly to FIG. 13, the buffer plate 68 is shown as having a number of bent-out tabs 70 which are spot welded to the rocker plate 62. The tabs 70 are deflected from the plane of the buffer plate 68 such as to cause the buffer plate 68 to extend in its unflexed state outwardly at a predetermined angle to the rocker plate 62. The restorative forces produced by the tabs 70 cause the buffer plate 68 to act as a leaf spring effective to capture and position the separating means 64 between the buffer plate 68 and rocker plate 62. The natural restorative forces in the tab 70 and the frictional forces between the separating means and the plates 62, 68 effects secure retention of the separating means 64.

In order that the base strip 66 constitute part of the cartridge, the strip 66 is provided with a series of apertures 72 through which is passed a retainer 74. The retainer 74 has a plurality of tabs 76 which are spot welded to the rocker plate 62 so as to join in a loose connection the base strip 66 and the rocker plate 62. Thus, by this construction, all of the removable blade holding elements namely the rocker plate 62, buffer plate 68, separating means 64, and base strip 66 are maintained in appropriate relative positions and are joined so as to be removable from or insertable into the blade holder as a unit.

The invention is not limited to the particular details of construction of the embodiments depicted, and it is contemplated that various and other modifications and applications will appear to those skilled in the art. For example, configurations of the wear-resistant structure other than those shown are within the compass of the invention. Wear-resistant materials other than those suggested may be employed. A long-life blade blade constructed according to this invention is preferably held in a blade holding apparatus capable of acting on the blade differentially along the length thereof so as to cause the blade tip to conform to deviations in the work surface, preferably apparatus of the construction described above, however under some conditions the blades may be held in blade holders of the standard types.

Whereas blade holding apparatus having the useful blade-conforming properties above described has been disclosed in combination with an extended-life blade having a somewhat specific construction, it is intended that blade holding apparatus implementing the principles described may be employed with any extended-life blade having a wear-resistant structure disposed thereon for operative engagement with a work surface, and further, may be employed with any extended life blade having a break-in structure or wear land of any form whatsoever disposed on the blade between the wear-resistant structure and the work surface when the blade is in an operative attitude relative to the work surface.

As used in this application the terms "doctor" and "doctoring" are intended to be interpreted in a broad

sense as encompassing wiping, coating, creping, cleaning, and other conventional operations performed by blades on work surfaces in the papermaking and related industries.

To alter the doctoring characteristics of the blade or for other reasons, the magnitude and characteristics of the described blade forces F_L , F_1 , F_2 , and F_3 can be varied by appropriately changing the relative dimensions of the rocker blade, and other elements of the apparatus and by adjusting the inter-force distances. Whereas the separating means has been illustrated in both of the described embodiments as comprising a closed fluid-filled tube, a solid or other type of separator may be used to space the tail portion of the rocker plate from the base of the working blade. Therefore, because certain changes may be made in the above-described apparatus without departing from the true spirit and scope of the invention herein involved, it is intended that the subject matter of the above depiction shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In apparatus for doctoring a moving work surface, in combination, a flexible extended-life blade comprising a blade body elongated in a first direction between first and second sides, said blade body having a leading edge along said first side for making initial contact with a work surface, said blade body having a continuous strip of a wear-resistant structure parallel to said leading edge and composed of a relatively harder and more brittle wear-resistant material for subsequently engaging the work surface; and

blade holding apparatus for supporting said blade for engaging said leading edge with a work surface, said holding apparatus including fulcrum means contacting said blade along a line between said sides and providing an extended pivot around which said blade can execute constrained rotation in reaction to force exerted at said leading edge by said work surface, and including profiling means bearing on said blade along a line between said pivot and said second side in proportion to said force for sensing irregularities in the work surface, said profiling means including an elongated flexible member having the property that a given pressure applied to it in one location will appear substantially uniformly at other locations throughout its length for reacting on said blade differentially along the length thereof in response to said sensing to cause said leading edge of said blade to tend to conform to said irregularities in the work surface and thereby to promote a substantially uniform pressure of the blade on the work surface, whereby chipping of said wear-resistant structure and the possibility of scoring and overheating of high spots on the work surface by the blade are minimized.

2. In apparatus for doctoring a moving work surface, in combination, a flexible extended-life blade comprising a blade body elongated in a first direction between first and second end surfaces, said blade body composed of a relatively wear-susceptible material along an edge of said first end surface which defines a wear land having a leading edge for making initial contact with a work surface, said blade body having on said end surface in spaced relation from said leading edge a con-

tinuous strip of a wear-resistant structure parallel to said leading edge and composed of a relatively harder and more brittle wear-resistant material for engaging the work surface after said land has become worn and has broken-in said blade; and

blade holding apparatus for supporting said blade for engaging said leading edge with a work surface, said holding apparatus including fulcrum means contacting said blade along a line on a side between said end surfaces and providing an extended pivot around which said blade can execute constrained rotation in reaction to force exerted at said leading edge by said work surface, and including profiling means bearing on said blade along a line between said pivot and said second end surface in proportion to said force for sensing irregularities in the work surface, said profiling means including an elongated flexible member having the property that a given pressure applied to it in one location will appear substantially uniformly at other locations throughout its length for reacting on said blade differentially along the length thereof in response to said sensing to cause said leading edge of said blade to tend to conform to said irregularities in the work surface and thereby to promote a substantially uniform pressure of the blade on the work surface, whereby chipping of said wear-resistant structure and the possibility of scoring and overheating of high spots on the work surface by the blade are minimized.

3. Apparatus according to claim 1 in which said blade holding apparatus includes a rocker plate elongated in said first direction between first and second edges, said holder providing a pivot line bearing on said plate on a line extending between said first and second edges, said rocker plate at said first edge bearing on said blade to provide said fulcrum means, said profiling means being located between said blade and said rocker plate near said second edge.

4. Apparatus according to claim 1 wherein said profiling means comprises a pliable tube closed at both ends and charged with a substantially incompressible fluid.

5. The blade defined by claim 2 wherein said blade defines adjacent said wear land on the side thereof opposite said leading edge a recess depressed below a plane containing said end surface, and wherein said wear-resistant structure is disposed in said recess.

6. The apparatus defined by claim 5 wherein said recess comprises a groove in said end surface.

7. The apparatus defined by claim 6 wherein said groove and said wear-resistant structure have a generally triangular cross-sectional configuration with one leg of the triangle lying in the plane of said end surface.

8. The apparatus defined by claim 7 wherein said cross-sectional configuration is right-triangular and the hypotenuse of the right triangle lies in the plane of said end surface.

9. The apparatus defined by claim 6 wherein said groove and said wear-resistant structure have a generally inverted trapezoidal cross-sectional configuration.

10. The apparatus defined by claim 6 wherein said groove and said wear-resistant structure have a cross-

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section generally in the configuration of a segment of a circle.

11. The apparatus defined by claim 5 wherein said recess and said wear-resistant structure have a generally rectangular cross-sectional configuration, and wherein said structure defines all of said end surface except for said wear land.

12. The apparatus defined by claim 5 wherein said recess is a bevel descending away from said land and

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wherein said wear-resistant structure has a generally right triangular cross-section with the hypotenuse thereof coincident with said bevel.

13. The apparatus defined by claim 5 wherein said recess and said wear-resistant structure have a generally inverted trapezoidal cross-sectional configuration, and wherein said structure defines all of said end surface except for said land.

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