This invention relates to a hardened steel razor blade in strip form for use in a magazine, the magazine being adapted to be removably mounted in a holder to provide a safety razor.

The magazine in which the blade of the present invention may be used embodies both a supply reel and a take-up reel for a strip razor blade together with a guide for supporting in position to be used for shaving a portion of the blade of suitable length as it passes from the supply reel to the take-up reel. In order to permit the blade to be used most effectively for shaving, the blade must be bent sharply adjacent at least one end of the guide. If the radius of curvature is too large in this position, the razor of which the magazine forms a part cannot reach the portions of the beard around the ears and under the nose; furthermore, the housing necessary for the large curvature obstructs the users' view in positioning the razor.

The steel used in a razor blade must be hardened in order to take and hold a cutting edge of the desired sharpness and durability. However, hardening of the steel inherently causes it to be brittle, making it impossible to bend over a small radius without breaking. While it is possible to achieve bend of a negative or reverse curve without breaking the blade by decreasing the thickness or gauge of the strip blade, the necessity for having sufficient body in the blade to permit handling and sharpening of it during the manufacturing operations and to enable it to have sufficient rigidity and strength under normal and use conditions imposes a practical minimum thickness limitation of about 0.001 inch. Even at this minimum gauge, it is still impossible to bend the strip blade on a radius as small as desired at the end of the guide without decreasing the hardness of the blade below that required for optimum shaving effectiveness.

One object of the present invention is to provide a blade for use in a magazine adapted to be removably mounted in a holder to form a safety razor, said magazine including a blade supply reel, a blade take-up reel, a blade-supporting guide, and an elongated flexible ribbon-like blade of special construction which is bent through an arc of substantial extent over a radius of about 0.02 inch to 0.1 inch adjacent at least one end of the guide. Another object is to provide such a blade in the form of a hardened ribbon steel blade having a gauge of about 0.001 inch to 0.003 inch and a Vickers hardness number from 650 to 900. Generally speaking, when gauge is thick, the hardness should be lower than when the gauge is thinner.

It has been found that magazines of the type described can successfully be constructed embodying a relatively long, flexible ribbon-like, hardened steel razor blade with the blade bent over a radius of about 0.02 to 0.10 inch, preferably 0.05 to 0.08 inch, adjacent one or both ends of the portion exposed for use in shaving, by employing for manufacture of the blade a steel strip having a gauge of about 0.001 to 0.003 inch, electroplating it to a thickness of about 0.00035 to 0.0003 inch or even more with a ductile and adherent coating of a metal such as nickel, copper, iron, gold, or silver which melts at a temperature above the hardening temperature of the steel, then hardening in the usual manner to a Vickers hardness of about 650 to 900 and sharpening by grinding and honing in the usual manner. In a magazine embodying such a blade, at least one bend extends through an arc of at least 90°. The radius need not be constant throughout the entire extent of the bend, but in shaving the radius of at least one bend should lie within the aforesaid range through at least 90° of the bend.

The steel employed for the strip razor blade embodied in the magazine of the present invention may be any of the medium or high carbon steels containing from 0.50% to 1.30% carbon and not over 0.50% chromium, preferably not over 0.35% chromium. Small amounts of manganese and silicon may also be present as in conventional safety razor blade steel. For best results, such steels should have Vickers hardness numbers of about 730 to 900, preferably of the order of 830. It is also possible to employ corrosion-resistant steels containing up to about 19% by weight of chromium, preferably from 12% to 14% by weight; and corrosion-resistant steels containing both chromium and nickel, from about 16% to 20% by weight of chromium and from about 7% to 10% by weight of nickel. Because of the fact that the hardening temperature of the corrosion-resistant steels tends to be higher than that of the medium or high carbon steels, the high melting metals iron and nickel are the materials of choice for electroplating such corrosion-resistant steel strips in accordance with the present invention. The hardness of corrosion-resistant steels may vary over a wider range than that of the medium or high carbon steels, a Vickers hardness number as low as 650 being acceptable in some cases.

In order to obtain adequate adhesion between the nickel or copper plating and the underlying steel base, it is important that the surface of the former be free from scale and degreased by suitable conventional procedures prior to the plating operation. While it is possible to plate a relatively wide band of steel and subsequently slit it into individual ribbons or strips each of which is slightly wider than the ultimate width desired in the finished razor blade, it is preferably to carry out all of the slitting operations before the plating operations in order to obtain a product of optimum flexibility.

Any conventional procedure may be employed for the electroplating step. The selected metal, nickel, copper, iron, gold, or silver, is electroplated on the ribbons or strips of the base metal and the minimum thickness of the plating is of the order of 0.00005 inch. Normally the thickness of the plating will be approximately 0.0001 inch.

After the completion of the electroplating step, including any conventional washing and drying procedures, the strip blade may be slit to the desired width, if the slitting has not previously been carried out in the preferred manner, and is then hardened and sharpened in the conventional manner. As a consequence of this procedure, the plating is removed from the cutting edge of the finished strip blade, leaving only the body of the blade so plated. It is also possible to slit the band of steel to final width, grind the edge to give it a preliminary sharpening without honing, electroplate with the desired metal, harden, and then finish the sharpening. The resultant blade has the plating covering a portion of the wedge faces of the blade adjacent the flat body portion of the blade.

There is shown in the drawings one embodiment of the present invention in the form of a magazine carrying a hardened steel razor blade in strip form, but it will be understood that the invention is not limited to the embodiment illustrated.

In the drawings:
FIG. 1 is an isometric view of a magazine containing a hardened steel razor blade in strip form, the magazine being adapted to be removably mounted in a holder to provide a safety razor;
FIG. 2 is an isometric view of a holder adapted to re-
ceive the magazine of FIG. 1 and to form a safety razor when the magazine is in place; FIG. 3 is an exploded isometric view, partly broken away, showing the several parts of both the magazine and the holder before assembly; FIG. 4 is a view in vertical cross-section, partly broken away, of the magazine inside the holder; FIG. 5 is a view in section taken along line 5—5 of FIG. 4; FIG. 6 is a side view, partly broken away and in section, showing the manner in which the blade is mounted in the magazine; FIG. 7 is a view in section taken along line 7—7 of FIG. 5; FIG. 8 is a view in section, partly broken away, taken along line 8—8 of FIG. 4; FIG. 9 is a view in section, partly broken away, taken along line 9—9 of FIG. 4; and FIG. 10 is a view in cross-section of an enlarged scale showing the relationship of the outer coil of the blade to the storage receptacle of the magazine.

As best appears from FIGS. 1 and 3 of the drawing, the magazine 10 includes a main housing 12; a back plate 14 carrying a blade-supporting guide 16 and a blade receptacle 18; a magazine 30 adapted to contain a supply coil of the strip blade; and strip blade 20, one end of which is in the form of a coil 22 received within receptacle 18, the other end of which is secured to a take-up arbor 24 mounted for rotation within opening 54. An indicator ring 28 is also rotatably mounted within the magazine with a portion of its face, bearing suitable indicia, visible through an aperture 36 in main housing 12. Indicating ring 28 is mounted for rotation in a circular recess 29 in housing 12 (FIGS. 3 and 4) and is provided with gear teeth on its inner margin which mesh with the gear teeth of pinion 32, and the inner diameter of ring 28 is sufficiently great so that the mesh teeth only at one portion of the periphery (FIG. 8), so that ring 28 rotates a fraction less than one revolution each time pinion 32 is turned through one revolution. This arrangement provides, through aperture 39, visible indication of the total number of revolutions through which arbor 24 has been rotated and in turn gives an indication of the number of shaving blade lengths remaining in the supply coil.

The blade-supporting guide 16 is in the form of a generally flat surface long enough to provide a straight portion of the strip blade of a length suitable for use in shaving. A vertical shoulder 33, 34 at each end of blade-supporting guide 16 serves as a backstop for the strip blade against which the unsharpened margin of the blade rests. A suitable number of spaced blade hold-down elements 36, 36 project forwardly from a raised shoulder 35 overlying blade-supporting guide 16 and spaced from it sufficiently to permit blade 20 to extend between elements 36 and guide 16. Elements 36 serve to maintain blade 20 in generally flat condition closely adjacent the upper surface of guide 16 when the magazine is not mounted in the holder.

Each end of blade-supporting guide 16 terminates in a sharply curved end 38, 38, the radius of curvature of which is approximately 0.06 inch, about which blade 20 is bent as it passes to and from the blade-supporting guide 16. The blade as it passes over each end 38 is bent through an angle of approximately 167°, as best appears in FIG. 5, thus ensuring that the exposed portion of the blade resting on guide 16 can be effectively used for shaving all parts of the face and neck.

Receptacle 18 is provided with a cylindrical inner wall 40 having an aperture 41 at one side through which the blade extends from the coil 22. Receptacle 18 has a depth somewhat greater than the overall width of blade 20 to ensure that the sharpened edge of the blade is protected from damage by contact with the opposing portion of housing 12 and to prevent the blade from binding. In addition, a plurality of retainers 42, 42 project outwardly from the margin of receptacle 18, the inner faces of which are inclined slightly toward the axis of receptacle 18, as best appears in FIG. 4. These retainers serve to urge blade 20 rearwardly into receptacle 18 in the event that it should have any tendency to ride outwardly as the coil 22 is unwound. The angle of inclination of the inner faces of retainers 42 is less than the angle of bevel at the sharpened edge of the blade, so that the retainers come in contact only with the shoulder or upper portion of the bevel when the blade rides outwardly, as best shown in FIG. 10, thus avoiding any contact with and possible damage to the ultimate edge of the blade.

In order to lead blade 20 from coil 22 to one end of guide 16 and to lead the used portion of the blade from the other end of guide 16 to take-up arbor 24, a pair of shoulders 44, 44 are provided inside housing 13, as best appears in FIG. 5. Each of these shoulders is inclined rearwardly toward back plate 14, as shown in FIG. 7, in order to urge the unsharpened edge of blade 20 against the back plate 14 and against vertical shoulder 33, 34 at the ends of guide 16. Moreover, as appears best in FIG. 6, the inner guide shoulders 33 and 34 are displaced rearwardly of the plane of back plate 14 against which coil 22 rests and against which the unsharpened edge of blade 20 rests while it is being wound up on arbor 24. This configuration ensures that the portion of blade 20 which rests on guide 16 is accurately positioned and butted up against shoulders 33, 34 at all times. A guard 50, which may be of conventional grooved or dentate configuration, is mounted so as to project beneath the sharpened edge of blade 20 as it rests upon guide 16 and forwardly thereof in spaced relation to the forward edge of guide 16 so that a slot 52 is provided between the guard 50 and guide 16 to accommodate the removal of debris accumulated during the shaving operation.

The leading end of blade 20 is provided with a tip 46 of greater thickness than the blade itself (FIG. 5). A slot 48 is provided in arbor 24 of sufficient width to receive tip 46, the slot having a narrowed portion 47 near the center of arbor 24 which prevents the tip from passing, although the thinner blade 20 is accommodated. In this fashion the blade may conveniently be secured to take-up arbor 24. Back plate 14 is provided with an aperture 54 into which a stepped portion of arbor 24 protrudes and within which it rotates, the arbor being provided with a projecting lug 56 which is connected through aperture 54 to enable the arbor to be rotated from outside the magazine in order to wind up blade 20 upon it.

The various parts of the magazine may be constructed of any conventional material. Housing 12 and back plate 14 (including guide 16, receptacle 18, etc.) are suitable made of die-cast metal or of synthetic plastic composition. Upon assembly of the several parts of the magazine, housing 12 is secured to back plate 14 by detents or lugs 57, of which two appear in FIG. 3, which snap or spring over the corresponding marginal portions of back plate 14.

The blade 20 which must be bent about the ends 38 of guide 16 is prepared by slitting from a ribbon of suitable steel such as one containing, in addition to iron, about 1.25% carbon, 0.18% chromium, 0.33% manganese, and 0.20% silicon and small amounts of the usual impurities) a strip about 0.1915 inch wide and about 0.0015 inch thick. The steel employed may be regular acid or basic open hearth or electric or vacuum remelted steel. The strip, which preferably has a very smooth surface finish, is thoroughly cleaned and degreased by conventional procedures, then plated with nickel by a conventional electrolysis process from a sulfamate nickel bath at a current density of about 0.75 amp./sq. in. for about 1/4 minutes at a temperature of about 135°F,
the plating having a thickness of about 0.0001 inch. The plated blade strip after washing with water and drying is hardened by heating to about 1500° F. (above the critical temperature of the steel), then quenching between water-cooled quench blocks and tempered by exposure for about 4 seconds to air maintained at a temperature of about 800° to 900° F to produce a Vickers hardness number of about 835 to 890. One edge is sharpened on a conventional sharpening machine to a razor edge, the strip is cut into lengths 30 to 90 inches long, and a tip 46 is welded to one end while the other end is coiled for insertion into receptacle 18. Upon assembly of the blade in the magazine, it is found that the blade can readily pass around both ends 38, 38 of blade guide 16 without fracturing or breaking despite the high hardness of the blade. Similar results are obtained by substituting a copper plating step for the nickel plating step in the manufacture of the blade. If desired, the cutting edge of the blade may be provided with a shaving-facilitating coating in a manner known to the art. Such a coating is particularly desirable when the steel of the blade has a hardness near the softer end of the range.

There is illustrated in FIG. 2 of the drawing a suitable holder 60 in which magazine 10 may be mounted so as to form a safety razor. The holder includes a head 62 provided with slots 64, 64 arranged to receive hold-down elements 36, 36 in mating relationship and to position the magazine 10 properly with respect to the holder 60. A forwardly projecting lip 66 extends continuously from one end of the head and is displaced to the other and is arranged, as shown in FIGS. 4 to 6, to bear upon the face of blade 20 and urge it into close engagement with the underlying guide 16. A handle 68 is connected to head 62 by means of a supporting web 70. Mounted on web 70 in position to engage arbor 24 when the magazine is mounted in the holder is a blade-advancing mechanism which includes a drive-pin carrier 72 journeled in an aperture 73 in web 70 and having a lever or crank arm 74 press-fit to its Shank at the rear face of web 70. An elongated magazine-locating element 76 is provided with an aperture mating with that of web 70 and is secured thereto by means of an extruded projection 71 extending through aperture 73 and fastened outwardly around it, as best appears in FIG. 9. The lower end of element 76 is provided with forwardly projecting hooks 78, 78 which engage a shoulder in the forward top portion of handle 68, while an ear 80 at the lower end of web 70 engages over a shoulder 82 at the rear of handle 68, thus serving to secure the handle and the web portion together.

Drive-pin carrier 72, as best appears in FIG. 9, is provided with a drive pin 84 mounted for axial movement within carrier 72 and carrying a pawl 86 which projects forwardly through a slot 88 in the forward face of carrier 72. Pin 84 is urged forwardly by means of compression spring 90 which seats against the inner face of lever arm 74. Pawl 86 is of the proper size and shape to engage with lug 56 of arbor 24 when the magazine 10 is mounted in holder 60, providing an operative connection between lever arm 74 and arbor 24 which may readily be engaged and disengaged when the magazine is mounted in or removed from the holder. The face 87 of pawl 86 is sloped so that if crank arm 74 is turned in the wrong direction, the spring-loaded pawl will simply ride up over lug 56 without engaging it. Lug 56 is preferably weaker than pawl 86 so that if the blade should jam, the lug, which is mounted in the replaceable magazine, will be broken rather than the pawl, which is mounted in the holder.

In order to maintain the magazine securely in place when mounted in the holder, a snap-action latch 92 is provided which is retained by a shaft 94 bridging the space between hook members 78, 78. A compression spring 96 is seated in a socket in the top of handle 68 and bears against the bottom of latch 92 (FIG. 4) in such fashion as to maintain the latch in either one of two positions and also biases the magazine toward the tip of the head to clamp the blade strip therebetween. An upsetting ear 98 on latch 92 engages over the bottom front margin of housing 12 when magazine 10 is mounted in the holder and the latch is in the position shown in FIG. 4, with spring 96 bearing against the latch forwardly of dead center. Latch 92 also includes a thumb-piece 100 and a cam 102 which bears against the bottom surface of magazine 10. As soon as the bearing point of spring 96 passes dead center, the latch is engaged to open position by the spring.

A retaining or click element 104 is mounted in slot 106 of web 70, being urged rearwardly outwardly through the slot by a pair of leaf springs 108 which bear against element 76. Retainer element 104 engages with a groove 110 in lever arm 74 and serves to releasably hold the lever arm in a desired position.

It will be apparent from the foregoing description that additional magazines may be provided, each identical in construction to the others and containing a fresh length of strip blade, as replacements for the first magazine when the blade has been used up.

Although specific embodiments of the invention have been described herein, it is not intended to limit the invention solely thereto, but to include all of the variations and modifications which suggest themselves to persons skilled in the art.

What is claimed is:

1. An elongated flexible ribbon-like razor blade capable of being bent about a central portion to 0.10 inch without breaking, said blade comprising a hardened and sharpened steel strip having a gauge of 0.001 to 0.003 inch and a Vickers hardness number from 650 to 900, said steel strip having a plating of a member of the class consisting of nickel, copper, iron, gold and silver to a thickness of at least 0.00005 inch.

2. A razor blade as claimed in claim 1 in which said plating is nickel.

3. A razor blade as claimed in claim 1 in which said plating is copper.

4. A razor blade as claimed in claim 1 in which said plating is iron.

5. A razor blade as claimed in claim 1 in which said plating is gold.

6. A razor blade as claimed in claim 1 in which said plating is silver.

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