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(54) IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF RAZOR BLADES

(71) We, WILKINSON SWORD LIMITED, a British Company, of Sword House, Totteridge Road, High Wycombe, Buckinghamshire, HP13 6EJ, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to razor blades, and more particularly relates to improved methods of manufacturing razor blades.

Razor blades are manufactured from steel or alloys in the form of strip which is successively subjected to heat treatments, printing (usual, but not essential), and edge forming up to and including final finishing of a cutting facet on one or both edges. Thereafter, the strip is cut into blade lengths, and a polymer coating is provided on each cutting facet.

According to the present invention the hardening prior to formation of a cutting facet is achieved by heating, at least the necessary region of the strip, by means of a laser beam.

Additionally, or alternatively, the heating which is required to cause adherence of the polymer coating to the cutting edge is produced by means of a laser beam.

The hardening of the razor blade strip by the use of a laser beam will be considered first. The surface of the strip is normally such that substantial reflection of the laser beam may occur; if this is the case, the area of the strip upon which the beam impinges is treated to reduce such reflection to a satisfactory extent, for example by making the surface matt black with paint or ink. A matt black photographic paint made by Johnsons of Hendon has been found to be satisfactory for this purpose.

After any necessary surface treatment to reduce reflection, the strip is moved through the laser beam at a rate such that sufficient heating occurs to produce the required degree of hardening. During the period when the strip is at elevated temperature it is maintained in an inert-gas atmosphere to avoid oxidation, for example by shrouding. The beam may be focussed so that the strip is hardened only for a sufficient distance back from an edge, and if both edges are to be hardened simultaneously two lasers, or an appropriate beam-splitting system, may be used.

Alloy razor blade strip manufactured by Samuel Fox & Co. Ltd., of Sheffield, and identified by them as SF 67, of approximately 0.10 mm thickness has been hardened in tracks 400 μm wide, the normal width of a ground cutting facet, to approximately 750 VPN (Vicker's Pyramid Number), using a 400 watt CO$_2$ laser having a peak power density of 2.4×10^5 Wcm^{-2} and a $1/e^2$ spot diameter of 670 μm, this region being 3.5 mm beyond the focus.

The centre of the beam is moved along a line which is greater than 200 μm inwards from an edge of the strip, even through the hardened zone is approximately 400 μm wide. This is because the hardened track which is formed is asymmetric relative to the line of movement of the beam as a result of conduction heat losses which occur on the side of the track remote from the edge. The positioning of the beam must also allow for the fact that during grinding at least 100 μm of the original edge will be removed.

With alloy strip different from SF 67, and particularly thicker strip, it may be necessary to heat an edge from both sides, using an appropriate number of lasers or splitting the beam(s) appropriately.

Strip speeds of the order of 9 to 12 metres per minute are feasible with the laser beam conditions stated above, it being understood that at lower strip speeds excessive heating occurs with subsequent distortion, or melting and hardening, or even cutting, whilst at higher speeds the required degree of heating, and hence hardness, will not be attained.

It will be seen that by using a laser beam for hardening it is possible to obtain hardening in the edge region only where it is required, with consequent power saving, the avoidance of end tempering, and the avoidance of problems associated with the entire width of the strip being unnecessarily hard and therefore brittle. The possibility of hardening the edge region, only, can be particularly useful in the case of alloys where it is difficult to restore temper to the main body of the strip for ease of processing, for example in the case of the case of maraging steels. The apparatus can be more compact than conventional hardening ovens and able to operate at higher speeds.

After final edge formation it is usual to provide the cutting facets with a coating of polytetrafluorethylene (ptfe). The ptfe is normally applied in a suspension and must be heated to cause sintering in order that the polymer will adhere sufficiently to the cutting facet. With the present invention the heat required for such sintering is produced by a laser beam in a similar manner to that described for hardening. Using the alloy strip referred to above with a similar laser, the spot size may be increased, for example within the range of from 1240 µm to 1430 µm (this region being 6.5 mm to 7.5 mm beyond the focus), because the sintering temperatures required are lower than those needed for hardening. The centre of the beam is positioned 1 mm inwards from an edge of the strip.

With an aqueous suspension of high molecular weight ptfe indentified by Imperial Chemical Industries as GP1, the thickness after sintering may typically be from 0.5 to 1.0 µm. The sintering is effected in an inert-gas atmosphere, typically with a laser power density of 6 to 7 $\times 10^4$ Wcm^{-2} and at a strip speed of 8 to 11 metres per minute, the heating part of the thermal cycle being completed in about 10^{-2} seconds. Preferably the sintering is restricted to a narrow track at the edge of the blade, as small as approximately 50 µm. Using a lower molecular weight ptfe, such as that sold under the registered trade mark VYDAX, lower sintering temperatures may be used, thus permitting the use of higher strip speeds, say up to 13 mètres per minute, or lower power densities up to 3.5 $\times 10^4$ Wcm^{-2}, or a combination of higher strip speed and lower power density such as to ensure adequate sintering.

Because the edge (or each edge) is sharpened the heating is more asymmetric than for hardening. However, as the polymer is sprayed onto only the first 200 - 300 µm from the edge the laser beam may be passed through a suitable optical system to provide an elongated spot, for example of 7000 µm by 200µm, positioned to heat only the polymer, thereby allowing substantially higher strip speeds.

As the heating can be local, the advantage is obtained that any printing inks used behind the cutting facet(s) can be chosen without the requirement that they must withstand the polymer sintering temperature, as is the case at present. Moreover, the effectiveness of any earlier passivation is not affected, as it is when the entire width of the strip is subjected to sintering temperature. Furthermore, it is believed that the edge is less softened because of the rapid surface heating and cooling. Finally, the use of a laser beam for sintering facilitates continuous, as opposed to batch, processing.

WHAT WE CLAIM IS:

1. In the manufacture of razor blades from strip and prior to the formation of a cutting facet on an edge of the strip, hardening said edge by heating at least the necessary region of the strip by means of a laser beam.

2. The manufacture according to claim 1, in which a surface on which the beam is to impinge is treated to reduce beam reflection.

3. In the manufacture of razor blades having a polymer coating on a cutting facet, causing adhesion of said polymer coating by heating at least the necessary region by means of a laser beam.

4. The manufacture of razor blades, substantially as described herein.

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