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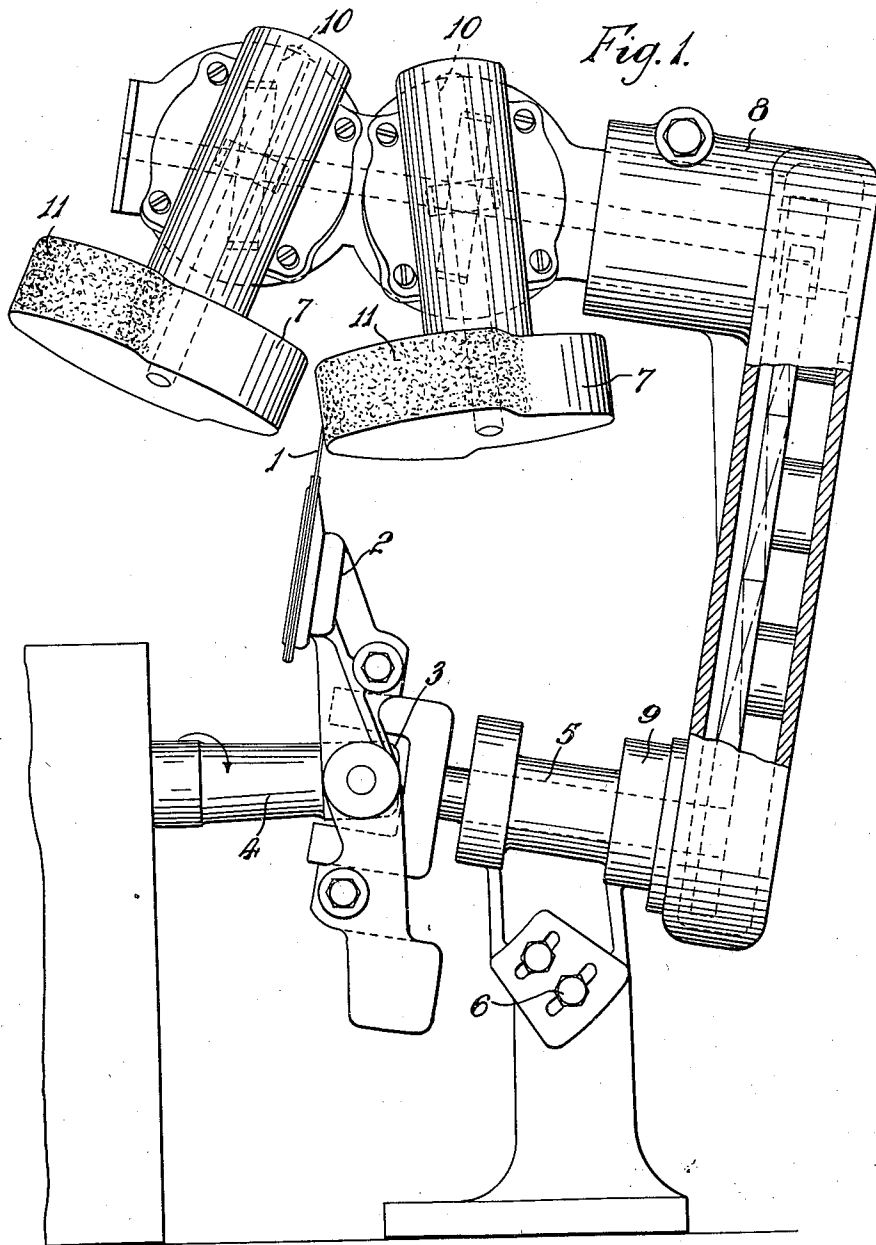
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GRINDING OF ROTATING ECCENTRIC KNIVES

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2 Sheets-Sheet 1



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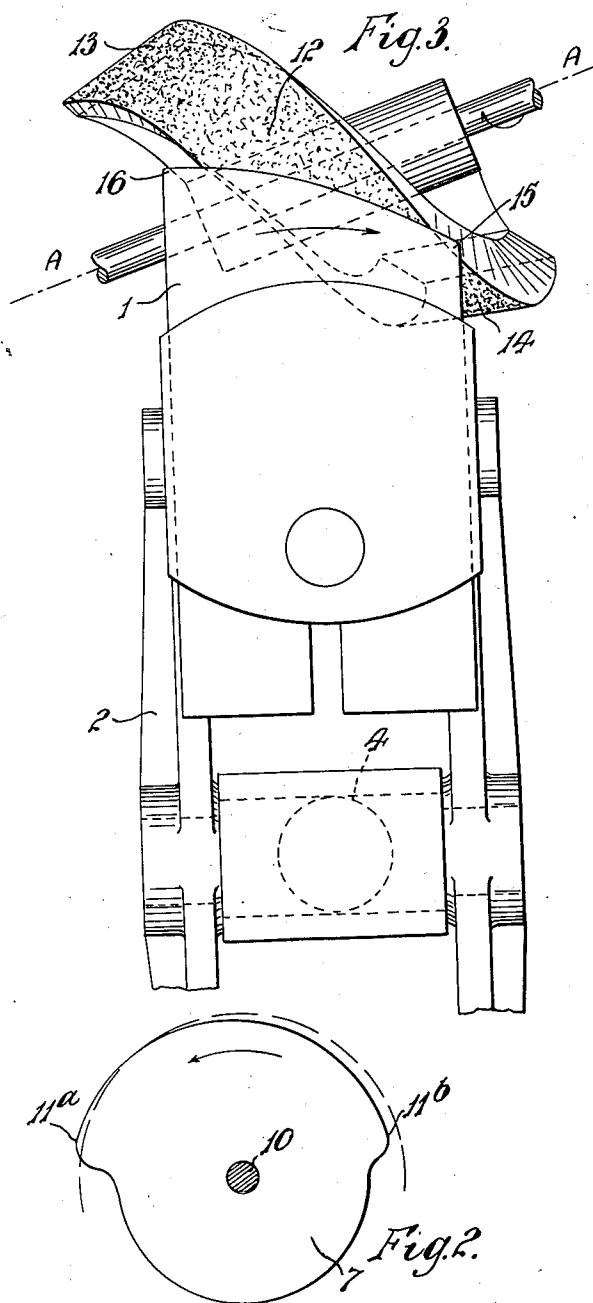
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UNITED STATES PATENT OFFICE

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GRINDING OF ROTATING ECCENTRIC KNIVES

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8 Claims. (Cl. 51-247)

This invention is for improvements in or relating to the grinding of rotating eccentric knives of the type in which the knife is mounted on a rotatable carrier, and has its edge eccentric to the axis of rotation of the knife and carrier, whether the knife rotates about an axis offset from the axis of the knife carrier or whether the knife is fixed angularly relatively to the axis of the knife carrier, and whether or not the knife edge executes a movement in the direction of the axis of the knife carrier during the cutting.

An object of the present invention is to provide apparatus for sharpening such knives at a time when there is no movement, or substantially no movement of the knife edge in an axial direction during the time that the knife is in engagement with the grinder.

According to the present invention apparatus for grinding or sharpening rotating eccentric knives of the type described, comprises a grinding element which is mounted to be rotatably driven in definite timed relationship with the speed of rotation of the knife, and which has its grinding surface so shaped (for example, eccentric to the axis of rotation of the grinding element) that as a result of its shape and rotation an "eccentric edge" is maintained on the knife. Preferably the grinding surface is cylindrical and is arranged eccentric to the axis of rotation of the grinding element and is inclined to the plane of the knife to grind the required chamfer of the latter.

The term "eccentric edge" used herein and in the appended claims with reference to the knife means any edge the leading end of which or that portion of the edge which first engages with the article being cut, is nearer to the axis of the knife carrier than the trailing end of the edge or that portion of the edge which is arranged to pass through the article being cut at a later time than the leading edge.

The invention will be more particularly described with reference to the accompanying drawings in which:—

Figure 1 is a side elevation showing one form of grinding apparatus constructed according to the invention.

Figure 2 is a detail of Figure 1 showing a plan view of one of the grinders.

Figure 3 shows diagrammatically an alternative construction.

Like reference numerals refer to like parts throughout the specification and drawings.

One construction of knife which may be sharpened by apparatus according to the present in-

vention is that used for cutting the cigarette rod of a cigarette making machine.

Referring to Figure 1, the knife blade 1 is fixed against angular movement relatively to the axis of rotation and is carried on a knife carrier 2 which is mounted on the link or yoke member of a universal joint 3 between two inclined shafts 4 and 5. The shaft 4 supporting the knife is parallel to the cigarette rod while the shaft 5 is downwardly inclined as shown in Figure 1. The shaft 5 is adjustable as regards its inclination through the medium of the adjusting bolts 6, and in this way by adjusting the inclined shaft 5 it is possible to cut cigarettes of different lengths.

In the case of a cigarette making machine, the cigarette rod is usually horizontal, and where throughout the specification the words "horizontal" and "vertical" are used, they are to mean, in the first case "a plane parallel to the bed of the cigarette making machine" and in the second instance "in a plane at right angles to the bed of the cigarette making machine".

The knife is arranged to rotate in such a manner that when it is intersecting the rod, it will be moving at the same axial speed as the latter. The cigarette rod is arranged at one side of, and parallel to the horizontal shaft 4 of the knife carrier. The grinders in each of the examples to be described are located directly above the horizontal shaft of the knife carrier so that the knife is engaged at a time or place when it possesses substantially a purely rotational movement about the inclined axis. Such a construction of knife is described in prior British Patent No. 324,379.

The grinders 7 are mounted upon a support 8 which is attached to the bearing 9 for the inclined shaft of the knife carrier. The grinder support is conveniently constituted by a bent arm rigidly attached to the bearing.

Since the angle of inclination of the inclined shaft is adjustable for enabling cigarettes of different lengths to be cut, and since the grinder support is rigidly connected to the bearing of the inclined shaft, then whatever setting the latter is given, the grinder support will be automatically moved so that the grinder, after having been set, will always be in the proper position for engaging the knife edge.

Each of the grinders 7 is constituted by a sector of a right cylinder as more clearly seen in Figure 2 and is rigidly mounted on a rotatable shaft 10 projecting downwardly from the grinder support 8. The surface 11 of the cylinder, which in effect is the grinder surface is eccentric to the axis of

the rotatable shaft 10 the eccentricity being shown in chain line in Figure 2. The rotatable shaft 10 is inclined to the vertical so that the required angle is obtained between the cylinder and the knife to grind the required chamfer.

The two grinding elements 7 are geared to the drive of the knife in definite timed relationship with the speed of rotation of the latter. The speeds of rotation are such that only one grinder 7 at a time engages the knife edge, and the two grinding elements lie on opposite sides of the knife edge. Owing to the fact that the grinder elements 7 are constituted by sectors of cylinders they can be located in this position, since it is possible to arrange that only one of the grinders 7 will be engaging the knife 1 at any one period of time. The ratio of angular velocity of the grinders to that of the knife may be 5.5:1 or 4.5:1 etc. These ratios ensure that alternate sides of the knife are engaged at each rotation of the knife.

The grinders 7 are so arranged that the difference in radial distance from the axis of the rotatable grinder shaft 10 to the leading and trailing ends (11a and 11b respectively) of the grinding surface respectively, is equal to the sine of the angle included between the knife and a right line on the grinding surface (that is, the chamfer angle) multiplied by the radial increase of the knife edge between its leading and trailing edges from the axis of the inclined shaft.

In cases where greater accuracy is required in maintaining the eccentricity of the knife edge, so that it remains an almost perfect curve, it may be even necessary very slightly to vary the shape of either or both grinder surfaces from the perfect circular cross sectional shape mentioned shown and/or from the amount of eccentricity defined above, the latter dimension then being used as a basis for the construction.

The rotation of the grinder is such that any portion of each grinder surface 11 possesses a component of movement which is tangential to or substantially tangential to the path swept out by the knife at the instant the said portion of grinder surface engages with the knife edge. Preferably the grinder surface and the knife are, at the moment that they are touched, both moving in the same direction. The grinding is effected owing to the difference in peripheral speeds of the knife edge and grinders.

The arrangement whereby the grinder surfaces 11 possess components of movement which are tangential to the circular path swept out by the knife edge, improves the cutting properties of the knife since it gives the knife a saw-like edge. Although the edge to the normal eye appears very similar to the usual type of edge, it is in fact provided with minute teeth like ridges which when magnified are visible, and although the saw edge is apparently smooth, the edge is nevertheless sufficiently rough to bite into the cigarette rod better than if the edge was perfectly smooth. Although two grinders have been shown in Figure 1, one could be omitted and the burr can be removed by an ordinary flat grinding disc mounted below the shaft 4.

In cases where the knife edge has a rotating movement at the moment of grinding where the "trailing end" of the knife edge engages the grinder surface first, then the grinder 7 will be rotated in the opposite direction to that shown in Figure 2, and the part 11b will engage the "trailing edge" of the knife, and the part 11a will engage the "leading edge".

An alternative construction of grinder is illustrated in Figure 3. If desired, the grinding element 12 may be duplicated so that each side of the knife is ground. The grinder or grinders 12 is or are supported as described with reference to Figure 1 on a support mounted on the bearing of the inclined shaft 5.

The grinders 12 in this alternative construction are located vertically above the axis of the horizontal shaft 4 of the knife carrier. Each grinder element 12 has a surface which is comprised of about $\frac{3}{4}$ of a turn or less of a helical strip. The shape of the grinding surface is that of the path in space which will be swept out by a right line on a conical grinder which is rotating about its axis, and the grinder is moved axially at such a speed and the axis is so directed that as a result of its shape and movement towards the base of the cone an eccentric edge is maintained on the knife.

The direction of the axis A. A. of the grinder which coincides with the axis of the imaginary cone is such that it lies in a plane at right angles to the horizontal shaft 4 of the knife carrier. The grinder axis A. A. is, however, inclined upwardly so that at all times the projection of a line joining the consecutive contact points of knife and grinder on to the vertical plane in which the axis of the grinder lies, is parallel to that axis and the convergence of the aforementioned right line towards the axis is towards the lower end of said axis. Since the axial movement of the imaginary cone is towards its base, this movement in the construction shown in Figure 3 is along the axis A. A. and towards the right-hand side of Figure 3. By arranging the axis of a grinder in this manner it will be seen that the variation in the angle between the surface of the grinder and the plane of the knife during the grinding operation is made as small as possible. The grinder is so arranged and rotated at such a speed that the leading edge 13 of the grinder engages the leading portion 15 of the knife edge and the trailing edge 14 of the grinder engages the trailing portion 16 of the knife edge. The leading edge 13 of the grinder surface is at the lower end of the inclined grinder axis A. A. The direction of rotation is such that the portion of grinder surface engaging the knife at any one moment, moves outwardly, that is, away from the axis of the knife carrier.

In the case where two grinders are provided, they are geared in a similar manner to the grinders in the first construction given above, and are so arranged that alternate sides of the knife are ground at each rotation of the latter. The angular speed of the grinders relatively to the knife may be 4.5:1, 5.5:1 or other such ratio to effect the desired result.

When two grinders are used, it may be desirable in practice slightly to modify the shape of the grinder surface from the truly theoretical to minimize irregularities in the grinding pressure and the theoretical shape will then be the basis from which the slight alterations are made.

In this construction also, the time of grinding the knife is moving in the opposite direction to that shown in Figure 3, then the direction of rotation of the grinder 12 must be reversed also.

In another form of grinder made according to the present invention but not illustrated in the drawing, the grinder is constructed after the manner of a worm thread, the grinding surface being constituted by the side of the thread. This grinder is mounted concentrically on and rigidly

fixed to a rotatable shaft, the axis of which is substantially at right angles to the plane of the knife at the moment of grinding. The pitch of the thread will depend on the radial increase between the leading and trailing edges of the knife and also on the relative peripheral speeds of the knife and grinder surface. In this construction also, as in the previous construction, the grinding surface may comprise a segment of a complete circle. This as in the previous cases would enable both sides of the knife to be ground alternately, and the relative angular speeds between knife and grinder could be similar to the speeds for effecting the results obtained by the previous construction.

What I claim as my invention and desire to secure by Letters Patent is:—

1. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a grinding element for the knife supported for rotation about a fixed axis, means to rotate the grinder synchronously with the cutter, said grinder having a shaped working surface which is cylindrical and is arranged eccentrically to the axis of rotation of the grinding element, said working surface being rotatable about the axis of rotation of the grinder and inclined to the plane of the knife to grind the required chamfer of the latter and which, on rotation of the grinder, follows the eccentric shape of the knife edge and grinds the latter.

2. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a rotatable grinding element for the knife, a support for the grinder, means to rotate the grinder and cutter synchronously, said grinder having a shaped working surface which corresponds to a sector of a right cylinder that is eccentric to the axis of rotation of the grinding element, said working surface being rotatable about the axis of rotation of the grinder whereby on rotation of the grinder, the said working surface follows the eccentric shape of the knife edge and grinds the latter.

3. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a grinding element for the knife supported for rotation about a fixed axis, means to rotate the grinder synchronously with the cutter, said grinder having a shaped working surface which is cylindrical and is arranged eccentrically to the axis of rotation of the grinding element, said working surface being inclined to the plane of the knife to grind the required chamfer of the latter and to follow the eccentric shape of the knife edge and grind the latter, any portion of the said working surface possessing a component of movement which is substantially tangential to the circular path swept out by the knife edge at the instant the said portion of the grinder surface engages the knife edge.

4. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a grinding element for the knife, a support for the grinder, means to rotate the grinder synchronously with the cutter, said grinder having a shaped working surface which corresponds to a sector

of a right cylinder that is eccentric to the axis of rotation of the grinding element, said working surface being rotatable about the axis of rotation of the grinder whereby the said working surface follows the eccentric shape of the knife edge and grinds the latter, any portion of the said working surface possessing a component of movement which is substantially tangential to the circular path swept out by the knife edge at the instant the said portion of the grinder surface engages the knife edge.

5. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a rotatable grinding element for the cutter, a support for the grinder, means to rotate the grinder synchronously with the cutter, said grinder having a shaped working surface which is of helical form and which is rotatable about the axis of rotation of the grinder whereby on rotation of the grinder the working surface follows the eccentric shape of the cutting edge and grinds the latter.

6. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support, and having a cutting edge eccentric thereto, means for rotating the cutter, said cutting edge having at a part at least of its rotation, a substantially purely rotational movement, a rotatable grinding element for the knife, a support for the grinder, means to rotate the grinder synchronously with the cutter, said grinder having a shaped working surface which is of helical form and which is rotatable about the axis of rotation of the grinder, whereby on rotation of the grinder the working surface follows the progressive movement of the knife edge in a direction radial to the axis of rotation of the cutter and grinds an eccentric edge.

7. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a grinding element for the cutter supported for rotation about a fixed axis, means to rotate the grinding element synchronously with the cutter, said grinding element having on its periphery a shaped working surface which is rotatable about the axis of rotation of the grinding element and inclined to the plane of the cutter to grind the required chamfer on the latter, the said working surface being of such shape that, due to the said shape, it follows the eccentric shape of the cutting edge and grinds the latter on rotation of the grinding element.

8. In a cutting off mechanism, a cutter support rotatable about a fixed axis, a cutter mounted on the support and having a cutting edge eccentric thereto, means for rotating the cutter, a grinding element for the cutter supported for rotation about a fixed axis which is obliquely disposed relatively to the plane of the cutter at the time of grinding, means to rotate the grinding element synchronously with the cutter, said grinding element having on its periphery a shaped working surface which is rotatable about the axis of rotation of the grinding element and inclined to the plane of the cutter to grind the required chamfer on the latter, the said working surface being of such shape that, due to the said shape, it follows the eccentric shape of the cutting edge and grinds the latter on rotation of the grinding element.