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ROTARY SLITTING KNIFE

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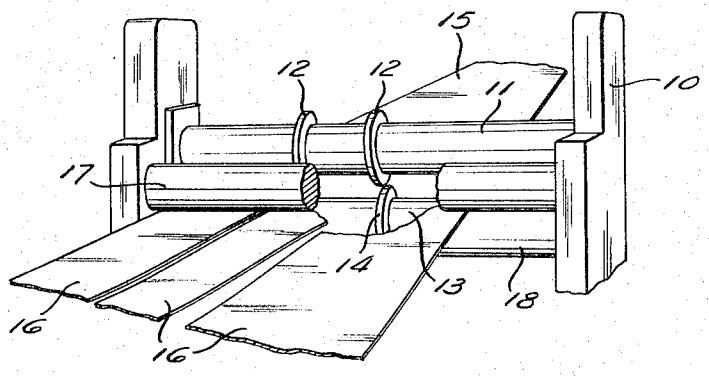


Fig. 1

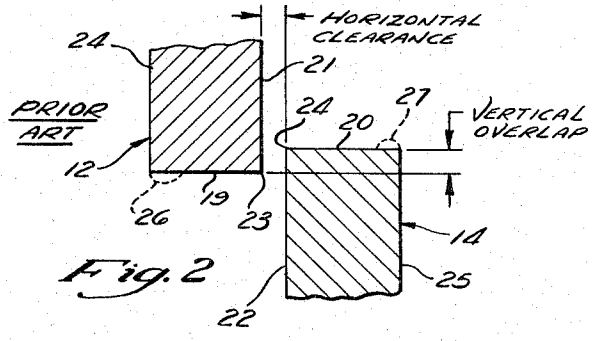


Fig. 2

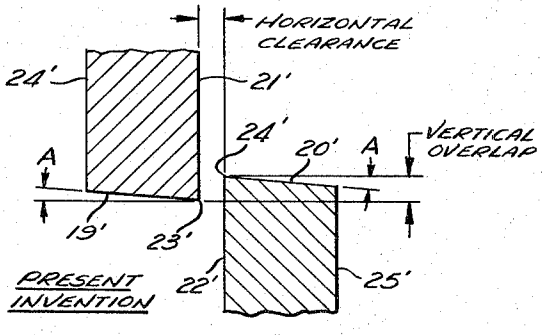


Fig. 3

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ROTARY SLITTING KNIFE

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This invention relates to a rotary slitting knife for use in slitting thin sheet metal, especially sheet polished to a bright or mirror finish.

More particularly, this invention relates to an improved knife for use in conventional equipment for gang slitting relatively wide sheet metal into narrower strips by passing the wide sheet between upper and lower pairs of circular knives mounted on driven horizontal arbors. Depending upon the thickness of the sheet greater than a practical minimum for a given metal of a specific grade and toughness (0.006" is the practical minimum for normal mild steel), the knives in each pair of upper and lower knives which cooperate to produce a particular slit are offset from each other horizontally at their adjacent inner side faces. Also, the knives in a pair may be set, in the plane defined by the axes of the arbors, so that the adjacent cutting edges either overlap or are separated. Somewhat inconsistently, such an overlap is termed a "positive clearance" and a separation is termed a "negative clearance." Whether the knives of a pair are set to provide a negative or positive vertical clearance in order to provide a satisfactory slit without rough or torn edges and without unduly dulling the edges depends, for a given metal of a specific grade, upon the thickness of the sheet; for normal mild sheet steel 0.150" thick, the knives are set for zero vertical clearance; for progressively lighter gauge sheets of the same steel, progressively greater overlap or positive clearance would be provided; for progressively heavier gauge sheets of the same steel, increasingly greater separated or negative clearance would be provided.

In producing knives for the above described slitting machines for sheet metal, tool makers have heretofore striven to grind the hardened peripheral or cutting surfaces and the internal arbor-fitting bores of all circular knives in a set to as perfectly cylindrical surfaces of identical diameters and as perfectly square to the parallel sides of the knives as production tolerances permit. As stated in the current catalogue of a leading tool company, ". . . if the knives are not *exceedingly accurate in all these respects* (and many, unfortunately, are not) slitting becomes unnecessarily troublesome and costly." (Emphasis supplied.)

The purpose of the prior art in seeking such squareness of the external and internal cylindrical surfaces to the parallel sides of the knives, as well as the identity of diameters, was to enable all knives in a set to be mounted on closely fitting arbors, spaced by accurately dimensional spacers, so that, without wobble or differences in diameter of the peripheral or cutting surfaces, the necessarily close vertical and horizontal clearance would be maintained between the knives of each pair of the several pairs in a set. The cylindricalness of the peripheral or cutting surface was sought in order to maintain the sharpness of the cutting edges and to stress the metal at the moment of slitting in as pure shear as possible; knives having beveled peripheral or cutting surfaces as commonly used in slitting paper, film, fabric and supported foils or metal leaf dulled quickly when used for slitting sheet metal, producing ragged and torn edges; also the lateral force vectors imparted by such beveled cutting surfaces might tend to tear laterally, rather than only to shear transversely and, thus, to squeeze or buckle the metal between pairs of knives, producing edges on the strip which might not only be ragged or nicked at given point but also crooked along the length of slit edge.

Despite the high state of development of the above-described prior art knives for gang slitting of sheet metal, they failed to solve a problem which has always been present and which has become increasingly serious with the increased demand for light gauge slit strips of metal, particularly stainless steel, having a mirror finish of the so-called "molding grade"; that is, relatively narrow strips of light gauge metal intended to be molded into trim strips for automobiles or other decorative purposes.

During a run of sheet of a gauge requiring zero or positive vertical clearance, sooner or later a small deposit of metal from the sheet being slit may accumulate and weld onto the peripheral or cutting surface at or near the outer side edge, i.e., the edge away from the cutting edge, of a prior art rotary knife. This welded deposit will thereafter scratch the strip and, once started, may quickly build up around the periphery of the knife and cause a continuous score parallel to the slit edge of the strip. This score may be barely noticeable on strip having a matte or mill finish, but on highly polished molding strip it may cause the strip to be rejected by the customer if passed by the mill or warehouse. Heretofore it has been impossible to predict when or on which knives in a set such scoring deposits will occur or to prevent their occurrences on prior art metal slitting knives; consequently, the only solution has been to maintain close and continuous inspection of both sides of all slit strips. When the amount of scratching had developed to a point warranting loss of production from down-time, the machine was either shut down to replace the unsatisfactory knives with knives that are free of such welds, or to replace the entire set with redressed and resharpened knives. Not only does such down-time increase production costs and delays, but failure to detect such scoring during production can cause the rejection and scrapping of large quantities of high-priced metal.

Another difficulty of prior art slitting knives is that, at unpredictable intervals during use and before a cutting edge has become sufficiently dulled to require sharpening by regrinding, the metal of the rotary knife can develop spalling on the cylindrical surface, leaving a groove along a circumference spaced from the cutting edge a distance in the order of one-half the gauge of the metal being slit. Unless the operators happen to observe such spalling and immediately shut down the slitting machine, the margin between the spalls and the cutting edge will break off in arcuate segments, thereby causing severe damage to the material and possibly serious injury to operators and the equipment.

The present invention is directed to a novel and improved rotary slitting knife, and to a slitting machine embodying such knives, which overcome the above described tendency to score or scratch the strip and which also avoids the spalling incipient to a break down of the cutting knife during use.

It is a principal object of this invention, therefore, to provide a novel and improved rotary slitting knife for use in slitting thin sheet metal.

It is also an object of this invention to prove a novel and improved slitting machine embodying such knives.

Another object of this invention is to provide such a slitting knife having a novel peripheral surface construction which substantially eliminates scoring or scratching of the strip with its attendant loss.

A substantial advantage of knives made according to this invention is that the peripheral surface spalling, characteristic of prior art knives, does not develop. The reason for the surface spalling of prior art knives, aside from being broadly attributable to "fatigue" (and this is actually a mere statement of result, rather than cause) is not fully and completely satisfactorily explainable; why knives made according to this invention do not

develop such spalling requires even greater speculation.

Further objects and advantages of this invention will be apparent from the following detailed description of a presently-preferred embodiment thereof, which is shown in the accompanying drawing.

In the drawing:

FIGURE 1 is a fragmentary simplified perspective view of an otherwise conventional slitting machine embodying the novel rotary slitting knives of the present invention;

FIGURE 2 is a schematic fragmentary vertical section showing the neighboring ends of a pair of prior art slitting knives which cooperate to slit thin sheet metal; and

FIGURE 3 is a view similar to FIGURE 2 and showing a cooperating pair of rotary slitting knives having the present novel peripheral surface construction and adapted for use in a machine of the general type shown in FIGURE 1.

Referring first to FIG. 1, the slitting machine shown in simplified form therein comprises a rigid frame **10** which rotatably supports a motor-driven, horizontal, rotary, upper arbor **11** carrying a plurality of upper rotary slitting knives **12**. The frame also rotatably supports a similar bottom arbor **13** carrying lower rotary slitting knives **14** which are paired with the upper knives to slit a relatively wide metal sheet **15** into several narrower longitudinal strips **16**. The sheet **15** is advanced horizontally between the upper and lower cutting knives by a plurality of pairs of upper and lower feed rollers **17** and **18** (only one pair being shown in FIG. 1) which respectively engage the top and bottom faces of the sheet and the strips.

Referring to FIG. 2, in accordance with known practice, when the sheet **15** is steel having a thickness less than about 0.150 inch, the cooperating upper and lower knives **12** and **14** of each pair have a vertical overlap, or vertical positive clearance, at their respective peripheral or cutting surfaces **19** and **20** where the sheet passes between them, as well as a horizontal clearance between their adjacent inner side faces **21** and **22**. The circular cutting edges **23** and **24** of the respective knives are at the intersections between their respective peripheral surfaces with these inner side faces.

As already explained, in accordance with the prior practice the peripheral or cutting surface **19** or **20** of each knife was made as precisely cylindrical as possible, with the axis of the cylindrical surface coinciding with the rotational axis of the respective arbor and with each such cylindrical peripheral surface engaging the sheet across the full width of that surface. After a period of time, metal particles produced by the slitting operation tend to build up on these peripheral surfaces near the outer side faces **24** and **25** of the respective knives, these deposits being shown in dotted lines at **26** and **27** in FIG. 2. These metal deposits on the slitting knives cause them to score or scratch the respective faces of the sheet along lines parallel to the slit produced by the cutting edges **23**, **24** at the inner side faces of these knives.

In accordance with the present invention, referring to FIG. 3, this difficulty is substantially completely eliminated by providing the slitting knives with novel annular peripheral or cutting surfaces which are deliberately made non-cylindrical, in direct contradiction to the prior practice. Instead, these peripheral or cutting surfaces are made inclined or sloping, preferably frusto-conical, extending at a small acute angle A with respect to the rotational axis of the respective knife, as shown in FIG. 3. Each of these peripheral surfaces, **19'** and **20'**, is inclined laterally outward away from the respective circular cutting edge **23'** or **24'** at the inner side face **21'** or **22'** of that knife in a direction toward the rotational axis of that knife.

I have found that this angle of inclination A must be kept within precise limits in order to fully accomplish

the purposes of this invention. The minimum angle is substantially 1°7½′ and the maximum is substantially 2°15′. If the slope of the peripheral surface is made less than 1°7½′, there remains an objectionable tendency for build-up of metal deposits on this surface which may score or scratch the metal sheet, this tendency being more pronounced the thinner the sheet being slit. If the slope of the peripheral surface is made greater than 2°15′, the life of the cutting edge **23'** or **24'** of that knife is significantly reduced, this tendency being more pronounced the thicker the sheet being slit. Also, if the slope is greater than 2°15′, the slit formed in the sheet tends to have a crooked, rough or ragged edge, this tendency being more pronounced the thinner the sheet.

Surprisingly, within this range of slopes of the slightly beveled peripheral or cutting surfaces, the actual cutting edges do not dull appreciably sooner than the edge of knives having true cylindrical cutting surfaces of equally hardened metal. Nor does the slight bevel tend to tear, rather than shear, the metal or provide a lateral vector in the plane of the strip sufficient to cause even narrow slit strips to warp or buckle and, thereby, produce crooked slit edges.

Except for this peripheral surface construction, the slitting knife may be otherwise identical to the prior knives for this purpose and may be made of any material considered suitable heretofore. Also, the criteria for the horizontal clearance and the vertical positive clearance (or vertical overlap) between the cooperating knives of each pair may be substantially the same as in the prior practice where the sheet metal is normal mild steel. For other steels, these clearances may be somewhat different, as determined by empirical experimentation. The rest of the slitting machine, apart from the knives themselves, may be in accordance with any design found suitable. As in the prior art knives, precise concentricity of the inner and outer surfaces of the knives and squareness to parallel sides, as well as precisely uniform diameters of the bores and cutting edges, respectively, in a set of knives, are desirable in order to maintain uniform clearances between the cutting edges of each pair of knives.

In the foregoing specification and the following claims, it is to be understood that the term "sheet metal" includes the materials known in the trade as sheet strip and/or coil stock.

I claim:

1. A rotary slitting knife having an annular peripheral surface and an inner side face which intersect to form a circular cutting edge, said peripheral surface sloping laterally away from said cutting edge and toward the rotational axis of the knife at an angle between substantially 1°7½′ and 2°15′ with respect to said axis.

2. A rotary slitting knife having a frusto-conical peripheral surface and an inner side face which intersect to form a circular cutting edge, said peripheral surface sloping away from said cutting edge inwardly toward the rotational axis of the knife at an angle between substantially 1°7½′ and 2°15′ with respect to said axis.

3. A rotary slitting knife for use in a slitting machine having means for advancing sheet metal along a plane of travel, a pair of rotary slitting knives on opposite sides of said plane of travel of the sheet metal, and means supporting said knives for rotation with their respective cutting edges overlapping each other in a direction perpendicular to said plane of travel of the sheet metal and offset laterally in said plane, said slitting knife having an annular peripheral surface and an inner side face which intersects to form a circular cutting edge for engagement with the respective face of the sheet metal, said slitting knife having said peripheral surface thereof sloping laterally away from said cutting edge and toward the rotational axis of the knife at an angle between substantially 1°7½′ and 2°15′ with respect to said axis.

4. A slitting knife for use in a machine for slitting

sheet steel up to about 0.150 inch in thickness having means for conveying the sheet steel along a substantially horizontal path, rotary upper and lower slitting knives disposed respectively above and below said path for engagement with the sheet steel from above and below, and upper and lower horizontal arbors rotatably supporting said knives with their respective cutting edges offset horizontally and overlapping vertically, said slitting knife having a frusto-conical peripheral surface and an inner side face which intersects to form a circular cutting edge for engagement with the sheet steel, and the peripheral surface on the knife sloping away from its cutting edge inwardly toward the rotational axis of the knife at an angle between substantially 1°7½′ and 2°15′ with respect to said axis.

No references cited.

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