

[54] **CHEMICAL HONING OF DIES**

[72] Inventor: **Albert J. Sarka**, Fairview Park, Ohio

[73] Assignee: **Harris-Intertype Corporation**, Cleveland, Ohio

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[51] Int. Cl. **B21k 5/20**

[58] Field of Search **156/14, 6, 2; 76/107 C**

3,214,309 10/1965 Leo et al. 156/14
3,421,865 1/1969 Hanson et al. 156/2

Primary Examiner—Bernard Stickney
Attorney—Yount and Tarolli

[57] **ABSTRACT**

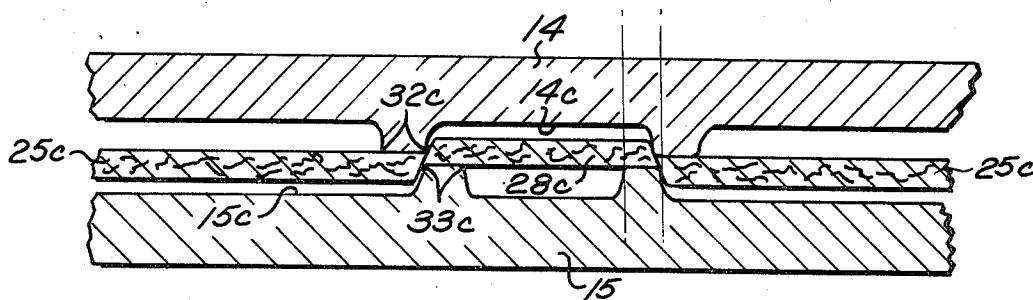
Cooperating male and female cutting and creasing dies for blanking cartons and the like are produced by a chemical milling process and which process includes a final honing step which removes the sharp corners on the lands of the dies prior to installation thereby readying the dies for immediate full speed use on the machine.

[56] **References Cited**

UNITED STATES PATENTS

3,170,342 2/1965 Downie 76/107 C

5 Claims, 5 Drawing Figures



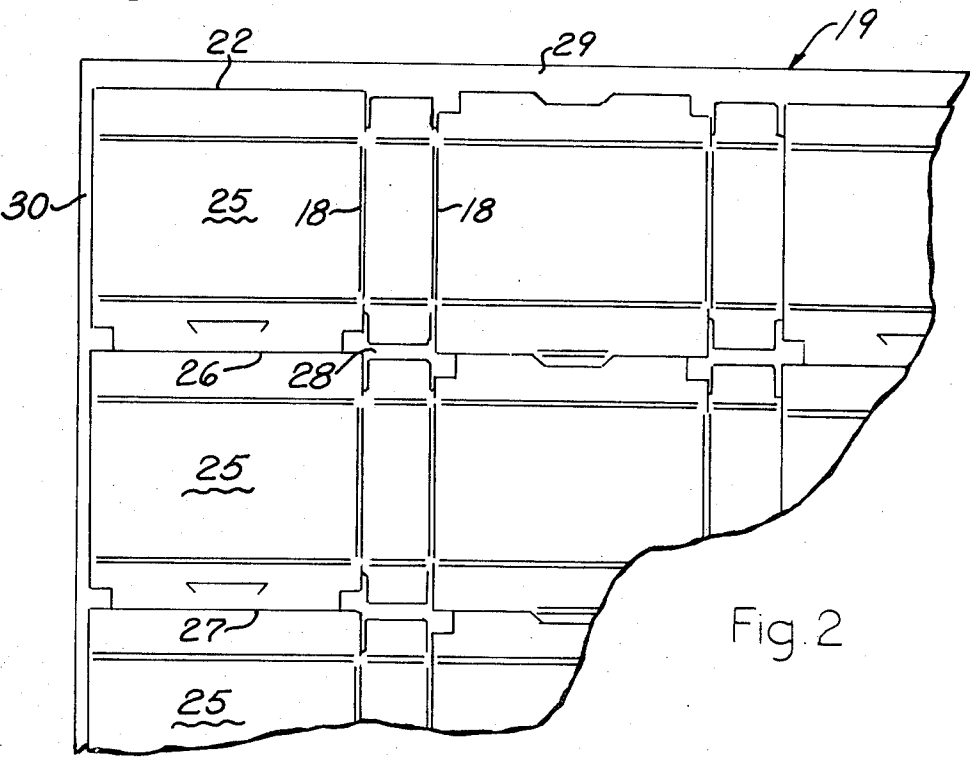
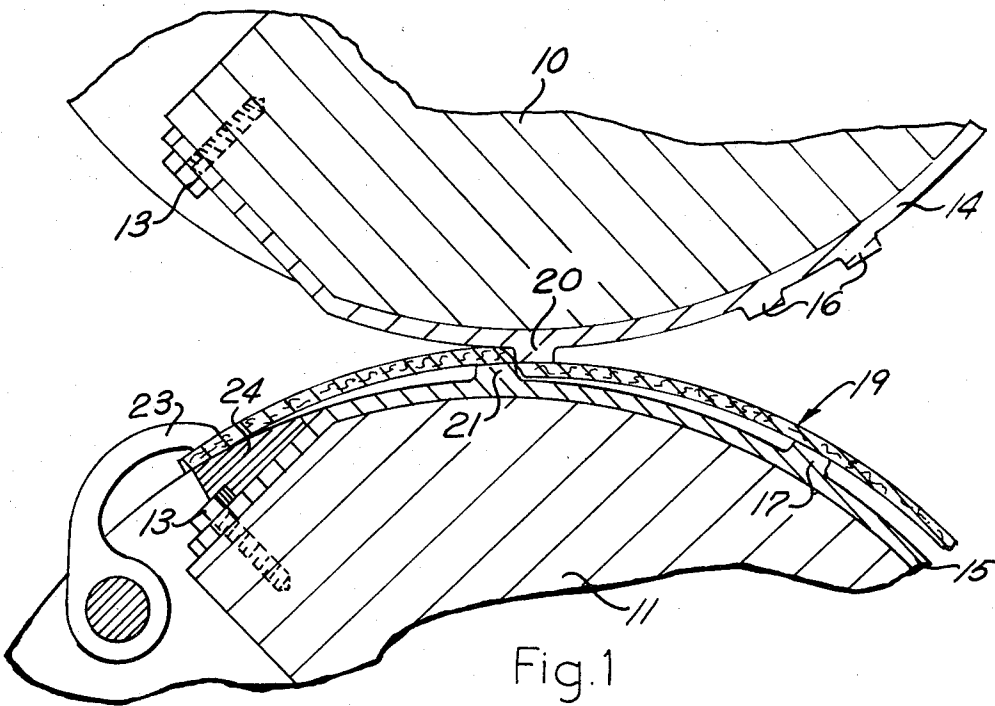


Fig. 2

INVENTOR
ALBERT J. SARKA

BY *Joind and Taralli*
ATTORNEYS

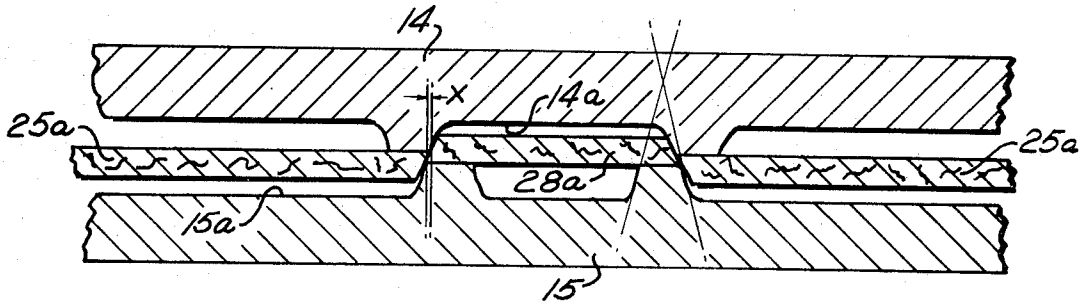


Fig. 3

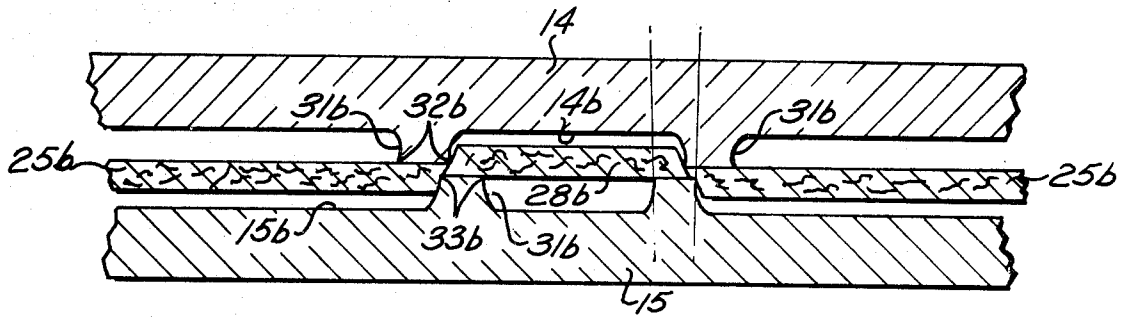


Fig. 4

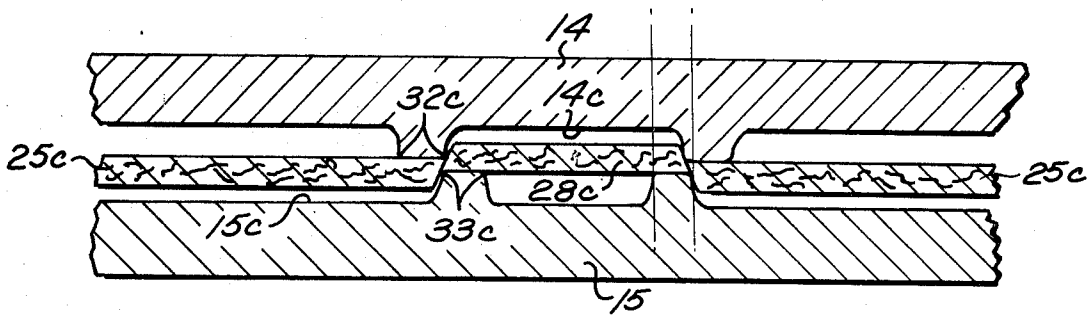


Fig. 5

INVENTOR
ALBERT J. SARKA

BY
Young and Tarolli
ATTORNEYS

CHEMICAL HONING OF DIES

This invention relates to the field of cutting and creasing dies and, more particularly, to an improved process for making such dies.

There is disclosed in U. S. Pat. No. 3,170,342, issued to R. H. Downie on Feb. 23, 1965, cutting dies of the type with which this invention is concerned. These dies, which have been in use on rotary machines for several years on a commercial basis, are employed for blanking cartons and the like from sheets or a web of material such as paperboard. The dies consist of cooperating male and female dies having cooperating male and female lands and are produced by a chemical milling process in which a resist material is coated on to the steel and hardened in selected areas by exposure to a photographic image of the desired land layout. This process provides a layer of resist on top of the areas to be produced as lands and lays bare the material between the lands so that it may be subjected to an acid etching treatment. An etching solution is then applied to remove some of the exposed material. However, it is well known in the chemical milling art that this etching action often causes undercutting of the land area below the resist material thereby leaving an overhang of resist at the top edges of the land and further tending to slightly undermine the land. Because of this undercutting, the ideal cutting land is seldom produced and, instead, lands are formed which have rather sharp top edge corners.

A problem has resulted from the presence of these sharp corners on the dies made in accordance with the Downie teachings. Thus, these corners tend to lock themselves into the cut edges of the carton until such time as the dies have been broken in sufficiently to wear off the edges. A typical break-in period for such dies may vary from 2 to 8 hours depending on various factors such as complexity of the layout, the type and thickness of the material being cut and the depth of etch of the dies. During this break-in period, the machine is required to run at speeds less than its normal operating speed thereby substantially reducing its productivity. Moreover, if any of the broke between the cartons sticks in the dies, it is necessary to shut down the machine to remove this broke. If this is not done, several layers of paperboard broke may stick in the dies, eventually causing a die smash. Since, at the present time, the cost of such dies remains relatively high, the potential for dies smashing seriously detracts from other advantages of the chemical milling process for die production. In addition, the problem of cartons sticking during the early break-in period causes carton handling problems as the cartons exit from the cutting nip.

It is the principal object of this invention to provide an improved method of producing dies by the chemical milling process which eliminates the sharp corners on the lands and, hence, the need for a break-in period for the dies.

It is a further object of this invention to provide a process for making cooperating male and female cutting and creasing dies which process includes a technique that simulates the effects of the machine break-in period and which can be accomplished with existing equipment for die production.

More specifically, it is contemplated by the principles of this invention that the cutting and creasing dies will be produced by conventional chemical milling processes but, in addition, a "chemical honing" step will be employed to remove the sharp corners created by the undercutting of the land area below the resist material. Thus, it has been discovered that by removing the resist material after the die has been completely etched, a quick pass of etching spray across the die will remove the sharp corners and will produce a die which closely simulates one that has been broken in by several hours of machine operation. As a result, dies produced by this chemical honing process do not require a break-in period, thereby enabling the immediate operation of the machinery at normal operating speeds.

Referring now to the drawings wherein like reference numerals indicate like parts in the various views:

FIG. 1 is a fragmentary cross-sectional view of cutting cylinders having a pair of dies and paperboard sheet being cut thereby;

FIG. 2 illustrates a portion of a sheet with a carton layout as it would appear immediately after having been cut between the dies mounted on the cylinder of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of an "ideal" pair of dies cutting sheet material therebetween, illustrating a type of preferred but not readily obtainable cutting lands;

FIG. 4 is a view similar to FIG. 3 illustrating the type of lands frequently produced heretofore in the process of making such dies and showing what occurs to the cartons and broke prior to completion of the die break-in period;

FIG. 5 is a view similar to FIG. 4 showing dies which have been produced in accordance with the present invention to remove their sharp land corners thus enabling them to be immediately operated at full speed when installed on a machine.

Referring now more in detail to the drawings, illustrated in FIG. 1 are dies of the type with which this invention is concerned which are mounted on a pair of cylinders 10 and 11. The dies are supported on the cylinders by conventional mounting means which are illustrated herein as bolts 12, 13. The dies are mirror image flexible steel plates constituting a female die 14 and a male die 15. The female and male dies 14 and 15 respectively receive their designation from the fact that the female die 14 has a pair of spaced scoring lands 16 between which is received a male scoring land 17. The lands 16 and 17 form what are commonly called a crease or score, illustrated as a pair of parallel lines 18 on a sheet 19 of paperboard or the like. Cutting lands 20 and 21 on the dies 14, 15 perform what has come to be known as a "rupture cut," which is illustrated in FIG. 2 as the cut lines 22.

As shown in FIG. 1, the sheet 19 is gripped between gripper fingers 23 and gripper posts 24 along its entire lead edge. A plurality of such posts are provided on cylinder 11, it being understood that the sheet was accurately registered to the cylinders prior to being taken by the gripper fingers and gripper posts in a conventional manner. It will be appreciated that as the cylinders 10, 11 rotate, the sheet 19 is carried along by the cylinder 11 and the lands 20, 21 cooperate to provide the cut lines 22 and the lands 16, 17 cooperate to form the crease or score lines 18.

Referring to FIG. 2, it will be noted that a sheet which has been cut in the nip between the cylinders 10 and 11, normally comprises cartons 25 which have "common" cut lines 26 and 27 for minimization of waste. Small pieces of internal "broke" or scrap 28 together with external lead edge broke 29 and side edge broke 30 are produced by the cutting and creasing operation. This broke 28, 29 and 30 may be removed down stream from the cutting nip in any known manner, one such method being shown in U. S. Pat. No. 3,410,183 issued to A. J. Sarka on Nov. 12, 1968. However, this broke frequently causes a problem by being compressed into a small area between sharp edges of the cutting lands as will be discussed hereinafter.

FIG. 3 illustrates the preferred or ideal shape of two cooperating pairs of cutting lands as a small section of broke 28a is cut between a pair of adjacent cartons 25. Lands having the illustrated configuration minimize the potential for sticking of the broke 28a in the etched recess 14a between the cutting lands. Moreover, there would be a minimum amount of sticking of cartons 25a to the lands 15a, thus, facilitating removal of the sheet as it is released by the grippers 23 upon exit of the sheet from the cutting nip. It will be noted in FIG. 3 that the cut lines between the broke 28a and cartons 25a are at an angle relative to the surface of the sheet. This is typical of the rupture cutting process in which there is a slight overlap of 0.002 to 0.004 inch between cooperating pairs of cutting lands. This overlap or "negative clearance" is illustrated by the letter x in FIG. 3.

Typically, the dies 14 and 15 are made of steel and are produced by a chemical milling process. This process involves the removal of portions of a thin metal plate by chemical means to form the background or depressed areas of the plate leaving the scoring and cutting edges standing above the background areas. These cutting and creasing edges or lands are small in cross-section, often rising above the plate only about 0.020 inch. An etching solution of an appropriate acid is used to remove the portions of the metal plate. Prior to the etching, the steel plate is provided with a pattern of the lands by coating the plate with a resist material which is hardened in selected areas by exposure to an image of the desired land layout. This may be done in accordance, for example, with U. S. Pat. No. 3,341,329 issued to T. H. Blake on Sept. 12, 1967. The photographic process and developing prior to the etching provides a layer of resist material on top of the areas to be produced as lands and lays bare the material between the lands so that the exposed material may be subjected to an acid treatment for the chemical milling action.

It is known in the chemical milling art, and recognized in the aforementioned Blake patent, that the chemical milling action causes a certain undercutting of the land area below the resist material. This undercutting requires that the resist land image actually be wider than the finally resulting land to compensate for the undercutting action and also to assure the proper overlap between the cooperating cutting lands. It is also known that for etching steel, an etching solution containing, for example, 20 percent nitric acid will undercut the coating approximately 0.010 inch per edge for an etching depth of 0.015 inch. Moreover, for best results, die etching takes place by providing a spray of the etching solution at right angles to the dies

while they are in a flat horizontal inverted condition. The spraying action, on hitting the die, tends to move some of the etching acid parallel to the surface of the dies thus enhancing the tendency toward undercutting of the lands. The result of this undercutting action is to leave an overhang of resist material at the top edges of the land and further tends to slightly undermine the land, the magnitude of which depends on factors such as the depth of the etch, the type of acid used and the fluid pressure with which the acid may impinge on the steel material.

Because of this undercutting action, it frequently occurs that the chemical milling process produces dies having lands such as those shown in FIG. 4. An undercut 31b of the land results in a sharp corner 32b which tends to anchor itself in the cut edge of the broke piece 28b as it is pressed into the recess 14b between the pair of cutting lands. The same thing happens on the die 15 where a sharp corner 33b may result in a gripping action on the carton 25b pressed into the recess 15b. Thus, the result of the undercutting 31b is to produce lands which are quite the opposite from the "ideal" land form shown in FIG. 3. Instead of the side walls of the lands paralleling the cutting angles as in FIG. 3, the side walls frequently intersect with the cut line as illustrated in FIG. 4.

It is proposed by this invention to eliminate the sharp corners 32b and 33b during the die production process, thereby eliminating the need for the break-in period when the die is first placed in use. The removal of the sharp corners is accomplished in the following manner. It has been normal practice, in the few years in which the process of rupture cutting has been commercialized, to permit the resist material to remain on top of the lands instead of removing the resist by a suitable stripping solution. It has been felt that the presence of the resist material on the lands has no adverse effect on the cutting ability of the dies when installed on the machine. However, it has been discovered that this resist material forms a slight overhang at the top edges of the land and this overhang, together with the slight undercutting of the land, is the primary basis for the formation of the sharp edges on the lands. Accordingly, it is proposed that the resist material be removed from the lands after the die has been completely etched. This can be accomplished by the use of a suitable stripping solution applied in a manner known in the chemical milling art. As is well known, the particular solution used depends on many factors including the thickness of the coating and whether the coating has been post baked. After removal of the resist coating, it is proposed to subject the die to a quick pass of the etching spray to provide what may be termed a "chemical honing" of the die. This pass of the etching spray will have little or no effect on the flat surfaces of the die but it will be effective to remove the sharp undercut corners illustrated at 32b and 33b in FIG. 4. Thus, the etching solution will "etch" the corners to round them off as shown at 32c and 33c in FIG. 5.

A die produced with this additional chemical honing step now has a land profile which more nearly approaches that of one which has been "broken-in" by several hours of machine operation on sheet material. Most importantly, chemically honed dies have been proven to be effective in enabling the immediate opera-

tion of the machinery on which the dies are installed at normal operating speeds rather than having to run them in for several hours at lower speeds.

While a chemical honing process has been disclosed as the technique for removing the sharp top corners of the lands, other techniques such as a very light sand-blasting or the like may be employed. However, a substantial advantage of the chemical honing process is that it utilizes the same basic equipment as is employed in the die production process.

While the invention has been disclosed in connection with a preferred embodiment, neither the disclosed embodiment nor the terminology employed in describing it is intended to be limiting; rather, it is intended to be limited only by the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. In a method for producing a cutting and creasing die having cutting and creasing lands thereon by a chemical milling process which includes exposing a resist coated surface of the die to a photographic image of the desired land layout, developing the exposed resist to harden the resist in the areas of the lands and to expose other areas of the die and applying an etching solution to the exposed areas of the die thereby to

remove some of the metal, said method comprising the steps of:

removing the resist material from the land areas after the milling process has been completed, and removing any sharp undercut edges from the lands.

2. The method of claim 1 wherein said step of removing the sharp edges comprises the step of chemically removing said edges.

3. The method of claim 1 wherein said step of removing the sharp undercut edges of the lands comprises the step of passing a spray of the etching solution across the surface of the die.

4. A method of removing the sharp edges from undercut areas of a resist pattern on a chemically milled article comprising the steps of:

removing the resist material from the undercut areas to expose the surface therebeneath, and applying an etching solution to the exposed surface of the undercut areas thereby to remove the sharp edges.

5. The method of claim 4 wherein the step of applying the etching solution comprises the step of passing a spray across the surface.

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