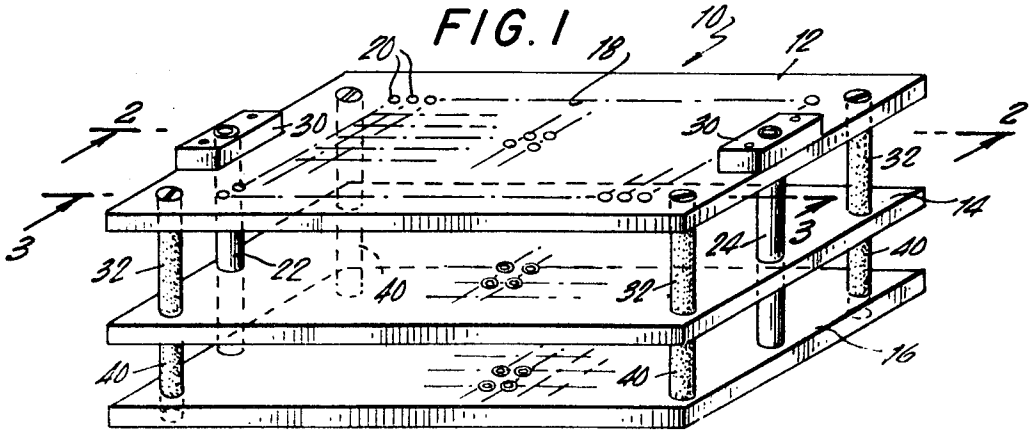
Sept. 28, 1971 D. BORELLO 3,608,413

HOLE PUNCHING DIE ARRANGEMENT

Filed Sept. 11, 1969

FIG. 1



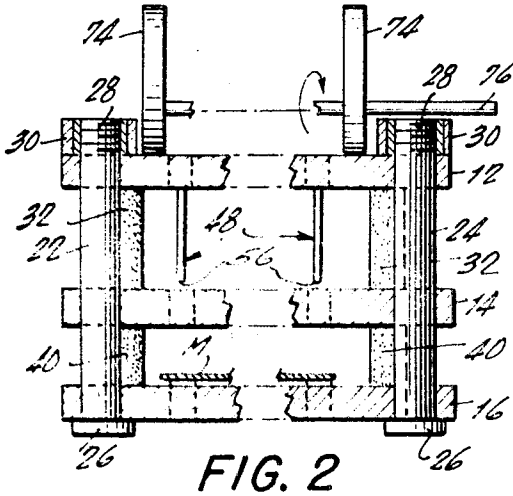


FIG. 2

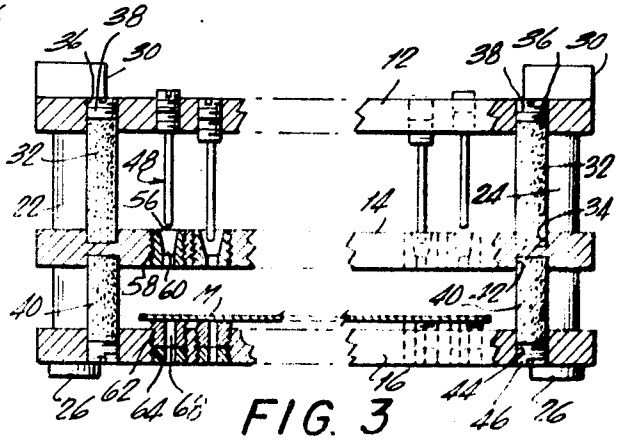


FIG. 3

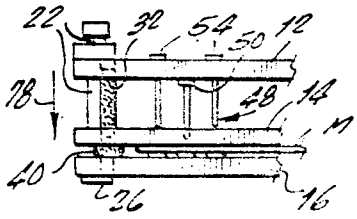


FIG. 4

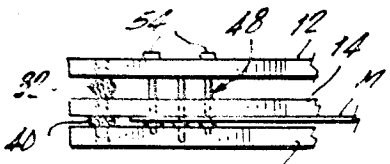


FIG. 5

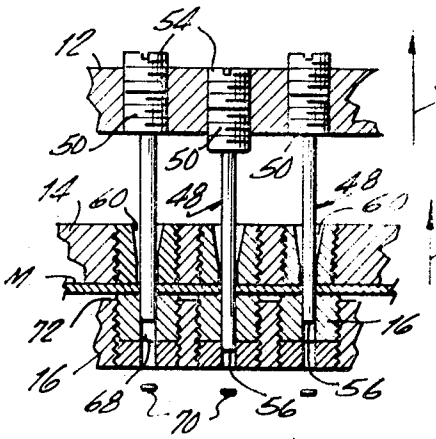


FIG. 6

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HOLE PUNCHING DIE ARRANGEMENT

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ABSTRACT OF THE DISCLOSURE

A plurality of cooperating male and female hole punching members respectively mounted in upper and lower die plates with an intermediate die plate held by upper and lower sets of resilient means between the upper and lower die plates. By adjusting the relative forces exerted by the resilient means, during a power stroke the lower set yields first to allow the intermediate die plate to ease into holding engagement with the material during hole punching operation, and during the return stroke the upper set is first to cause withdrawal of the male punching members from the material while the material is still being held. As a consequence, numerous holes are effectively punched having little or no peripheral burrs.

The present invention relates to the production of perforated metal or the like, and more particularly to an improved arangement of die plates mounting hole-punching tooling and having a noteworthy mode of operation for producing burr-free holes or openings.

The use of an intermediate stripping die plate between the upper and lower die plates which actually mount the cooperating cutting tooling, dies, or punch members is already well known. Typically, this plate is suspended or otherwise supported from the upper plate which mounts the male punch members with a biasing spring interposed between it and the upper die plate. The biasing spring is effective in holding the material following punching operation and during withdrawal or stripping movement of the male punches from the material, but it is not otherwise effective in contributing to efficient hole-punching operation. Among other things, for example, this typical prior art arrangement has no spring or resilient means cushioning the impact of the stripping plate against the material supported on the lower die plate.

Broadly, it is an object of the present invention to provide an improved hole punching die arrangement overcoming the foregoing and other shortcomings of the prior art. Specifically, it is an object to float the stripping plate between opposing resilient means and to achieve proper sequential movement of this die plate during the power and return strokes by adjusting the forces exerted by these resilient means.

An arrangement of superposed, punch-mounting die plates demonstrating objects and advantages of the present invention includes cushioning resilient means interposed between an otherwise conventionally downwardly biased stripping plate. The arrangement, however, further includes simple and effective means for regulating the relative forces exerted by the opposing cushioning and biasing means so that the former does not interfere with the holding and stripping function of the stripping die plate which, nevertheless, is effectively eased into material-holding contact against the urgency of the cushioning means.

The improved die arrangement hereof also includes other noteworthy structural features. Among such features is the capability of adjusting the depending position of each of the male punches from the upper die plate. The invention contemplates making the necessary adjustment such that the punches are, at different times, urged through the material. This has been found to minimize stressing of the material.

The above brief description, as well as further objects, features and advantages of the present invention, will be more fully appreciated by reference to the following detailed description of a presently preferred, but nonetheless illustrative embodiment in accordance with the present invention, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a simplified perspective view of a hole punching die arrangement according to the present invention;

FIG. 2 is a side elevational view in section taken along line 2—2 of FIG. 1, illustrating further structural features of the arrangement;

FIG. 3 is similarly a side elevational view, but taken in section along line 3—3 of FIG. 1, and illustrating further structural features;

FIGS. 4 and 5 are partial front views illustrating the sequential movements of the die plates of the arrangement during a typical power stroke. More particularly, FIG. 4 illustrates the first movement sequence of the material holding and stripping die plate into holding engagement with the material, and FIG. 5 illustrates the second or concluding movement sequence of the male punch-holding die plate closing upon the material and providing hole-punching operation; and

FIG. 6 is a partial sectional view further illustrating the material punching operation of the arrangement hereof.

Reference is now made to the drawings, and particularly FIG. 1, wherein there is shown a simplified, perspective illustration of a multiple die plate arrangement, generally designated **10**, which is particularly useful in punching plural holes in thin strip material. A material with the punched holes (not shown) which is advantageously produced by the arrangement **10** is that used as the anode and cathode plates for batteries. The mention of this product is not intended as a limitation on the use of the arrangement **10**, but inasmuch as battery plates require extensive perforation or the punching of numerous holes, sometimes as many as a hundred, this product readily serves to illustrate the noteworthy production performance of the arrangement **10**, all as will be described now in greater detail.

In the simplified perspective view of FIG. 1, it is readily noted that arrangement **10** includes three die plates, to wit: a first upper, movable male punch-holding die plate **12**, an intermediate or interposed material holding and stripping die plate **14**, which is also movable during operation of the arrangement **10**, and finally a stationary, lower female punch-holding die plate **16**. Within a prescribed operative area of the die plates, as illustrated, for example, by the operative area **18** delineated on the die plate **12**, the plates are provided with aligned plural openings, individually and collectively designated **20**. Respectively disposed in these openings, all as will be described in greater detail subsequently, are the male punch members **48** in die plate **12**, guide members **58** for the male punch members in die plate **14**, and finally female punch members **62** in die plate **16**. Naturally, the location of the aligned holes **20** determine the location where holes will be punched in material M fed between the two lower die plates **14** and **16**. Moreover, in accordance with a noteworthy aspect of the operation of the arrangement **10**, during a power stroke or when the die plates close upon the material being punched, the movement of the die plates occurs in two distinct movement sequences. First, die plate **14** closes upon the material being punched which is then in an interposed position between it and die plate **16**. Next, die plate **12** is urged through closing movement which results in the male punch members being forced through the securely held material. During reverse or opening movement of the die plates, die plate **12** is the first moved through opening movement to its starting or

ready position, such movement occurring while the die plates **14** and **16** are still in holding engagement with the material M that has been punched. Thus this opening movement of die plate **12** results in stripping movement of the male punch members **48** from the perforated material M.

Referring now to FIGS. 2, 3 in conjunction with FIG. 1, it will be noted that arrangement **10** includes a pair of spaced-apart guide bars **22** and **24**, the lower ends of which extend through and beneath the die plate **16** and, as best shown in FIG. 2, have movement-limiting flanges **26**. The bars **22, 24** are also extended through through bores in the intermediate die plate **14** and, at their opposite ends, are threaded as at **28**, and are each threadably engaged to stop members **30** such that the members **30** and flanges **26** define the maximum extent of opening movement of the die plates **12** and **14** relative to the stationary die plate **16**.

Normally holding the die plates **12, 14** and **16** in their open positions relative to each other are a first and second set of resilient means respectively having an interposed position between the pair of die plates **12** and **14** and between the pair of die plates **14** and **16**. More particularly, the first set of yieldable resilient means consists of four generally cylindrical compressible plastic members, individually and collectivey designated **32**. The description of the operative mounting of one resilient member **32** should suffice for all. As best shown in FIG. 3, the lower end of resilient member **32** is seated in an upwardly facing counterbore **32** of the die plate **14** while the upper end thereof is projected into a threaded through bore **36** and seated against a threaded member **38**. As generally understood, resilient member **32** has an inherent resistance to compression which is a function of the material of which it is fabricated and, in response to a load placed upon it will exert an equal and opposite force. Also as generally understood, the resistance to compression and corresponding outward urgency of member **32** can be regulated by the load placed upon it and, this in turn, in the illustrated embodiment is a function of the threaded position of member **38** within the threaded bore **36**. That is, upon tightening up of the member **38**, member **32** is, of course, compressed, thus building up the resistance of this member to further compression. The significance of the adjusted resistance to compression of the first set of resilient members **32** will become more apparent subsequently in the description.

The second set of resilient means, individually and collectively designated **40**, is practically similarly mounted in its interposed position between the die plate **14** and stationary plate **16**. In this instance, however, the upper end of each member **40** is seated in a counterbore **42** in the lower surface of the die plate **14** and the lower end is projected into a threaded through bore **44** and seated against a cooperating threaded member **46**. From the foregoing description it should therefore be readily apparent that the die plates **12, 14** and **16** are normally maintained in an open relation in their respective ready positions as illustrated in response to the urgency of the resilient members **32** and **40** preparatory to a power stroke during which, as already noted, die plates **12** and **14** are urged through closing movement upon the die plate **16** and result in the punching of holes through the material M in place between the die plates **14** and **16**.

To actually punch holes in the material M, use is made of a plurality of male punch members, individually and collectively designated **48**. Each male punch member **48** includes an upper threaded body **50** threadably disposed in a cooperating threaded through bore **52** in the die plate **12** so that each of the members **48** has a depending operative position from the male punch-holding die plate **12**. A threaded member **54** is threaded against each of the punch bodies **50** to hold the same in place. As readily noticeable in FIG. 3, it is advantageous to have the different male punch members **48** adjusted to different depending positions from the die plate **12** so that the punching or cutting ends **56** of these members actually are urged through a punching stroke through the material M at different times. This has been found to minimize the extent of stress created in the material during hole punching operation.

Turning now to the construction of the intermediate or stripping die plate **14**, it will be noted that in alignment with each male punch member **48** there is a threaded guide member **58** including a central guide opening **60** through which the male punch is projected during closing movement or a power stroke of the arrangement **10**.

The cooperating female punch members, individually and collectively designated **62**, are threadably disposed in threaded through bores **64** in the stationary die plate **16**, each of the members **62** being held in place by a threaded member **66**. Each cooperating pair of members **62, 66** includes an aligned central opening **68** of a size and shape conforming to that of the depending shank of the male punch members **48**. This is clearly illustrated in FIG. 6 wherein it is further illustrated that the openings **68** function as exit openings for the material **70** removed from the material M in order to produce the punched holes in the material M. It should also be noted that in a preferred setup of the arrangement **10**, that it is desirable to threadably adjust each of the female members **62** so that the upper portion thereof extends slightly above the upper surface **72** of the stationary die plate **16**. This slight clearance has been exaggerated in FIG. 6 for purposes of clairity of illustration. It has been found that movement of the material M along the stationary plate **16** thus does not result in wear of the upper surface **72**, but only in wear of the upper portions of the female die members **62**. When this wear becomes excessive, it is necessary then merely to replace the members **62** rather than the entire die plate **16**.

The operation of the arrangement **10** can readily be understood from FIGS. 2, 4 and 5 to which reference is now made. Preferably, the die plates **12** and **14** are urged through hole punching movement by the rotation of one or more eccentrics **74** appropriately fixedly mounted on a power shaft **76**. That is, with material M in its proper interposed position between the die plates **14** and **16**, the eccentrics **74** are rotated so that the throw thereof is effective in causing movement of movable die plates **12** and **14** in accordance with the movement sequences now to be described. The present invention contemplates that in the setting up of the arrangement **10**, the first set of resilient members **32** will have the greater extent of resistance to compression such that when the eccentrics **74** urge die plate **12** through movement, the resilient members **32** resist compression while the second set of resilient means **40** yields to the compressive force being applied by the eccentrics **74**. As a consequence, and as best shown in FIG. 4, both the die plates **12** and **14** descend through closing movement **78** with the result that die plate **14** closes upon material M which is in postion upon the stationary die plate **16**. This closing movement, however, is cushioned by the resilient means **40**. Then, while the material M is being held between the die plates **14** and **16**, continued closing movement of the upper die plate **12** results in the male punch members **49** being urged through punching movement through the material M, all as is clearly illustrated in FIGS. 5, 6.

In response to continued rotation of the eccentrics **72**, and more particularly rotation of these members past dead center point, the die plates **14** and **12** are correspondingly released for return or opening movement to their respective initial starting positions. In this direction of movement, again since the resilient members **32** are exerting the greater force, the first die plate to move is die plate **12**, such movement being opening movement illustrated by the arrow designated **80** in FIG. 6. During this movement, die plate **14** remains in holding engagement against the material M under the bias or urgency of the resilient means **32**. As a consequence, the male punch members **48**

are smoothly and effectively withdrawn from the material so as to minimize burring of the periphery of the holes that were punched in the material M.

Ultimately, the force urgency of each member **32** reaches a point where it is less than the urgency being exerted by the members **40** such that disengaging movement of the die plate **14** from the material M starts to commence. At this time, however, the male punches **48** are completely withdrawn from the material M. As a consequence of opening movement **82** of the die plate **14**, the material M is released and either can be removed and replaced with another sheet requiring punching or, if in strip form, the next succeeding length portion can be moved into proper position for hole punching.

A latitude of modification, change and substitution is intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features.

What is claimed is:

1. A hole punching die arrangement comprising an operative, superposed arrangement of a male punch-holding die plate, a material holding and stripping die plate, and a female punch-holding die plate, movement actuating means operatively arranged to urge said die plates from starting ready positions through closing movement incident to material punching operation and thereafter to release said die plates for opening movement back to said ready positions, and a first and a second arrangement of yieldable resilient means of unequal resistance to compression respectively having interposed positions between said die plates, said die plates having threaded bores therein in which are accommodated the opposite ends of said resilient means of said first and second arrangement, threaded members threadably adjustable in position in said threaded bores to correspondingly regulate the extent

of resistance to compression of said resilient means, said first resilient means between said male punch-holding die plate and said material holding and stripping die plate having said larger extent of resistance to compression, whereby during said closing movement of said die plates, said second resilient means yields first resulting in holding engagement of said material by said material holding and stripping die plate and during said reverse opening movement of said die plates said first resilient means expands first resulting in stripping movement of said male punch-holding die plate relative to said material holding and stripping die plate.

2. A hole punching die arrangement as defined in claim **1** including stop means confining said die plates to a selected extent of opening movement in response to the urgency of said resilient means.

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U.S. Cl. X.R.

83—142, 383, 527, 622, 685, 687, 690