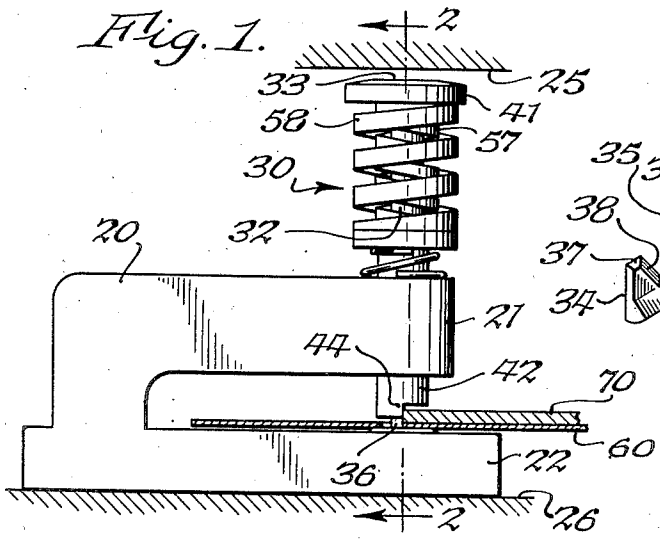
Sept. 1, 1953 G. F. WALES ET AL 2,650,663

APPARATUS FOR NIBBLING

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Fig. 1.



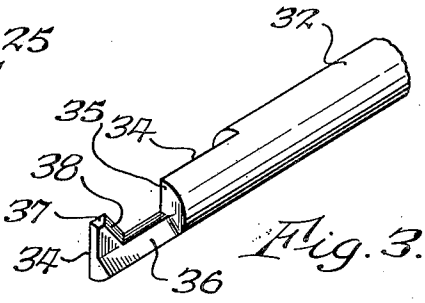




Fig. 3.

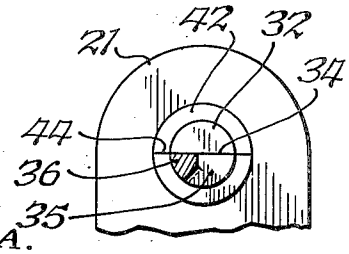



Fig. 4.

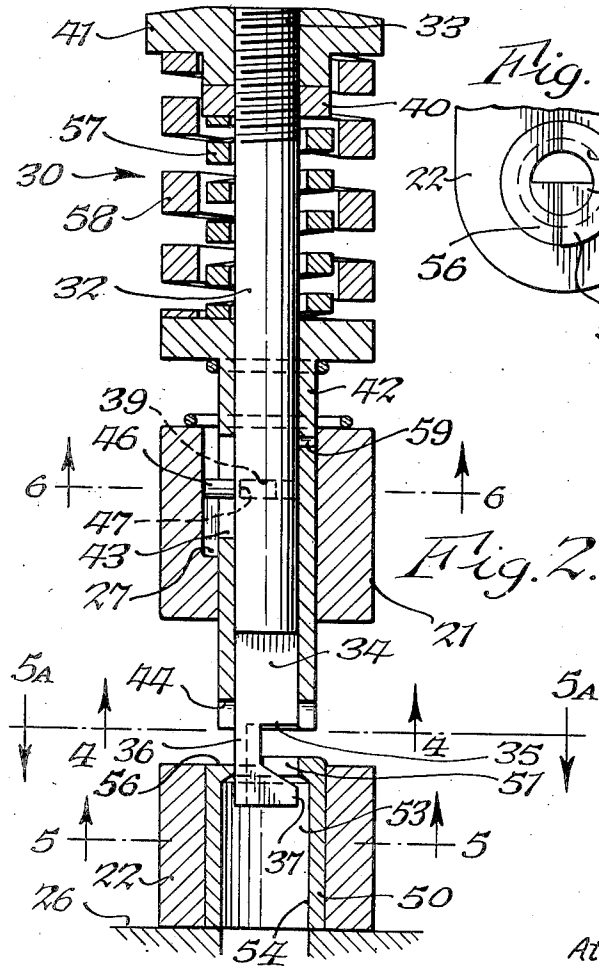



Fig. 2.




Fig. 5A.

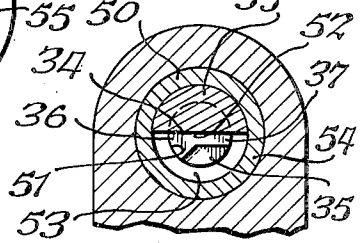



Fig. 5.

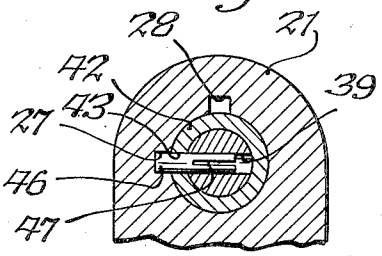



Fig. 6.

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APPARATUS FOR NIBBLING

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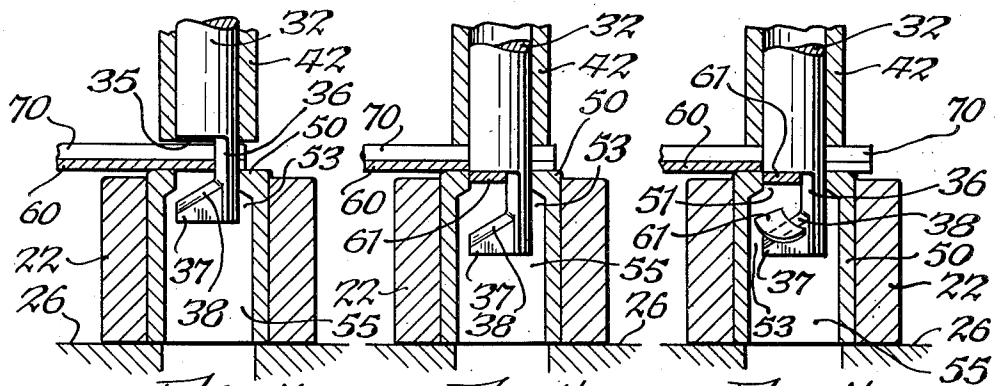



Fig. 7a. Fig. 7b. Fig. 7c.

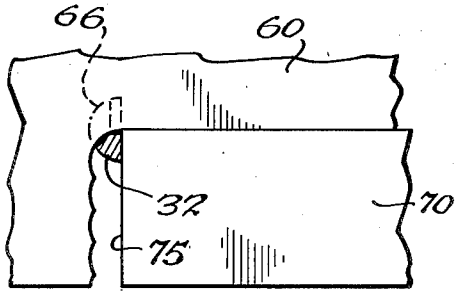



Fig. 8.

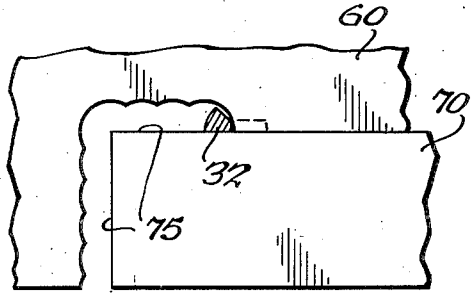



Fig. 9.

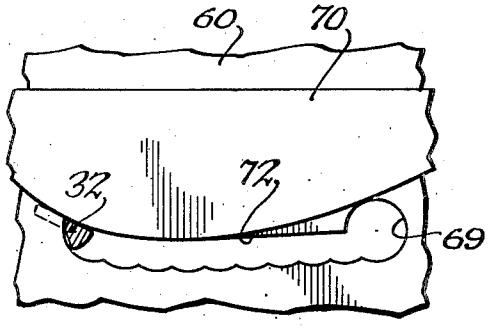



Fig. 10.

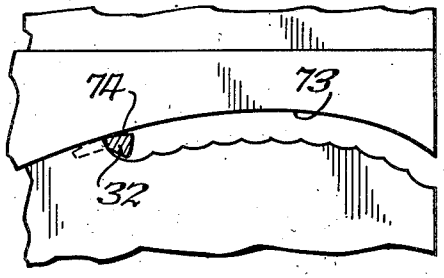



Fig. 11.

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APPARATUS FOR NIBBLING

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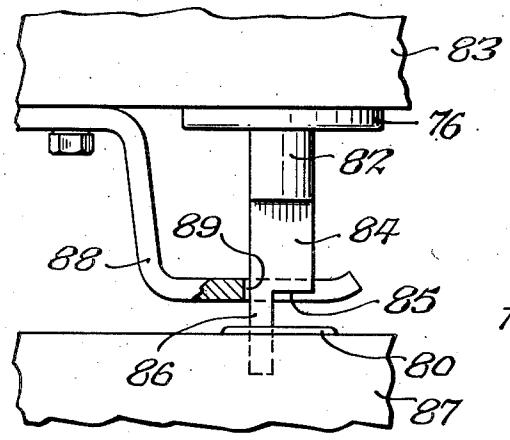



Fig. 12.

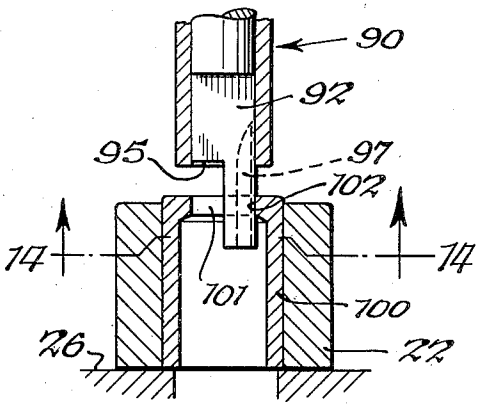



Fig. 13.

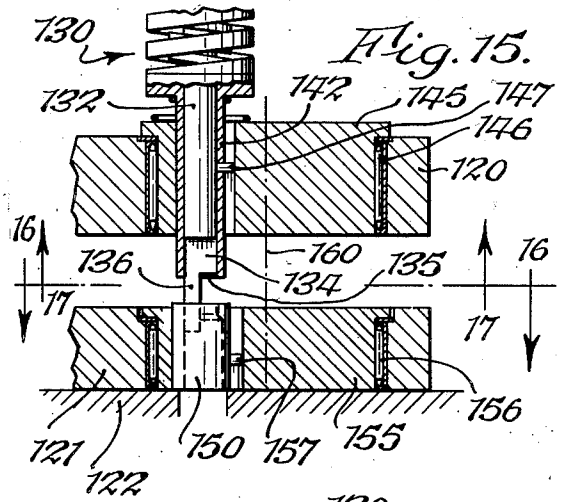



Fig. 15.

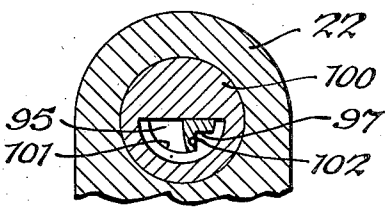



Fig. 14.

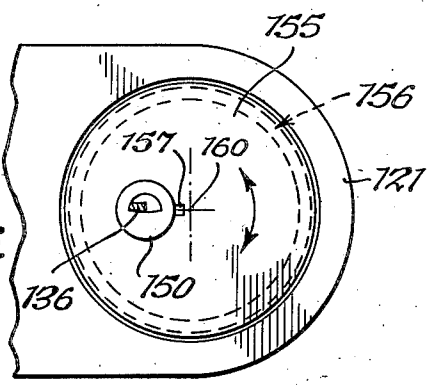



Fig. 16.

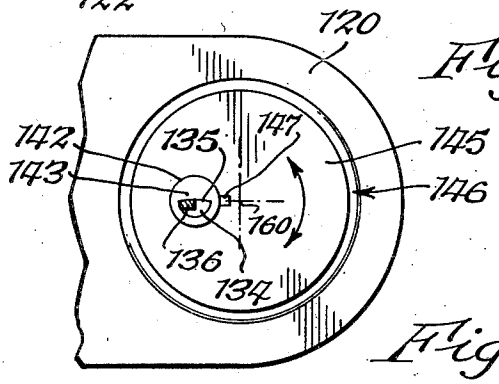



Fig. 17.

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2,650,663

# UNITED STATES PATENT OFFICE

2,650,663

## APPARATUS FOR NIBBLING

George F. Wales, Kenmore, and Paul H. Taylor, North Tonawanda, N. Y.; said Taylor assignor to said Wales

Application December 29, 1948, Serial No. 67,954

13 Claims. (Cl. 164—47)

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This invention relates to perforating apparatus and more particularly is concerned with novel methods and apparatus for cutting sheet material by nibbling.

There are several methods of cutting the contoured sheet metal work-pieces which are used in industry for the production of consumer goods. For high production runs a male and female die are generally employed which blank out the work-piece in one, two or more operations, depending upon its character. This is the method of tooling employed in all high production industries. However, a large majority of applications are such that this expensive form of tooling would not be justified by the probable production runs to be made. For instance; in medium range production it is a general practice to overcome the high cost of the above finished dies by making temporary dies to provide a work-piece. These temporary dies have a short life and provide a work-piece which generally requires finishing operations. Because of tooling costs, in low production work it has been the general practice to saw, use hand snips, or any other type of hand tool to provide the approximate work-piece and then complete the work of finishing the edge of the work-piece by filing or other hand operations. In recent years a practice has developed of nibbling the low and some medium production run work-pieces because the greater rapidity of the perforation operation made this process more economical than some dies and the hand operations. However, because the nibbling operation is generally done with a round punch, an unfinished edge is always obtained if the maximum feed of nibbling is undertaken. That is, if the feed of the nibbling operation is rapid the circular shape of the punch leaves a scalloped edge along the work-piece which must be dressed off if a finished edge is required. This condition can be alleviated somewhat by slowing the feed of the work-piece so that a very fine scalloped edge is developed, which is satisfactory in many cases without further operation. It will be obvious though, that if the speed of operation is slow, the advantages of nibbling are largely lost and sawing or some other method of preparing the work-piece might just as well be utilized, unless the scalloped edge of the high feed condition can be hidden from the eye. Because of the above difficulties many companies have abandoned the use of nibbled work-pieces for any parts which appear to the customer's eye. Due to the low cost of nibbling, however, these companies have continued to utilize nibbled parts

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where they are hidden from the customer's view, so that the scalloped edge was not objectionable. In addition, some companies have utilized an oblong or rectangular punch for nibbling along a straight line or for round ends exposed to the eye of the consumer as the series of flats on the straight line or periphery of the nibbled blank generally proved satisfactory without further finishing or other rework.

It will now be obvious to those skilled in the art, that where the scalloped edge of a contoured work-piece can be hidden or where a flat punch for a straight line or a fixed radius can be employed, the present practice of nibbling can be utilized. However, it will be readily apparent that this excludes nibbling a large share of the low and medium production run work because it employs varying contours and is visible to the eye.

Another difficulty experienced with the high rate of perforations encountered in nibbling, was the necessity for removing the punch and die more often for sharpening or replacement. The excessive time lost in replacing punches and dies raised the cost of nibbling. To overcome this lost time we devised a self-contained nibbling unit similar to the quick-change perforating unit which is illustrated in Fig. 15 of Patent No. 2,364,-011. This patent is a modification of basic Patent 1,955,866 and both of these patents are assigned to our interests. However, the high perforating rate when nibbling made more critical a difficulty experienced in this construction due to the rapid dulling of punch and die. Since a dull punch and die greatly increases the stripping force required over that for a sharp punch and die, the variation in stripping pressure changes rapidly when nibbling, due to the rapid dulling of the punch and die. The continuous reciprocating operation is at the rate of 165 to 800 strokes per minute and this prevents discovering a dull punch at the instant it fails to strip so that damage may result as will be described hereinafter. In single perforating work the ram stops at the end of each perforation and a dull punch can be detected because the stripping spring fails to withdraw the punch from the work-piece. The punch can then be removed and replaced or sharpened without causing damage.

When a punch sticks in nibbling it may withdraw suddenly from the work-piece at the instant the ram is at the top of its stroke allowing the punch to strike the ram sufficiently hard to damage the punch or ram. In the event the self-contained nibbling device is being used on a long

stroke press-working machine, the gap between the head of the punch and the ram, in its upper position, may be sufficient to allow the punch to jump completely out of the holder and the succeeding stroke of the ram may cause great damage and create hazard to the machine operator. While a heavier spring may be utilized, stickiness may still occur and the stored inertia in the heavier spring may make it withdraw more severely driving the punch out of the holder. In addition, the heavier spring is generally more subject to fatigue and raises the perforating load on the machine. Although methods for restraining the springs under initial tension have proven moderately successful on single hole units, the continuous operation of the nibbling cycle prevents the use of restraining means for nibbling punches.

The primary object of our invention is to provide a companion nibbling punch and die which will provide a finished edge regardless of the contour around which they are travelling.

Another object of our invention is to provide a nibbling punch and die which provides a finished edge and yet permits maximum machine tool speed.

A companion object of our invention is to provide a companion nibbling punch and die which are easily manufactured.

Yet another object of our invention is to provide a nibble punch and die in which the component most easily replaced is provided with the variable clearances for various material thicknesses.

Yet a further object of our invention is to provide a companion punch and die for nibbling which is adapted to nibble around a work-piece on fixed centers or around a template.

Still a further object of this invention is to provide a companion nibbling punch and die adapted to be installed in a self-contained holder assembly.

A related object of this invention is to provide resilient biasing means, for stripping the punch from the work-piece, which matches the stripping force required at any material thickness.

Still another related object of this invention is to reduce the dynamic energy after stripping.

Still another object of this invention is to provide novel key means for maintaining a shaped punch and die in alignment.

Still a further object of this invention is to provide novel key means for maintaining the punch and die in aligned relationship.

Another object of this invention is to provide a novel nibbling apparatus and method in which the punch and die turn in relation to the desired feed rather than the work-piece.

A related object of this invention is to provide novel apparatus and methods for nibbling around templates, to fixed gauges and to a scribed line.

Fig. 1 is a side elevation showing our punch and die as adapted to a self-contained holder such as shown in Patents Nos. 1,955,866 and 2,364,011 and illustrating a method of nibbling a work-piece from a juxtaposed template.

Fig. 2 is a sectional view taken in line **2—2** of Fig. 1, showing the relative relation of the punch, its adjustable head, nested stripping springs, stripping guide and die of our device, and illustrating the key pin extended through the stripping guide for guiding the punch and die with relation to the holder for the novel method of nibbling to fixed gauges or centers.

Fig. 3 is a perspective view of our punch illustrating the keyed section for keying the punch to the die and the adjacent nibbling cutting surfaces of said punch.



Fig. 4 is a sectional view taken as noted of Fig. 2, showing the half-round punch section and the notched guide sleeve which permits the template to be in juxtapposition to the flat punch surface.

Fig. 5 is a section on the line **5—5** of Fig. 2, showing a section of the die, which illustrates the slug clearance therein and a two piece die construction.

Fig. 5A is a section on the line **5A—5A** of Fig. 2 illustrating the two piece die construction and the burr clearance relief for permitting the passage of a burr through the die when feeding the workpiece.

Fig. 6 is a section on the line **6—6** of Fig. 2, which illustrates the keyways in the holder and the slidable pin for keying the punch to the holder and retaining the punch on the guide.

Fig. 7A illustrates in section, the action of this punch on its initial nibbling stroke.

Fig. 7B indicates the slug which is removed on this stroke.

Fig. 7C is a view taken after several nibbling operations have taken place, indicating the pile-up of the slugs, and showing how they drop off, one by one, to pass by the keyed section of the punch.

Fig. 8 is a view illustrating the nibbling device and method of use which will permit cutting out a square blank and showing the nibbling punch about to punch out a circular segment after which it will turn a corner to start another leg of the square work-piece.

Fig. 9 is a view illustrating the punch around the corner and showing the square blank cut thereby.

Fig. 10 is a partial fragmentary view illustrating my device cutting an outside convex contour and starting said contour inside a sheet from a hole perforated therein.

Fig. 11 illustrates a similar view but with a punch-cutting section having a convex instead of a straight periphery so as to provide an essentially finished edge on the inside concave contour of this work-piece.

Fig. 12 illustrates how our punches and dies can be applied to a standard nibbling device, such as is widely used now throughout industry.

Fig. 13 indicates in side sectional elevation, a modified punch and its companion die in which the underhung key is eliminated.

Fig. 14 is a section taken as noted on the line **14—14** of Fig. 13 which illustrates how the keyway is formed inwardly from the half-round die section to engage a key formed in the round punch section.

Fig. 15 illustrates still another modification of our apparatus and methods in which special keying of the punch or die is eliminated by positioning the punch and its companion die aperture considerably off center, so that the workstop becomes the key and the punch and die function in a castering manner, which permits the method of working to a scribed line.

Fig. 16 is a section of the die and its anti-friction turntable in which it is mounted, taken as noted on the line **16—16** of Fig. 15.

Fig. 17 is a section, taken as noted on the line **17—17** of Fig. 15, and illustrating the shaped stripping guide for stripping light metal without drawing the metal up in the guide.

In the following description we discuss our novel half-round nibbling punch and die which can be

used for three different methods of nibbling. That is, nibbling to a contoured template, nibbling a work-piece mounted to turn on fixed centers, or slide parallel to a gauge stop, or to a scribed line formed on the work-piece itself.

In the illustrations we indicate four different methods of maintaining the shaped punch and die in alignment. We illustrate this novel nibbling punch and die keyed as is now the practice and by three new novel methods heretofore not utilized for this purpose. While we are concerned primarily with the novelty of our shaped nibbling punch and die and the methods of use, the combination with the three alternate methods shown for keying the punch to the die, along with the novel stripping means, are deemed of great importance in the satisfactory operations of our invention for all the required nibbling conditions.

The two existing methods of keying a punch in aligned relationship to a die which we illustrate herein, are only illustrated to indicate the adaptability of our shaped punch to the existing nibbling processes and apparatus now utilized by industry.

In Figs. 1 and 2 we illustrate the preferred form of our companion nibbling punch and die as used in the self-contained punching unit similar in function to that shown in Patent No. 1,955,866 assigned to our interests. When used in a nibbling machine, this unit would take the form illustrated herein, which is identical to that of holder 55—56 illustrated in Patent No. 2,364,011 also assigned to our interests. It will be obvious that the die 50 can be forced out of the bottom 22 of holder 20 and the punch assembly 30 can be lifted out of the top 21 of holder 20 to effect rapid replacement of punch and die, as is shown in Fig. 15 of the above patent.

Having thus established the background for this device, we will also refer to Fig. 3 and consider the features of the preferred version of our device representing the improvements over the prior art. Punch assembly 30 comprises the punch 32 having the threaded head extremity 33 and the punch-cutting extremity 35, which with co-operating die opening 51 of die 50 effects the removal of metal from work-piece 60. It will be noted that co-operating cutting surfaces 35 and 51 of punch 32 and die 50 respectively, are arcuate and effect a semi-circular cut. This shape and slight modifications of it is the main feature of our invention, as it provides the versatility and ease of manufacture of the round nibbling punch and die with the finished edge of the rectangular punch and die mentioned heretofore. This construction also reduces the stripping force required over the comparative round nibbling punch. In addition, this shape makes possible any contoured configuration of work-piece with a finished edge. The reasons for this versatility in nibbling and ease of manufacture as a result of this shaped construction, will be discussed hereinafter.

Extending downwardly from the punch cutting edge 35 is the work-piece stop 36. Extending under cutting edge 35 from this stop 36 is the unique key 37 which serves to key the shaped die assembly 50 to the punch assembly 30, as illustrated in Fig. 5. It will be obvious that the key 37 bears against the flat surface 52 of die 50, so that one arcuate cutting surface 35 of punch assembly 30 will always be in line with a complementary semi-circular die opening 51 of the die assembly 50, so that in effect they are keyed



together for relative aligned slidable movement, such as occurs when the punch assembly 30 moves toward die assembly 50 in the perforating operation while being held against relative angular, or rotative movements. As shown, punch 32 of assembly 30 is a relatively simple shape yet includes the key 37 formed out of the punch itself. Conversely, referring also to Figs. 5 and 5A, it is obvious that single piece die 50 would require complicated internal machining. To eliminate this expensive machining we utilize a simple round die 54 having a cutting edge 51 formed therein and an accurately made clearance counterbore 53. In this round die 54 and counterbore 53 we insert the semi-circular stepped plug 55 which is also a simple turned part. It will now be apparent that plug 55 can be soldered or brazed to die 54 as illustrated in these views or can be left as a loose piece in die 54 since the key 37 will always keep it in alignment and it will be supported by the bed of the press 26 for nibbling. It will be obvious that when punch 32 turns with a loose, freely movable plug 55 it need only turn the plug 55 in following a contour, rather than the whole die assembly 51 in the method described hereinafter. This loose construction also increases die life as the entire round cutting edge 51 can be utilized giving twice the life of a one-piece die. This construction also makes possible the perforating of a round starting hole using a round punch since only the plug and nibble punch must be removed to permit perforating a round hole from a round punch.

It is well to point out here that the above loose construction is only suited to nibbling the harder alloys since the burr clearance recess 56 of die assembly 51 is not then required as there is no tendency to drag a burr down into the die when nibbling hard materials. However, we have illustrated in these figures the construction suited to both soft and hard materials in which the die assembly 50 must be provided with the burr clearance recess 56 shown best in Figures 2 and 5A. In this construction stepped plug 55 is brazed or otherwise fastened to round die 54 and then the burr clearance 56 is ground in the die assembly 51 so that a downwardly formed burr in soft material will clear the die assembly 51 by means of recess 56 when the work-piece is fed toward work stop 36 of punch 32. This has proven valuable as otherwise the burr customarily found in perforating soft materials projects into the die assembly 50 and will not permit feeding the work-piece.

Since clearance must be provided in punching equal to roughly 10% of the metal thickness being punched, it is obvious that clearance can be machined more easily and economically in punch body 32 from the cutting edge 35 upwardly for the length of surface 34. Clearance is thus provided in the punch rather than in the die as is the customary practice. For punching various thicknesses, punches having various clearances would be employed rather than dies having variable clearances. This is advantageous also, since one die will outwear three or more punches and extra dies are not required, as is the standard practice.

Referring back to Fig. 1, it will be observed that the self-contained holder unit 20 is of a standard size and that in this instance some clearance is apparent between ram 25 and nut 41 of punch assembly 30, as the press stroke is greater than the perforating stroke of the unit. With a longer stroke press, this clearance would be substantial. As discussed previously, an extreme clear-

ance condition is not troublesome in single hole perforating work, but in nibbling it creates difficulty. In the nibbling operation the punch is operating continuously at from 165 to 800 perforations per minute, so that punches and dies dull rapidly and stripping becomes difficult within a short while. In our usual self-contained perforating unit, the stripping spring is always under preload, either because the stripping springs are contained under compression or are preloaded by compressing the spring from the action of the press ram prior to any contact of the punch with the work-piece. This creates difficulty however, if the punch sticks in the work-piece due to the poor stripping, as when it releases from the metal in a delayed action, it has considerable stored energy in the moving punch and the heavy spring. Since the spring itself is still under load at the movement of exit from the work-piece, this stored energy causes the punch to spring up in many cases out of its socket, and it must be replaced manually. Considering, that one nibbling punch may make one thousand or even more perforations on one piece whereas a perforating punch may make only a few perforations, it will be obvious that poor stripping due to dull punches and dies is a serious problem to consider in nibbling. Since in some machines, a preloaded spring can cause the punch to leap clear of the holder, so that it will not be aligned for the next stroke, this must be avoided in the continuous nibbling operation, as it would be dangerous for the ram to come down with the punch clear of the holder. Obviously, this is not critical in single stroke operation, as the punch can be replaced manually prior to the next perforating operation, but in nibbling the ram is operating continuously. To overcome this difficulty and prevent damage to key **37** of our punch **32**, we employ oppositely wound nested springs matched to the nibbling punch, so that the stripping loads required for nibbling any material thickness is balanced completely throughout the travel of the punch by the force of the nested compressed stripping springs **57** and **58** for a dull punch **32** and die **50**. In addition, the length of the heavier stripping spring **58** is such that it is under no load at the instant the punch **32** withdraws from the work-piece **60**. The resilient force required to overcome any minute variations in stripping pressure at zero or thin metal thicknesses is provided entirely by light spring **57**. It is now apparent that by utilizing only the light spring **57**, after the punch **32** withdraws from the metal, the dynamic force applied against punch **32** is much less, reducing or eliminating the tendency of the punch to bounce. To maintain this condition, we provide the adjustable nuts **40—41** for keeping the same relation between punch cutting surface **35** and stripper **42** and springs **57** and **58**. If required, spacers can be inserted between nuts **40** and **41** which will accommodate any variations between the length of the springs **57** and **58**, so that they can be properly matched to provide the desired stripping condition. The reduction or elimination of the bounce of punch **32** is extremely important in the device of Figs. 1 through 11 as if the operator is feeding when the punch **32** bounces, the key **37** may be damaged due to the blow thereon.

As shown in Figs. 2 and 6, another important feature of our invention resides in the method of keying the punch and die in relation to the holder. The usual practice for keying the punch is to key the guide to the holder by a key and the punch to the guide by means of a complementing guide shape which guides the shaped tip of the punch. In our present invention we utilize a key pin on the punch which extends through the guide to engage the key ways in the holder. This eliminates a build-up in tolerance as only the tolerance between one key and keyway is involved. With this construction the guide bore can be round rather than shaped to the punch end. We go a step farther in this novel keying device for our nibble punch and die and utilize an extensible key pin **46** which can be extended to engage the holder so as to guide the punch assembly **30** and die assembly **50** in aligned fixed relationship with keyways **27** or **28** in holder **20** or retracted so that only the punch assembly **30** and die assembly **50** are maintained in aligned relationship. The key pin **46** is extended in the event a gauge is used for nibbling to a straight line or for nibbling a circle from a fixed center normal to the tangent cut provided by the flat face **34** of punch **32**. To key the punch assembly **30** to the holder apparatus **20**, we provide a pin **46** with a resilient split **47** which can be extended out of bore **39** of punch **32** and slot **43** of stripper guide **42** by pushing on the pin **46** through bore **59** of guide **42**. With pin **46** extended it will be possible to engage either key way slot **27** or **28** of holder arm **21** to maintain punch assembly **30** and its keyed die **50** in selective fixed positions. Pin **46**, when retracted, is within slot **43** of guide **42** so that only punch **32**, guide **43** and die **50** are keyed for aligned movement together, but they are freely revolvable as an aligned unit in holder **20** to follow a template **70**. This is the method of nibbling shown in Fig. 1 and Figs. 7 through 11.

The freely revolvable punch and die provides an important advantage as it permits the nibbling of longer work-pieces than is possible on a conventional nibbler. For instance, when nibbling a hole inside a large rectangular sheet, the work-piece can be fed in any direction. This permits the use of a machine having a shorter throat depth since the shortest distance to the edge of the work-piece can always be within the throat area of the machine.

Having discussed how our punch assembly **30** and die **50** can rotate freely for following a template **70**, or be keyed to holder **20** for holding a line parallel to a gauge bar, or a circle from a pivotal center normal to the flat cutting face **34** of punch **32**, we will now refer to Figs. 1 and 7A through 7C to show the template operation in detail. It will be observed in Fig. 1 that template **70** is bearing against the step **44** in stripping guide **42** and that because of key **46** and guide **42**, punch **32** is cutting work-piece **60** on a line governed by the template **70**. It will be noted also that template **70** could also bear against the flat face **34** of punch **32**, but we have found its action is better if it bears against the step **44** of guide **42** to control the punch. We will now refer to Figs. 7A through 7C for the detailed operation.

It will be noted in Fig. 7A that work-piece **60** is resting against stop **36** of punch **32** and that template **70** is against stripping guide **42**. Fig. 7B illustrates that the punch **32** has descended, causing slug **61** to be sheared out of work-piece **60**. Fig. 7C illustrates the next nibbling stroke after which slug **61** drops out of die opening **51** and is deflected off the slanted face **38** of key **37** into die clearance space **53**. Once clear, it will go down the slug chute of the machine.

Fig. 8 illustrates nibbling around a square template 70 and shows the punch 32 about to cut the slug 66 out of work-piece 60, after which punch 32 will be manually turned in its own perforation, which it has just made and continue around the corner as is illustrated in Fig. 9. This is the outstanding feature of our invention in that it provides a finished edge 75 and yet can go around a square corner while operating, without damaging the punch or die. This finished edge means that our punch can be larger, operating at a much slower speed than is conventionally used in nibbling and yet cutting at a much greater rate. This in itself increases the life of punch and die tremendously and makes the nibbling operation much more attractive.

It will be obvious here that if the punch is keyed as previously described for fixed operation, work-piece 60 and template 70 can be turned equally as well as turning the punch assembly 30 and die 50 and without any other effect thereto. However, as described previously, a rotating punch permits nibbling larger work-pieces.

Fig. 10 illustrates starting a nibbling operation from inside a sheet by using a perforation 69 in work-piece 60 and removing punch assembly 30 and re-inserting through perforation 69. This is another outstanding feature of our invention since the stop 36 would preclude this rapidity of operation if the punch 32 was attached to the ram 25 as is done on conventional nibblers.

Fig. 11 illustrates nibbling an inside contour 73 in which punch 32 and die 50 would have a convex face 74 instead of the flat face 34. Convex surface 74 can also be used for outside contours but does not give quite as good a finished edge as flat face 34. Combinations of flats and radii on this finished cutting edge could provide almost any condition desired for a particular class of work-piece.

In Fig. 12 we illustrate the application of the half-round nibbling punch and die to a conventional nibbler. In this configuration we illustrate the old expedient of maintaining a shaped punch and die in aligned relationship by means of a rigid attachment after alignment. Keys are also sometimes employed for this purpose in conventional machines, or in self-contained holders such as in Fig. 1. We show a nibbling punch 82 having a half-round punch section 84 terminating in a cutting edge 85 and work-stop 86 and a companion die 80. Punch 82 is rigidly attached to the keyed ram 76 of a conventional nibbler frame 83, so that it cannot revolve. Die 80 is rigidly attached to bed 87 of nibbler frame 83 so that it is maintained in aligned relationship with punch 82. In this configuration only the work stop 86 is required as both the punch 82 and die 80 are maintained in alignment. A positive stripper 88 mounted on nibbler frame 83 has an opening 89 through which punch 82 projects. In this arrangement the template 70 and work-piece 60, of our previous illustrations, is caused to move in the plane of the table to change the contour rather than turning the punch as previously discussed. It will be obvious to one skilled in the art that this old expedient of keying a shaped punch and die can be equally applied to the holder 20 of Fig. 1 and that with the extending key 37 removed, the configuration would be identical to Fig. 12 but in a self-contained unit.

Referring now to Figs. 13 and 14 we show our second alternate novel keying means. In this arrangement punching assembly 90 is identical to punch assembly 30 of Fig. 1, except that punch 92 has a key 97 formed therein which is engaged by keyway 102 formed within the half round die section 101 of die 100. It will be noted that the key and keyway are formed inwardly because an outwardly extending key on the punch 92, projecting above the die 100, would prevent the action of Figs. 8 and 9. The construction illustrated here is more satisfactory when nibbling heavier stock and following a template as there is no key obstruction under the cutting edge 95 of punch 92. However, it will be obvious to one skilled in the art that die section 101 with its key 102 is much more difficult to fabricate than the die of Fig. 1.

Referring now to Figs. 15, 16 and 17, we illustrate our arrangement which provides a novel and more simple key means which makes possible a method of following a scribed line with our shaped nibbling punch, so that a template or key is unnecessary.

We illustrate a self-contained holder 120 which is enlarged in plan form so that it will accommodate the anti-friction turntables 145 and 155 having needle bearings 146 and 156 respectively, to assure easy turning of the turntables. Turntables 145 and 155 rotate easily about axis 160. Removably keyed by key 147 within turntable 145 at a point remote from the axis 160, is a punch assembly 130 identical in configuration to punch assembly 30 of Fig. 1, but embodying a different punch 132 having a downwardly extending stop 136 engaging a die 150. As is illustrated in Fig. 17, stop 136 is merely the partial section of the half-round end 134 of the punch 132 remaining when cutting edge 135 is formed. This extends downwardly into die 150 as is illustrated in Fig. 16 and serves to key the punch 132 to the die 150 which is removably keyed by key 157 to turntable 155. Since the keyed punch assembly 130 is to all intents and purposes a part of turntable 145 with respect to movement about axis 160 and keyed die 150 is a part of turntable 155, stop 136 acts within die 150 as a remote key so that they must move in unison about axis 160. Obviously guide 142 and turntable 145 could be made in one piece as could be die 150 and turntable 155 without affecting the operation. Because of this remote location of the axis of punching from the axis of rotation 160, the feeding of a work-piece against stop 136 causes punch 132 and die 150 to caster in unison about axis 160, thus assuring the nibbling punch following the direction of feed by the operator. In this arrangement the nibbling can be made to follow a scribed line. Because no template is required in this configuration of our device, the guide 142 has a shaped end 143 conforming to the shape 134 of punch 132. This assures stripping light gauge material.

Having thus described our invention, we claim:

1. In a nibbling apparatus, a freely rotatable die having cutting edges, and a punch having a working end which in cross section is of generally circular segmental shape and which has meeting circumferential and chordal cutting edges, said die having complementary cutting edges, said punch being extended axially at one side beyond said working end to define a work stop section and a key, said key cooperating with said die to permit relative axial movement of said punch with respect to said die while preventing relative angular movement between said punch and die.

2. In nibbling apparatus, a freely rotatable die having cutting edges, one of which is at the

end of a flat face, and a punch having a working end which in cross section is of generally circular segmental shape, the meeting circumferential and chordal edges of one side of said end providing cutting edges which are complementary to and which cooperate with the cutting edges of said die, and said punch being extended axially at one side to define a work stop section and a key, said key having a flat face which engages said first mentioned flat face to permit relative axial movement of said punch with respect to said die while preventing relative angular movement between said punch and die.

3. In nibbling apparatus, a freely rotatable die having cutting edges, and a punch having a working end which in cross section is of generally circular segmental shape, the meeting circumferential and chlordal edges at one side of said end providing cutting edges which cooperate with the cutting edges of said die, said punch being extended axially at one side to define a work stop of reduced cross section and a key, said key having a portion which extends laterally with respect to said work stop section and which cooperates with said die to permit relative axial movement of said punch with said die while preventing relative angular movement between said punch and die.

4. In nibbling apparatus, a freely rotatable die, a freely rotatable guide sleeve, a punch reciprocable in said sleeve, and means keying said punch to said sleeve so that relative angular movement between them is prevented, said punch and die having cooperating cutting edges and said punch having an extension for keying said die to it so that the punch, sleeve and die may turn only as a unit and so that said punch may reciprocate with respect to the die, the lower end of said sleeve being formed to provide diametrically opposed shoulders for engaging a template to control the turning movements of said punch and die so that in cutting a workpiece a finished edge will be produced.

5. In combination, a nibbling punch and die, said punch having a cutting shank portion which is generally semi-cylindrical in shape and which has a cutting end face intersecting said shank portion and defining with said shank portion a circumferential and a generally chordal cutting edge, said punch having an extension axially beyond said end face which has a side face that is a continuation of said chordal cutting edge, said die being generally cylindrical in shape, and a plug positioned in and fitting said die, said plug being generally semi-cylindrical in shape and having a generally chordal side complementary in shape to the said side face of said punch extension.

6. A nibbling punch having a working portion which has an outside surface that is arcuate in profile, an inside surface which is connected at opposite lateral ends thereof to said arcuate surface, an end face intersecting said inside and said outside surfaces and defining with said surfaces cutting edges, and an extension projecting axially beyond said end face, said extension having one side surface thereof which is a continuation of said inside surface and being connected by a narrow neck portion with said end face, and terminating in an end portion which projects laterally at both sides of the axis of said punch, said neck portion having an area less than half the area of said end face.

7. A nibbling punch having a working portion which has an outside surface that is arcuate in profile, an inside surface which is plane and which extends between the ends of said outside surface and in a direction axial of said outside surface, an end face intersecting said inside and said outside surfaces and defining with said surfaces cutting edges, and an extension projecting axially beyond said end face, said extension having one side surface which is plane and which lies in the same plane as said inside surface, and said extension being connected by a narrow neck portion with said end face and terminating in an end portion which projects laterally at both sides of the axis of said punch, said neck portion having an area less than half the area of said end face.

8. In nibbling apparatus, a rotatably mounted punch having an outside surface that is arcuate in profile, an inside surface which is connected at opposite ends to said arcuate surface, an end face intersecting said inside and said outside surfaces and defining with said surfaces cutting edges, and an extension projecting axially beyond said end face, said extension being of less area than said end face and having one side surface thereof which is a continuation of said inside surface, and a die mounted to be freely rotatable about an axis extending in the same direction as the axis of rotation of said punch, said die having a cutting edge complementary to the cutting edge of said punch, one part of the cutting edge of said die being engaged by the said one side surface of said extension to key the punch and die to rotate together.

9. In nibbling apparatus, a rotatable punch having an outside surface that is arcuate in profile, an inside surface which is plane and which extends between the ends of said outside surface, an end face intersecting said inside and said outside surfaces and defining with said surfaces cutting edges, and an extension projecting axially beyond said one face, said extension being of less area than said end face and having one side surface which is plane and which is a continuation of said inside surface, and a die mounted to be freely rotatable about an axis extending in the same direction as the axis of rotation of said punch, said die having a bore which is semi-cylindrical in cross-section and having a cutting edge complementary to the cutting edge of said punch, said bore having one bounding face which is plane and which is engaged by the plane face of said extension to key said punch and die together.

10. In combination, a nibbling punch and die, said punch being reciprocable axially and having a cutting shank portion which is generally semi-cylindrical in shape and which has a cutting end face intersecting said shank portion and defining with said shank portion an arcuate and a chordal cutting edge, said punch having an extension projecting axially beyond said end face which has a plane side face coplanar with said chordal cutting edge and extending in the direction of the punch axis, said extension being connected by a narrow neck portion with said end face and terminating in an end portion which projects laterally at both sides of the axis of said punch, said neck portion being of less than half the area of said end face, said die being freely rotatable about an axis coaxial with said punch and having cutting edges complementary to those of said punch and having a plane chordal surface against which the plane side face of said extension bears as the punch reciprocates.

11. In combination, a support, a sleeve slidable axially in said support, a nibbling punch and die, said punch being reciprocable axially in said sleeve, means for selectively keying said punch to said sleeve or said punch and sleeve to said support, said punch having a shank portion and a cutting end face which intersects said shank portion and which defines with said shank portion the cutting edges of said punch, said punch having an extension axially beyond said end face which has an inside plane face that extends in the direction of the axis of the punch, said extension being connected by a narrow neck portion with said end face and terminating in an end portion which projects laterally at both sides of the axis of said punch, said neck portion being of less than half the area of said end face, said die being freely rotatable and having cutting edges complementary to those of said punch and having a plane chordal surface against which the inside plane surface of said extension bears as said punch reciprocates.

12. In combination, a nibbling punch and die, said punch having a shank portion and a cutting face which intersects said shank portion and which defines with said shank portion the cutting edges of said punch, said punch having an extension projecting axially beyond said end face which has an inside plane surface that extends in the direction of the axis of the punch, said extension being connected by a narrow neck portion with said end face and terminating in an end portion which projects laterally at both sides of the axis of said punch, said neck portion being of less than half the area of said end face, said die being freely rotatable and having cutting edges complementary to those of said punch and having a plane chordal surface against which the inside plane surface of said extension bears as said punch reciprocates.



13. A nibbling punch having a shank portion and a cutting face which intersects said shank portion and which defines with said shank portion the cutting edges of said punch, said punch having an extension projecting axially beyond said end face which has an inside plane surface that extends in the direction of the axis of the punch, said extension being connected by a narrow neck portion with said end face and terminating in an end portion which projects laterally at both sides of the axis of said punch, and said neck portion having an area less than half that of said end face.

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