

May 22, 1951

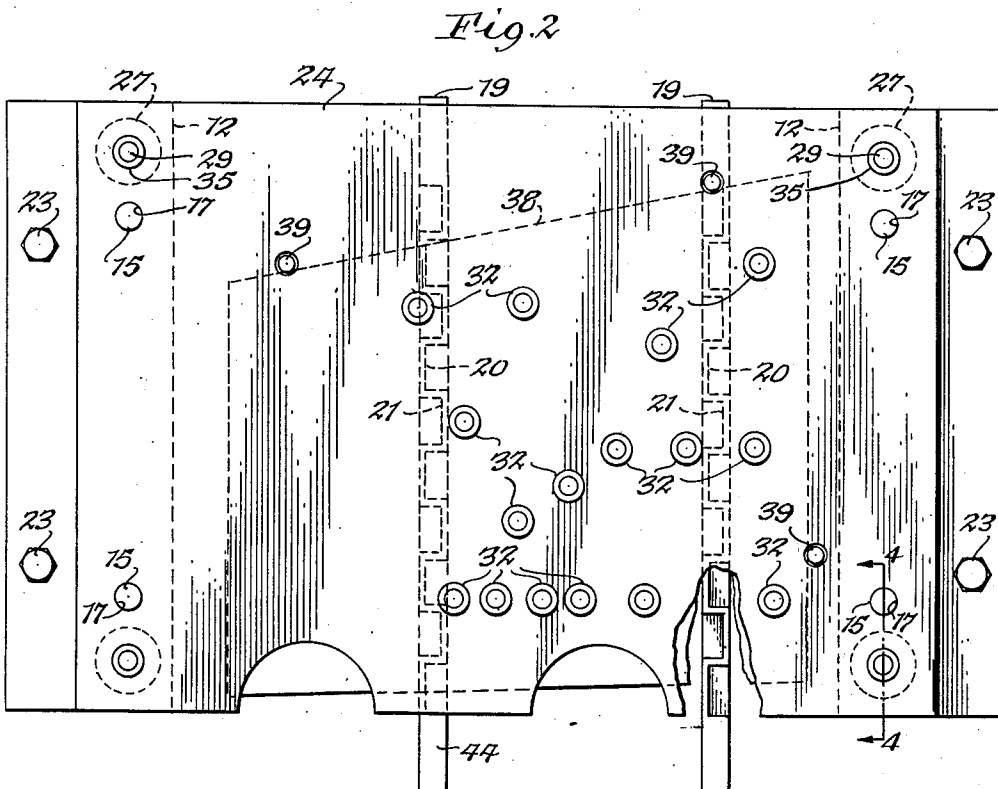
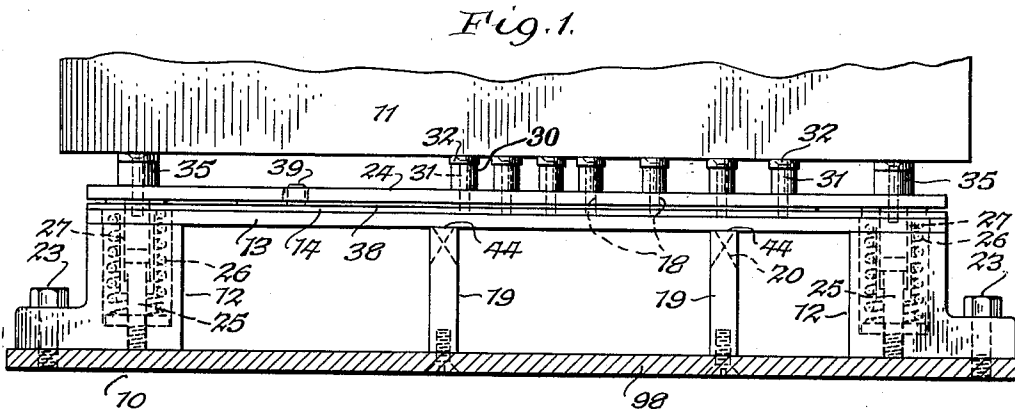
G. F. WALES

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

Filed March 19, 1943

5 Sheets-Sheet 1



George F. Wales INVENTOR.
BY Parker, Prochnow & Farmer,
ATTORNEYS

May 22, 1951

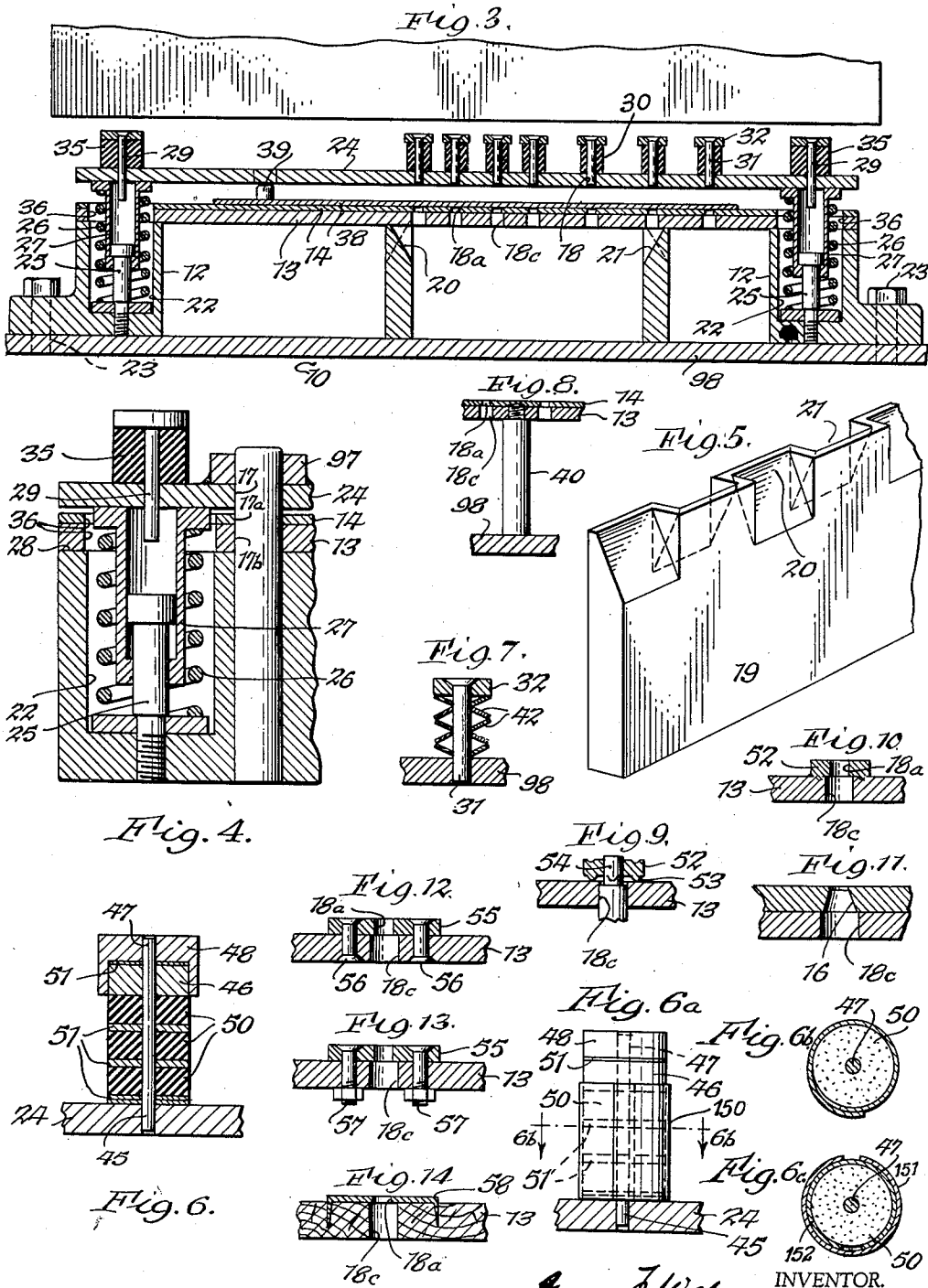
G. F. WALES

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

Filed March 19, 1943

5 Sheets-Sheet 2



George F. Wales
BY *Carver, Prochnow & Farmer*
ATTORNEYS

May 22, 1951

G. F. WALES

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

Filed March 19, 1943

5 Sheets-Sheet 3

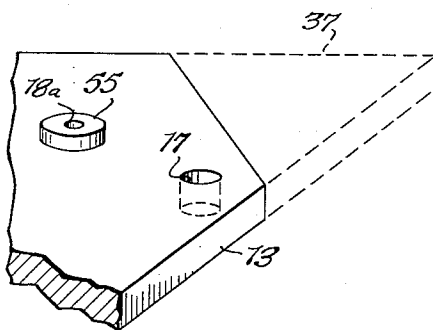
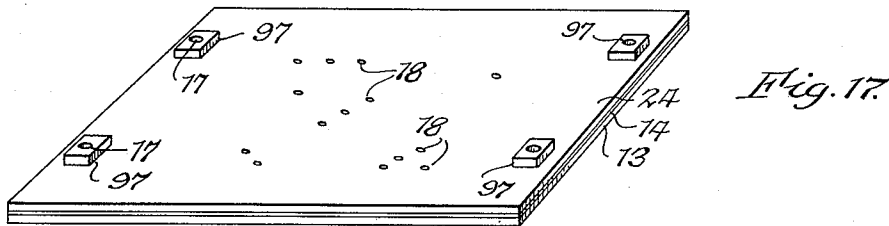
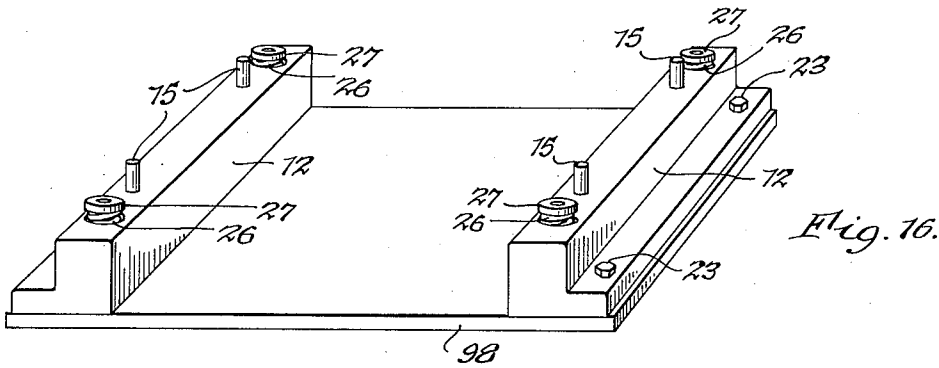


Fig. 18.

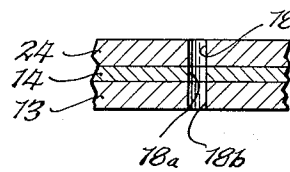
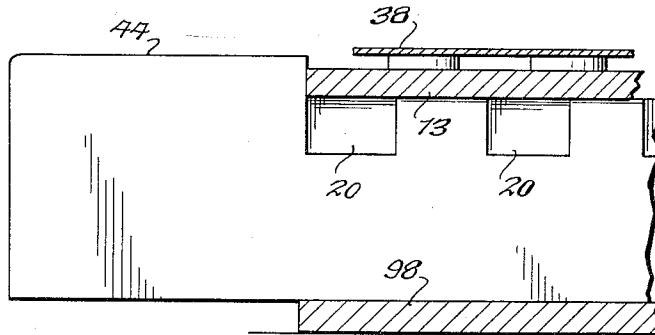


Fig. 15.



George F. Wales, INVENTOR

Parker, Pinchman & Farmer
ATTORNEYS

May 22, 1951

G. F. WALES

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

Filed March 19, 1943

5 Sheets-Sheet 4

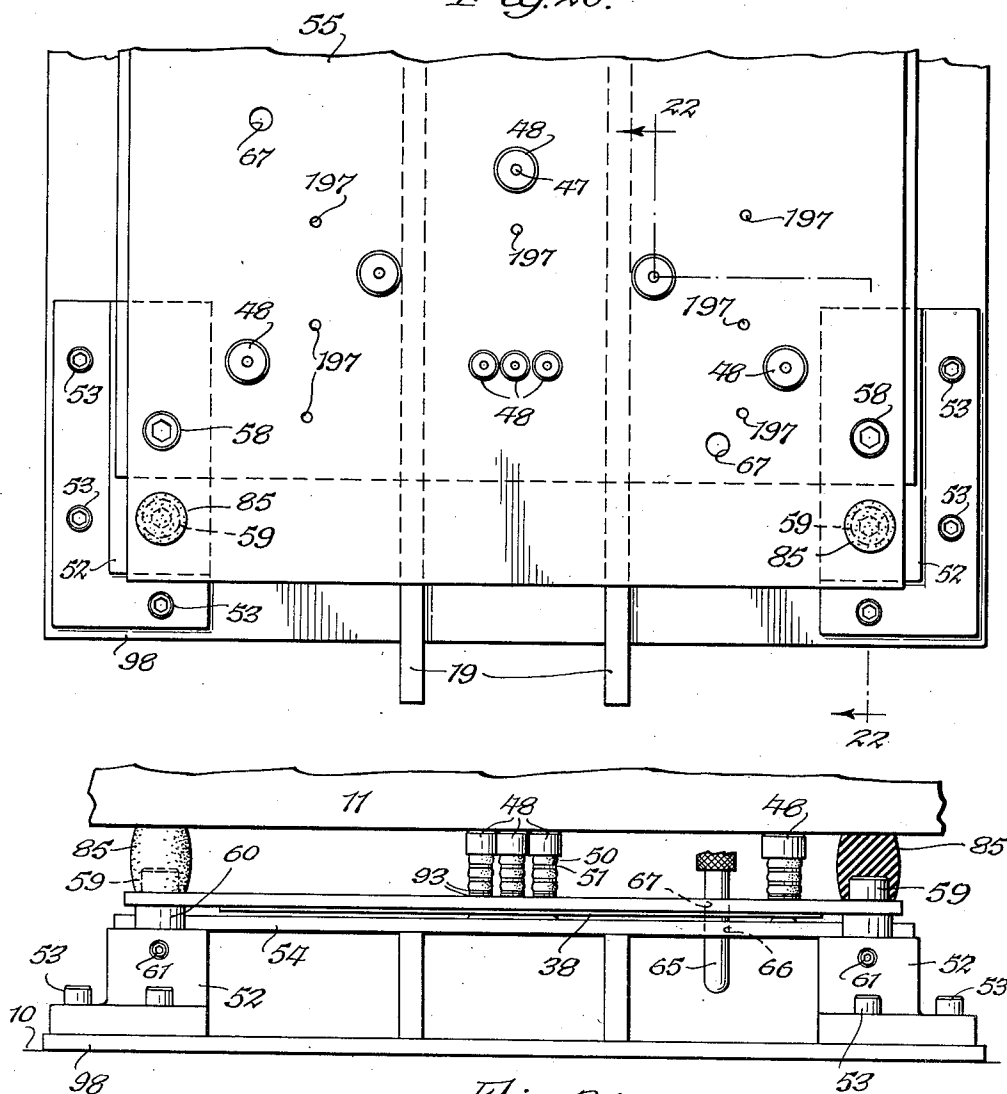


Fig. 27.

George F. Wales, INVENTOR

Parker, Prochno & Farmer,
ATTORNEYS

May 22, 1951

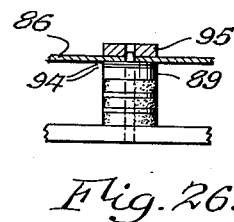
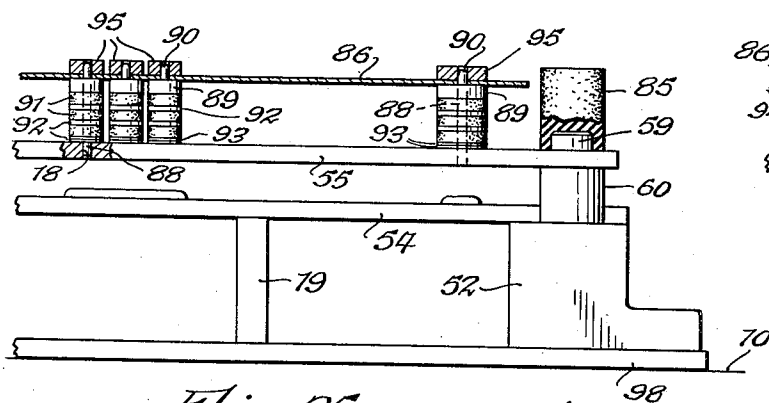
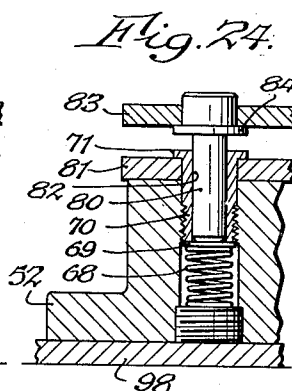
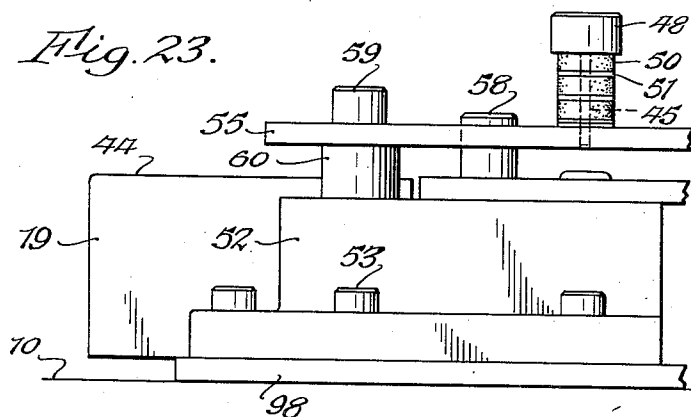
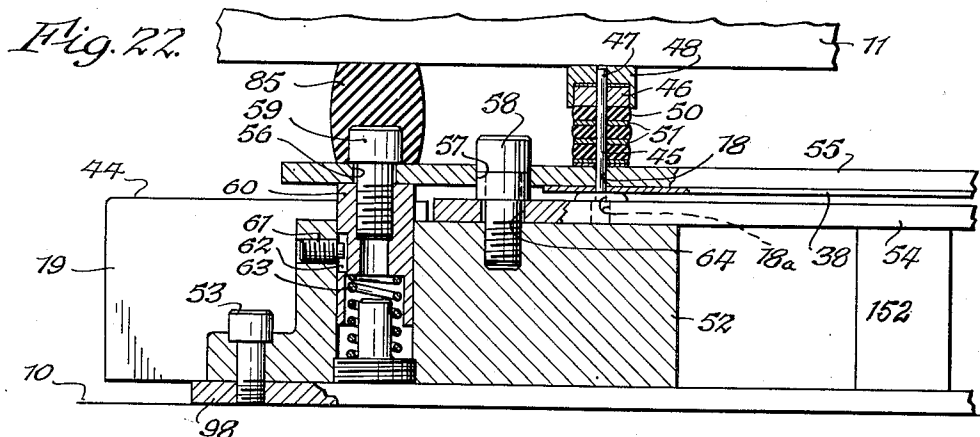
G. F. WALES

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

Filed March 19, 1943

5 Sheets-Sheet 5



George F. Wales, INVENTOR

Parker, Prochman & Thomas
BY
ATTORNEYS

UNITED STATES PATENT OFFICE

2,553,615

METHOD AND APPARATUS FOR PERFORATING SHEET MATERIAL

George F. Wales, Kenmore, N. Y.

Application March 19, 1943, Serial No. 479,749

7 Claims. (Cl. 164—90)

1

This invention relates to an apparatus for punching holes at specified locations throughout the areas of sheets of material such as sheet metal, and is particularly adapted for punching the numerous rivet holes required in the thin metal panels or sheets which are used in aircraft construction to form the outer surfaces of wings, fuselages, and the like, but the invention may be applied to other uses where relatively large numbers of holes are required in panels or sheets of materials.

The main object of my invention is to provide an apparatus and method for punching holes in sheet materials, which is simple in construction, economical to manufacture and use, and efficient in its purpose and which can be made to operate on work sheets of any desired size.

Another object is to provide such an apparatus for the successive accommodation of any number of pairs of punch and die carrier plates, thus requiring the preparation only of new plates when new patterns of holes are to be punched.

Another object is to provide an apparatus of this kind in which the punch plate is movable bodily to and from the work and in which the punches mounted thereon are movable relatively to the punch plate for perforating the work.

A further object is to provide an apparatus of this nature in which so-called non-critical, or non-metallic materials may be used for the majority of parts, especially the punch carrier plates, the base plates and the support members, and portions of the die carrier plates.

Another object is to provide inexpensive individual die elements such as washers which may be spot-welded or otherwise attached to die carrier plates or small machined die elements which may be more easily attached than has heretofore been possible.

Another object is to provide a new type of punch and stripper element which may rest freely on a movable punch carrier plate.

Another object is to provide an apparatus and method for punching a multiplicity of holes in which the punch carrier plate is free from unsupported pressure of punching and stripping the work from the punch, and all such pressure is transmitted through the work, onto the die plate, thence through the supports to the bed of the press.

Another object is to provide a die plate for an apparatus of this nature which is made of an air-hardening metal and hardened around the die openings.

A further object is to provide an apparatus of

2

this description in which the punches may be instantly serviced by lifting them freely out of their guideways in the punch carrier plates to prevent loss of time when a punch fails.

These and other objects and the several novel features of this invention are hereinafter more fully described and claimed and the preferred form of construction by which these objects are obtained, is shown in the accompanying drawings in which:

Fig. 1 is a front elevation of one form of perforating apparatus embodying my invention, showing the same in a press with the reciprocating ram in its lower-most position in which the punches are driven through the work.

Fig. 2 is a top plan view of the apparatus shown in Fig. 1.

Fig. 3 is a sectional elevation of the apparatus shown in Figs. 1 and 2 with the punch plate elevated and the ram of the press in a partially elevated position.

Fig. 4 is a fragmentary vertical section, on an enlarged scale, of the guide post and punch plate lifting device with the plate in a down or operative position and showing a means for increasing the guide post bearing in said plate.

Fig. 5 is a perspective view of one of the intermediate auxiliary support bars shown in Figs. 1, 2 and 3.

Fig. 6 is an enlarged section of a punch and stripper combination having provision for maintaining the overall length of the same constant to compensate for grinding of the punch.

Fig. 6a is an elevation of a punch unit of modified construction.

Fig. 6b is a section thereof, on line 6b—6b, Fig. 6a.

Fig. 6c is a section of a punch unit of another modified construction.

Fig. 7 is a fragmentary sectional elevation of a similar punch with stripping means of alternative construction comprising trunco-conical spring washers arranged in pairs.

Fig. 8 is a fragmentary sectional elevation of a die carrier plate support of modified construction having the form of a pin or post.

Fig. 9 is a fragmentary cross section showing the die supporting plate and an individual die blank ready to be projection-welded to said plate.

Fig. 10 is a fragmentary cross section showing the same plate and die blank as in Fig. 9 after having been welded.

Fig. 11 is a fragmentary cross section showing the manner of relieving the die hole to provide rapid slug clearance.

Fig. 12 is a fragmentary cross section of a die blank riveted to the die plate.

Fig. 13 is a fragmentary cross section of an alternate means of attaching the die blank to the die plate by means of screws or bolts.

Fig. 14 is a fragmentary cross section showing a thin die blank stapled to a non-metallic die plate.

Fig. 15 shows a fragmentary elevation, partly in section, of an intermediate die plate supporting bar having a forwardly projecting feeding ledge flush with the top of the die plate on which an edge of the work may be placed before inserting it into the apparatus.

Fig. 16 is a perspective view showing the two main supporting members bolted to a base plate preparatory to having the die support plate and punch plate placed over the guide posts.

Fig. 17 is a perspective view of the punch plate, die plate, and die-supporting plate, with their guide post apertures in coaxial alignment with one another, and holes drilled through all of them in accordance with the pattern of the holes desired in the work.

Fig. 18 is a fragmentary cross section thereof, on an enlarged scale, showing the holes drilled in the three plates shown in Fig. 17.

Fig. 19 is a fragmentary perspective corner view of a die-supporting plate to which a die blank has been attached and also showing how the corners of the die supporting plate may be removed to clear the punch plate spring lifting mechanism.

Fig. 20 is a plan view of a modified construction for mounting the punch carrier and die plates, comprising separate supporting members each having single guide and punch plate lifter means.

Fig. 21 is a front elevation thereof.

Fig. 22 is a fragmentary section thereof, on a larger scale taken on line 22—22, Fig. 20.

Fig. 23 is a fragmentary side elevation of the apparatus shown in Figs. 20 to 22.

Fig. 24 is a fragmentary sectional elevation of a combination guide and lifter device of modified construction.

Fig. 25 is a fragmentary elevation, partly in section of an apparatus such as shown in Figs. 20 to 23 having a template, or finished work-piece arranged between the top of the punch head to act as an additional steadying device for the punches.

Fig. 26 is a fragmentary elevation, partly in section of a punch unit of modified construction.

It is a feature of this invention that the entire apparatus may be set up or assembled outside of the press. Thus any number of these devices may be made ready in anticipation of usage. It is desirable that the shut height of all of these devices be standard so that by merely sliding them in and out of the press they are ready to operate.

A feature of this apparatus which makes this improvement possible is that the punches are in no way connected with the ram of the press. This device is self-contained with the punches, guides, strippers and dies assembled on the holder and regardless of the press in which it may be operated, requires no attachment to the press other than resting on the bed or bolster and having some means for preventing its shifting.

10 represents the stationary bed or bolster of a press and 11 the reciprocating ram which is movable vertically toward and from said bed.

In the space between this bed and the ram of

the press, the perforating apparatus embodying my improvements is arranged and adapted to be operated by the movement of the ram toward the bed for the purpose of punching holes in the material or work-piece 33 fed into the perforating mechanism or apparatus.

The particular embodiment of my invention which is shown in Figs. 1 to 19 of the drawings is constructed as follows: The main frame or carrier of this punching apparatus may be of any suitable construction so that the working parts mounted thereon may be supported on the stationary bed 10 of the press below the vertically movable ram or slide 11 of the latter and capable of being shifted freely over any desired part of the bed and still be underneath the ram for the purpose of operating the working parts of the punching apparatus to produce perforations in the work sheet 33 which may be of any suitable material, e. g., sheet metal.

Although the frame of the perforating apparatus may be variously constructed, the same preferably comprises a lower base plate 98 which is adapted to rest on the bed of the press. This base plate may be large enough to accommodate many sizes of apparatus or may be made to the exact size required for a particular setup. At the time this application is being filed, metals are called "critical materials" and it has been my object to design my apparatus so that "non-critical materials" may be used wherever possible. There are a number of ply-wood, pressed-wood, lignon and other compositions in this category, and I prefer to use them wherever possible. Base plate 98 may be made of any of the non-critical materials.

The numeral 12 represents upright supports which may be made of non-critical materials, and which are mounted upon base plate 98 and attached thereto by means of cap screws 23. This apparatus may be used without base plate 98 by attaching supports 12 direct to the bolster or bed 10 of the press if desired, although when assembling my apparatus outside of the press, it is desirable to use plate 98 to render the apparatus more rigid and more easily handled.

Before supports 12 can be tightened or bolted in place, however, it is necessary that the plates carrying the punch and die working parts be located upon them properly, for example, by providing the supports with upright guide posts 15 which pass through accurately located holes in these plates.

Numeral 24 represents a punch carrier plate, 14 a die plate, and 13 a die support plate as shown in Figs. 1, 3, 4, and 17. These three plates cooperate with one another to control the elements for punching holes in work-pieces 33 placed between the punch carrier plate 24 and die plate 14. It is necessary that the holes 18 in punch carrier plate for carrying and guiding the punch units, which in the construction illustrated, comprise a punch body 31 and punch head 32, be formed perpendicular to the top face of punch carrier plate 24. As die holes 18a in plate 14 cooperate with the punches and act as the die element, they must be accurately located coaxial with the holes 18 in plate 24. This accuracy may be obtained by drilling the three plates together or as otherwise described later.

Before drilling the plates together as shown in Fig. 17, however, it is desirable to prepare the plates for the guide posts 15 by boring coaxial guide post holes 17, 17a, and 17b, Figs. 2 and 4. In the organization as shown in Fig. 2, the sup-

5

port members 12 are long and each carries two guide posts 15 spaced apart standard distances, although they may carry as many guide posts as are necessary, first to locate the plates 13 and 14 on the support members 12 properly, and then to guide the punch carrier plate 24 as it moves up and down in the operation so that the punches are coaxial with the die openings.

Guide post holes 17, 17a and 17b may be drilled in a drill jig arrangement for the purpose, thus assuring accurate spacing between the holes and accurate boring of same.

To provide a better guide at times for the punch carrier plate, a block 97 may be attached to it at each guide post hole, or in the case, plate 24 is of non-metallic material, strips may be bolted thereon to accomplish the same purpose.

Referring to Fig. 17, guide post holes 17 are formed in alignment through the three plates 13, 14 and 24, and while all plates of a set have these holes spaced apart to agree with the spacings of the guide posts 15 in the supports 12, these spacings may vary in other plates and supports to suit different sizes of work.

After the guide post holes 17, 17a and 17b have been formed, the plates are held with these holes in alignment while holes 18, 18a and 18b are formed wherever a hole is to be punched in the work-piece. These holes 18, 18a and 18b are first drilled and reamed or otherwise finished to the diameter required in the punch carrier plate 24 to properly guide the punch and hold it in a vertical position.

The plates 13, 14 and 24 are then separated and each hole 18a of the die plate 14 is enlarged in diameter to provide the proper amount of clearance with the punch, which clearance should be from 5% to 25% of the thickness of the material to be punched. For example, if the punch 31 has a diameter of .100 inch and the thickness of aluminum sheet to be punched .125 inch, a clearance of .012 inch would work well. Therefore, the die holes 18a would be reformed to a diameter of .112 inch. As shown in Fig. 11, these die holes may be relieved as at 16 from the underside to allow slugs to clear more readily. Holes 18b in the die carrier plate 13 are then enlarged, as shown at 18c, Fig. 11.

A feature of my invention is that it makes possible the use of low carbon steel plates for supporting plate 13, the die plate 14 being made of 40% or more carbon steel, either straight or containing alloys such as chrome, molybdenum, vanadium or other hardening or homogenizing elements. Some alloys of this nature may be hardened by applying heat about the drilled hole with a torch or by electrical induction methods, until the metal reaches a critical temperature, and then quickly quenching with water. Before hardening around each hole, plate 14 is in a soft and machineable state so that it may readily be drilled and relieved as has been explained.

Die plate 14 may also be made of an air-hardening steel which may be hardened locally around each die hole by merely heating with a flame or electrical induction methods.

In many instances, it may be desirable to weld or otherwise attach die plate 14 to die carrier plate 13 and this is especially true where the holes to be punched are all near the center of the apparatus. In such case, guide post holes 17a need not be formed in die plate 14 as the plate need not extend into that area.

With the plates thus prepared, they are ready

6

to be mounted on the support members of the frame when required.

The support members 12 are provided with means for elevating punch carrier plate 24 above the die plate 14 to provide a space for inserting and removing the work-piece 38 as shown in Fig. 3. This elevating means may consist of any mechanism which will cause plate 24 to rise in an even manner after the perforating operation has been performed, as shown in Fig. 1, and which will yield to the downward pressure of the press ram on the punches so that plate 24 will bear on its underside against the work before the punches penetrate same. In order to accomplish this, I show by way of example in Fig. 4, a spring elevating means located wherever necessary to properly lift the punch carrier plate. These elevating means may be located in any desired relation to the support members 12, and in the construction shown, they are arranged mainly in holes or depressions 22 formed in the supporting members. Each elevating device shown in Figs. 3 and 4 includes a bolt 25 in the hole secured to the supporting member at the bottom of the hole, a sleeve 27 slidable relatively to the bolt and having an inwardly extending flange at its lower end which engages the head of the bolt 25 to limit the upward movement of the sleeve relatively to the bolt. A coil spring 26 extends about the bolt 25 and sleeve 27 and urges the sleeve upwardly by bearing against an outwardly extending flange on the upper end of the sleeve. The punch carrier plate 24 rests on the upper ends of sleeves 27 of the elevating devices.

The elevating devices are accurately made so that all of these devices used on a frame will rise to the same level and so that all will exert the same amount of upward pressure, to provide uniform forces on different parts of the plate 24, to cause the plate to rise evenly without any tendency to bind on the guide posts. In their extended positions, the tops of all of these devices are on the same plane so that when plate 24 is placed upon them, it is parallel with the top faces 28 of support members 12 and with plate 13 which rests constantly on said faces.

In order to avoid as much as possible any deflection or sagging of the middle portion of the plate 24, the springs 26 are not materially stronger than is required to elevate the plate 24, thus offering little resistance to the downward pressure of the plate when the ram on the way down engages the tops of the punches. A precaution to prevent this deflection may comprise placing on the top of plate 24 and directly over each elevating means, an auxiliary depressor of heavier construction than the punch units, see Figs. 1, 2, 3 and 4, as having guide pins or punches 29 and rubber sleeves 35 similar to the resilient stripping sleeves 30 of the punches 31. The stem 29 of the auxiliary depressor 35 extends slidably through a hole in the punch carrier plate 24, which may be over the hole 22 in the supporting member 12.

Thus when the ram of the press descends, it engages these auxiliary depressors, and since the rubber sleeves 35 are heavier and offer more resistance to the ram than the rubber sleeves 30 of the punches, greater pressure is exerted by the ram on these auxiliary depressors than on the punches, so that the main pressure for lowering the punch carrier plate is exerted on these depressors. Thus by reducing the pressure on the punches in the middle portion of the plate 24 during the lowering thereof, the tendency of the

7

plate 24 to sag or deflect is greatly reduced and the plate 24 is caused to lower evenly regardless of how many punch elements are on the plate or where they are located.

After preparing the die plate 13 and the die supporting plate 14, as explained above, it is necessary to cut clearance holes 36 in them to permit the die supporting plate 13 to engage and rest on the top of support members 12, and to permit the elevating means to extend through these clearance holes to engage the punch carrier plate 24.

Having thus explained the structural features of this apparatus, it is now apparent that the support members 12 may be used to support any number of plates with various patterns of holes 18 formed in them and that it is only necessary to prepare new plates 13, 14 and 24 whenever a new work-piece pattern is to be perforated, or to form another series of holes for another work-piece pattern in the same plates.

To place the apparatus in condition to operate, a suitable base plate 98 is placed on a work bench and support members 12 placed upon the base plate. Die carrier plates 13 and die plates 14 are then placed on support members 12, their guide post holes 17 engaging guide posts 15. The clearance holes 36 prevent the lifter springs 26 from acting on the plates 13 and 14, or if desired, in place of these clearance holes, the corners 37 of the die plate and die supporting plate may be removed.

After die support plate 13 is in position on the support members 12, with guide posts 15 in their cooperating guide openings, the support members 12 are bolted to the base plate by means of bolts 23. If plate 13 were now removed, the supports and base plate would appear as shown in Fig. 16.

Additional supports, such as bar supports 19, may be used under intermediate portions of the die support plate wherever required, or support posts or pins 40, Fig. 8, may be used for this purpose if more convenient. These supporting posts may have their upper ends screwed into threaded holes in the die supporting plate 13, or may be held in their operative positions in any other desired manner.

These bar supports 19, which are described more in detail in my copending Patent No. 2,380,485 are cut away by downwardly tapering slots 20 and 21 on opposite sides and alternating to provide an effective support for plate 13 of the full width of the bar as shown in Fig. 5. Feeding ledges 44, as shown in Figs. 2 and 15 may be provided on these bars level with the top of the die plate 14 but extending forward, for the purpose of providing a ledge upon which an edge of the work may be placed before being inserted into the apparatus.

After the die supporting plate 13 and the die plate 14 are in position, as explained above, punch carrier plate 24 is placed over the guide posts and comes to rest on the tops of the elevating spring sleeves 27, as shown in Fig. 3.

Punch units including the proper size of punch and stripper are then assembled to punch carrier plate, as shown in Fig. 3, with the punches being guided in the previously described openings 18.

The punch units shown in Figs. 1 and 3 comprise a punch body 31 and a head 32 joined tightly together. Surrounding each punch is a compressible stripping member 30 which may, for example, be in the form of a rubber sleeve, to withdraw the punch from the work after it has

8

penetrated same. This punch and stripper arrangement may take any form, the requirements being that the punch must travel straight up and down in its guide hole in the plate 24 and not be subjected to bending strains by the stripping member, which must normally support the punch so that the lower end thereof is above the lower face of the punch carrier plate 24.

Another requirement is that the punch body be as short as possible, since the shorter it is, the more strength it has to resist bending stresses. In making the punch short, the device for withdrawing the punch from the work must accordingly be confined in a small space. This means may take any form, but preferably has a provision for maintaining the overall length of the punch units substantially constant even if the punch body is shortened by repeated sharpenings. The distance from the bottom of the ram when in its lowest position to the top face of punch carrier plate 24 should always remain constant, so that the extent to which the stripping means is compressed does not exceed the compressible limit of the stripping element.

I show a punch unit including a punch, and a stripping and adjusting device of this nature in Figs. 6, 22 and 23. As shown in Fig. 6, the punch consists of punch body 45 extending through punch head 46 to form a projection 47 extending above the head 46, the punch being brazed or otherwise attached permanently to said head. On top of said head, I place a cap 48 having a hole in the center to allow projection 47 to extend inside of the cap. This cap may be merely placed in position or attached by any means.

For the purpose of stripping and supporting the punch body, I show in Figs. 6 and 22 rubber washers 50 which are compressible, and which are separated from each other by metal washers 51 which fit snugly around the punch body, and several metal washers may initially be placed below the lowest rubber washer 50. The purpose of the cap is to remove same for the transferring of one or more metal washers 51 from below the stack of washers to a position above the head 46 of the punch as the punch becomes shorter due to sharpening or grinding. This maintains the overall length from the top of cap 48 to the bottom working face of punch 45 at a sufficiently uniform length so that the compressible washers 50 are never overstrained when the ram is in its lowest position.

Other means of stripping are shown in Fig. 7 where a number of pairs of truncated-conical spring members or washers 42 are shown, alternate washers being inverted, and in Fig. 1 where solid rubber sleeve is used.

I have also found that greatly increased stripping pressure may be obtained from the rubber washers or disks of the punch units shown in Fig. 6, by means of resilient split sleeves placed about the rubber disks. For example in Fig. 6a, I show a resilient sleeve 150 having its ends overlapping and which is arranged about the washers 50 and exerts radial inward pressure against them. When downward pressure is exerted on the rubber disks 50, they tend to bulge outwardly, and this causes the resilient sleeve 150 to expand in diameter against its spring tension. Consequently, when the pressure on the punch units is released by the upward movement of the ram, these rubber washers return to their original positions due to their own resiliency and due to the horizontally or radially directed force exerted on them by the sleeve 150.

In Fig. 6c I have shown two resilient split sleeves 151 and 152 arranged one about the other with their vertical slits staggered, so that the rubber cannot be forced out through the slits. The contracting force of the two sleeves acts horizontally or radially on the rubber disks and thus increases proportionally the vertical force which the rubber disks exert on the punch to strip the same from the work. Resilient sleeves such as shown in Figs. 6a, 6b and 6c can also be used about the rubber stripper sleeves shown in Figs. 1 to 3 inclusive.

Gage devices of any suitable kind or a nest for the work may be provided to ensure correct positioning of the work relatively to the punches and dies. In the construction shown, gage pins 39 are provided which may be arranged in accurately located holes in the die plate, and the punch carrier plate 24 is provided with holes through which the gage pins 39 extend when the plate 24 is in its lower position, see Figs. 1, 2 and 3.

It was explained above that it is unnecessary to have the die plate 14 cover the entire surface of the die support plate 13. As die plate 14 is made of critical materials, it is desirable to reduce the amount of material used wherever possible. To accomplish this, I have devised a method of making small die plates or blanks as shown in Figs. 9 to 14 inclusive. These blanks may be attached to die support plate 13 by any means. In Fig. 9 is shown a die blank 52 having projections 53 and resting in position on plate 13 ready to be electrically welded in place on an ordinary spot-welding machine, the blank being located in exact alignment with hole 18c by pin 54 which may be a separate piece or part of the welding machine. After being welded blank 52 appears, as shown in Fig. 10, the projections having been fused and welded to the die support plate 13. During the welding operation the blank 52 may be heated to a hardening temperature so that by quenching it with a dash of water or by other means, the cutting edges will be hardened. Of course unhardened blanks without die apertures may be spotted and fastened on the supporting plate wherever a die aperture is to be and the hole forming operation in the blank performed after such assembly, after which the die cutting edges may be hardened.

In Fig. 12, I show another form of die blank 55 held to die support plate by rivets 56, and in Fig. 13, the same die blank attached to plate 13 by means of small bolts 57. In Fig. 14, I show a thin die blank 58 which may be attached to certain non-critical materials by stapling. In Fig. 19, a perspective view is shown of a die blank 55 welded to plate 13. Dies of any other suitable or desired form may be used with my apparatus.

It will be clearly understood from the foregoing description how the base plates, support members, support bars, die carrier plates and punch carrier plates may be made of non-metallic and therefore, non-critical materials in many cases and that the base plate 98 and support members 12 may be used over and over again for the accommodation of various sizes and patterns of punch carrier and die carrier plates.

As also explained above, when this apparatus is organized as shown in Fig. 2, the guide post holes 17 must be accurately spaced to fit the two fixed center guide posts 15 on either end of supports 12. In many instances, it will be desirable to facilitate matters by separating supports 12 into two or more sections.

The organization of the apparatus shown in

Figs. 20 to 23 is practically the same as described above, but differs mainly in that the plates are supported at their corner portions, or only at intervals along two opposite edges. 52 represents a corner support having flanges with holes in them through which bolts 53 may pass to attach them to base plate 98. In this instance, punch carrier plate 55 has holes 56 and 57 formed at the desired locations, hole 57 being formed accurately to size to accommodate the individual guide post 58 which is in the form of a socket head screw accurately ground to diameter to provide a sliding fit in hole 57. Hole 56 is drilled larger than the diameter of screw 59 so that holes 56 and 57 do not have to be bored at an accurate distance one with the other, so that in assembling punch carrier plate 55, it is only necessary to engage guide 58 in guide hole 57 after which screw 59 may be tightened to sleeve 60 which is prevented from turning by dog point screw 61 engaging a slot 62 in the sleeve 60. The function of spring 63 is to elevate punch carrier plate 55 as explained previously.

In assembling this device for use, die carrier plate 54 which may be constructed as heretofore described in connection with Figs. 1 to 19, is first placed upon support members 52 and guide bolt 58 inserted through hole 64 and screwed down to bear lightly on die carrier plate 54. Punch carrier plate 55 is then placed over the numerous guide posts 58 as described above and screw 59 drawn down tightly to bind this plate 55 to sleeve 60.

In this condition, the holes 18 and 18a are not in proper axial alignment due to the clearance between the threaded end of the guide post 58 and hole 64, although the error is slight. By inserting proper locating means such as pins 65 in holes 66 and 67 which are in proper relation with the other holes, exact alignment between the punch and die holes may be readily attained after which guide post screws are pulled tightly against die carrier plate 54 to anchor same in position.

The chief advantage of using the method just described is that the guide post holes 57 in the punch carrier and die carrier plates do not have to be formed as accurately as in the first method, and the mounting is more flexible. The supports 52 may be arranged at intervals along opposite sides of the apparatus wherever needed.

After the apparatus is assembled and placed in the press, auxiliary depressors 85, made entirely of rubber and having depressions in their lower ends to receive the heads of bolts 59, may be placed in positions on the bolts 59 for the purpose of depressing plate 55 evenly. Auxiliary depressors of any other suitable or desired construction may be used.

If the punch carrier and die supporting plates are large, it may be desirable to provide additional supports along the opposite edges between the supports 52, such, for example, as blocks or posts 152, Fig. 22.

In Fig. 24, I show an alternative construction in which the guide and lifter are combined. 69 represents the lifter spring, 69 a washer, 70 a guide sleeve and 80 a guide and elevating pin. Guide sleeve 70 has a hexagon-shaped head 71, by means of which the sleeve may be removed when removing die carrier plate 81 and may also be used for tightening same in place upon assembling, after which the guide and elevating pin 80 is inserted into the bore or opening 82 of said sleeve, and punch carrier plate 83 set in

position on a flange 84 of the guide and elevating pin.

In Figs. 25 and 26, I show an alternative means of adjusting the punches to operate evenly and means for retaining all punches in alignment with the die holes and in correct positions on the punch carrier plate, thus providing better rigidity to the punches and eliminating the possibility of individual punches lifting out of the punch carrier plate by accident.

In these figures, the main part of the apparatus is as described in connection with preceding figures, and the difference is in the punch units, and the addition of a guide template 85. The punch body 88 of each punch unit has head 89 securely attached thereto and the punch body 88 extends through the head as indicated by 90. Surrounding the punch body in alternate layers are rubber washers 91 and non-compressible washers 92 to provide stiffening support for the punch and stripping force for withdrawing the punch after it has penetrated the work. When the punch is new, washers 93 are placed between punch carrier plate 55 and the stripper as shown in Fig. 25. As the punch becomes dull, it is sharpened by grinding off the bottom end, and in order to maintain the overall length the same in spite of this shortening, washers 93 are moved from below the resilient stripper to positions 94 above the punch head as shown in Fig. 26. The punch units shown in Fig. 26 are the same overall height as those shown in Fig. 25, the only difference being that washers 93 are above the punch head rather than below. This causes the entire punch to be lowered into plate 55 and the working end to get back to the level it originally occupied when new, as it is shortened.

For the purpose of insuring all punch units being maintained in vertical positions in relation to the punch carrier plate, I provide the pilot pins 90 on top of the punch heads and a template 85 which rests between heads 89 and cap members 95 having openings which just fit around the pilot pins. This template may be prepared separately or when the plates are drilled, as shown in Fig. 17. It may also be prepared as follows:

All of the punches and strippers with auxiliary heads 95 engaging heads 89 are assembled in place. A piece of metal which is to become template 85 is placed in the apparatus and punched. It is then removed and positioned on the punches as shown at 86. Therefore, the first work-piece produced on the apparatus becomes the template, if so desired.

While I have shown the various punch carrier and die plates provided with holes for only one perforating job, yet it will be obvious that, if desired, two or more series of holes could be provided in each plate arranged according to the patterns of holes for a plurality of different types of work. Punch units are arranged in one series of holes at a time and when the desired number of sheets have been perforated with this arrangement of punches, the punches are removed from these holes and arranged in the holes of a different series, whereupon the apparatus is ready to perforate other work-pieces.

Although the various forms shown on the drawings represent few practical embodiments of my invention, it is to be understood that the same may be varied as to details and still contain the essence of my improvements as summed up in the following claims.

I claim as my invention:

1. In a perforating apparatus for use on a press having a movable ram, the combination of a die supporting plate and a punch carrying plate, supports to which said die supporting plate is rigidly secured, elevating means on said supports engaging said punch plate for yieldingly holding the same in spaced relation to the die plate, punches on said punch carrying plate extending upwardly therefrom for actuation by the ram of a press, resilient stripper means for each punch, and resilient compressible members arranged in proximity to said elevating means for engagement by the ram of the press for causing the punch plate to be moved toward the die plate during the downward movement of the ram.

2. In a perforating apparatus for use on a press having a movable ram, the combination of a die supporting plate and a punch carrying plate, supports to which said die supporting plate is rigidly secured, elevating means on said supports engaging said punch plate for yieldingly holding the same in spaced relation to the die plate, punches on said punch carrying plate extending upwardly therefrom for actuation by the ram of a press, resilient stripper means for each punch and bearing against said punch carrying plate and transmitting downward movement of the ram to the punch carrying plate, and auxiliary compressible members on said punch carrying plate adjacent to said elevating means for carrying a part of the pressure of the ram for moving said punch carrying plate to prevent substantially downward deflection thereof.

3. A punch unit including a punch having a head, resilient stripping means arranged to be engaged by the head and to be compressed during the movement of the punch through the work, and including an annular member of rubber extending about the punch, and a resilient split metal sleeve arranged about said annular rubber member and exerting radial pressure on said rubber member toward said punch to supplement the stripping action of said rubber member.

4. A punch unit including a punch having a head, resilient stripping means arranged to be engaged by the head and to be compressed during the movement of the punch through the work, and including alternately arranged rubber disks and rigid disks, and a cylindrical split resilient sleeve extending about said stripper and resiliently opposing the outward expansion of said rubber disks.

5. A punch unit including a punch having a head, resilient stripping means arranged to be engaged by the head and to be compressed during the movement of the punch through the work, and including alternately arranged rubber disks and rigid disks, and means acting on the peripheral portions of said rubber disks for exerting radial pressure against the edge portions of said disks during expansion of said disks, the radial force of said means supplementing the resilient pressure exerted by said disks in a direction of the length of the punch.

6. A punch unit including a punch having a head, resilient stripping means arranged to be engaged by the head and to be compressed during the movement of the punch through the work, and including an annular rubber member extending about the punch, and a resilient split metal sleeve arranged about said annular rubber member and having its edges overlapping, to exert radial pressure on said annular member opposing the outward expansion thereof and supplement-

ing the stripping pressure of said rubber member lengthwise of the punch.

7. A punch unit including a punch having a head, resilient stripping means arranged to be engaged by the head and to be compressed during the movement of the punch through the work, and including an annular rubber member extending about the punch, and a pair of resilient cylindrical split members arranged one about the other and about said rubber member and the openings formed by the split members staggered, said split members pressing radially on said rubber member and supplementing the stripping pressure of said rubber member lengthwise of said punch.

GEORGE F. WALES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 22,422	Whistler et al. -----	Jan. 18, 1944
83,586	Arnold -----	Nov. 3, 1868
189,656	Rowan -----	Apr. 17, 1877

Number

217,692
563,098
609,682
5 629,558
667,700
909,739
1,244,112
1,420,252
10 1,447,000
1,665,771
1,822,468
1,964,752
2,013,976
15 2,105,139
2,265,726
2,326,588

Name	Date
Kator -----	July 22, 1879
Thompson -----	June 30, 1896
Krah -----	Aug. 23, 1898
Gogley -----	July 25, 1899
Hick -----	Feb. 12, 1901
Barrett -----	Jan. 12, 1909
Mackle -----	Oct. 23, 1917
Goehr -----	June 20, 1922
Wilson -----	Feb. 27, 1923
Cady -----	Apr. 10, 1928
Wales -----	Sept. 8, 1931
Wales -----	July 3, 1934
Wales -----	Sept. 10, 1935
Demboski et al. -----	Jan. 11, 1938
Greenberg -----	Dec. 9, 1941
Wales -----	Aug. 10, 1943

FOREIGN PATENTS

Number	Country	Date
29 30,274	Great Britain -----	Dec. 30, 1910

OTHER REFERENCES

"Steel," page 104 (date not known), a copy of which is in 164—118 and the article entitled "Air-craft Dies."