Aug. 15, 1944. F. WALES 2,355,765

F NCHI PPARATUS AND METHOD

I March 18, 1943 3 Sheets-Sheet 1

Fig. 1.

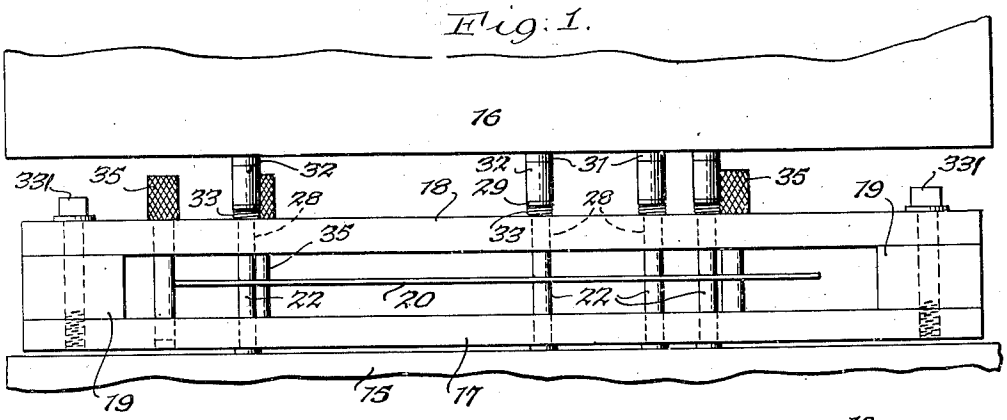



Fig. 2.

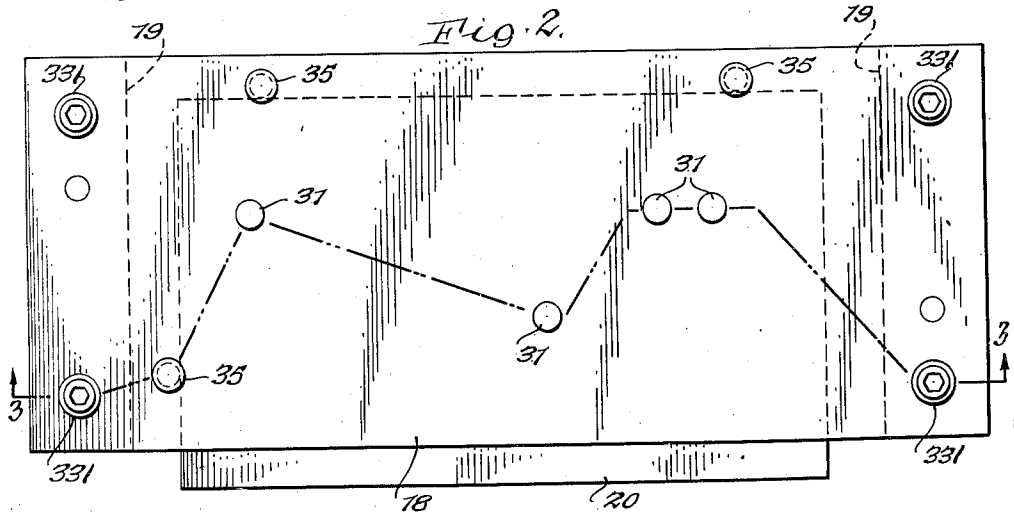
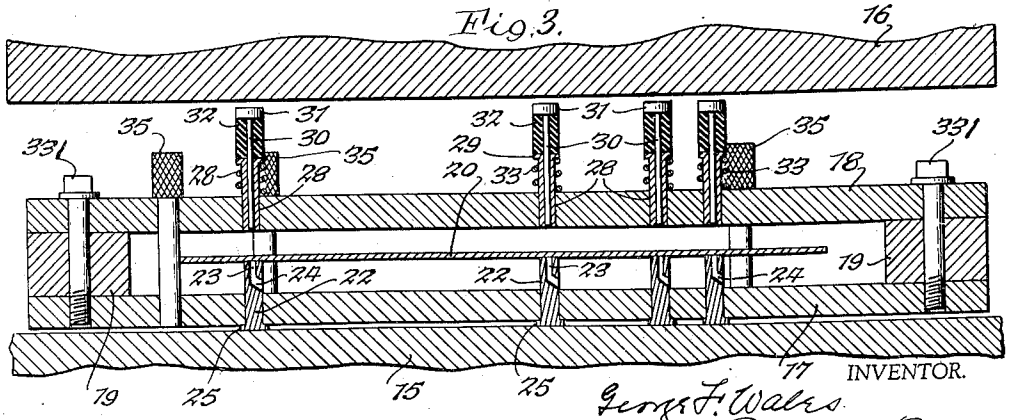



Fig. 3.

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Aug. 15, 1944. G. F. WALES 2,355,765

PUNCHING APPARATUS AND METHOD

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Fig. 4.

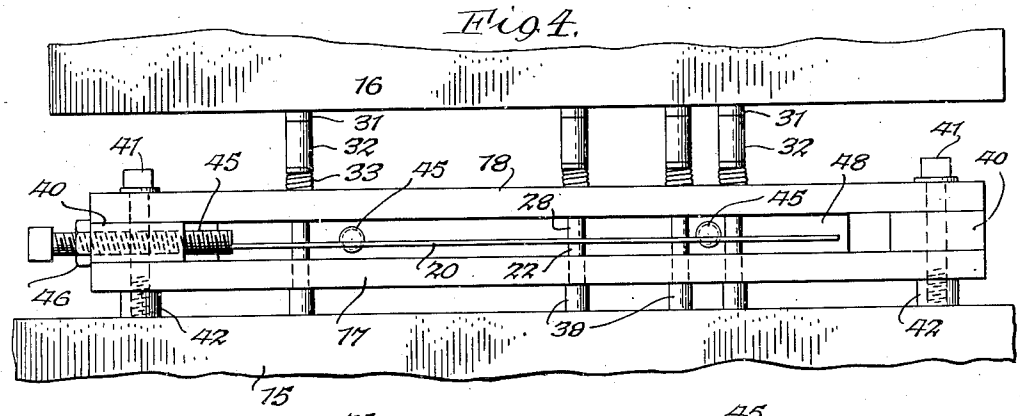



Fig. 5.

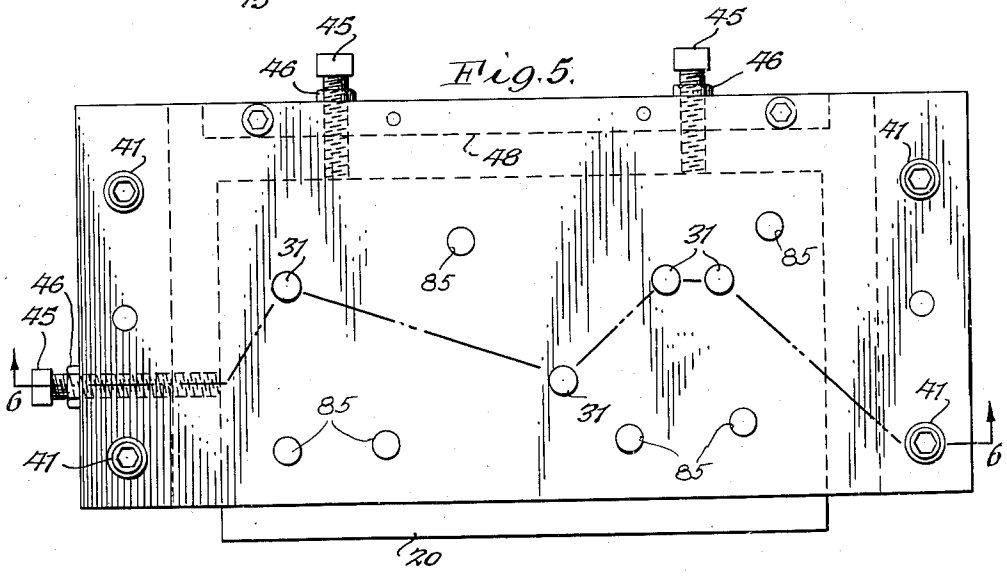
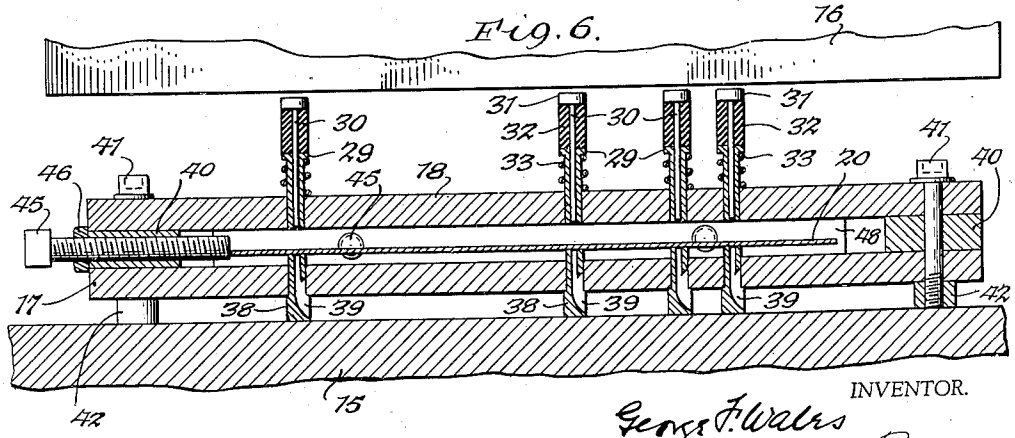



Fig. 6.

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PUNCHING APPARATUS AND METHOD

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Fig. 7.

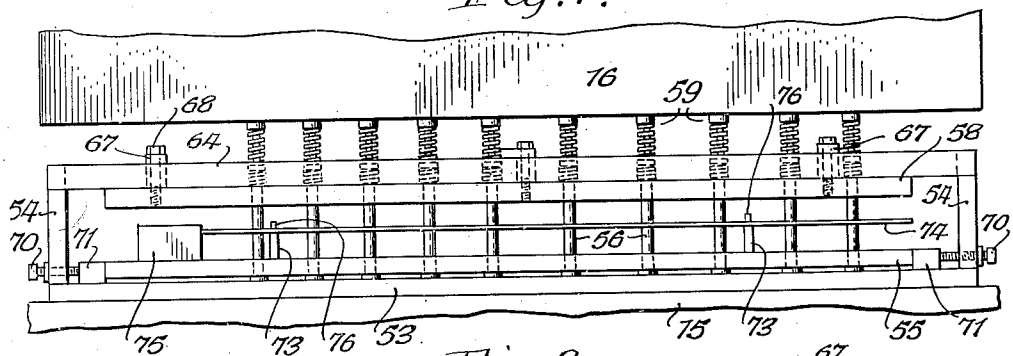



Fig. 8.

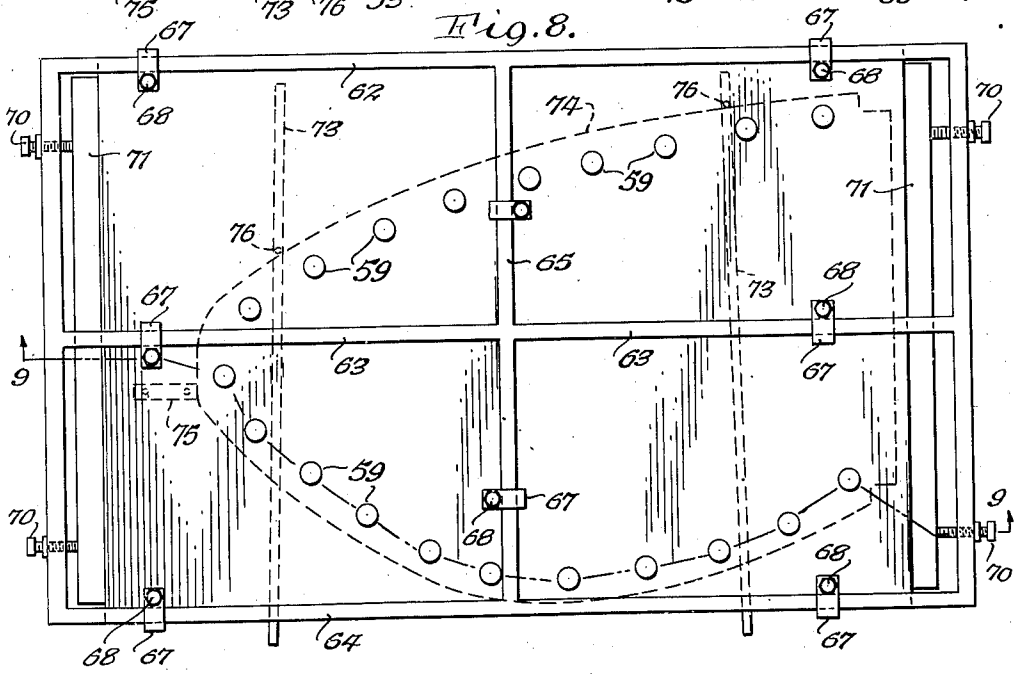
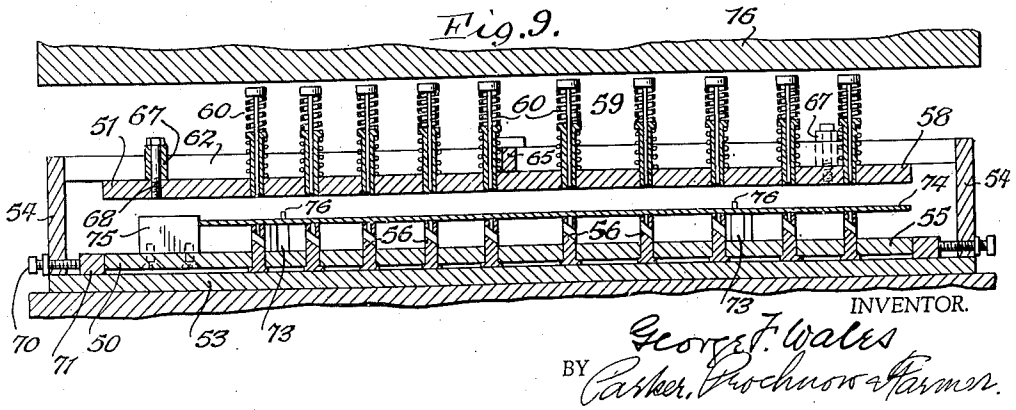



Fig. 9.

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Patented Aug. 15, 1944

2,355,765

# UNITED STATES PATENT OFFICE

2,355,765

## PUNCHING APPARATUS AND METHOD

George F. Wales, Kenmore, N. Y.

Application March 18, 1943, Serial No. 479,614

38 Claims. (Cl. 164—94)

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 the plates when new patterns of holes are to be punched.

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

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

A further object is to provide an apparatus of 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.

Another object of this invention is to provide die plates which are so constructed that the dies may readily be removed therefrom for use in another die plate for another job.

A further object of this invention is to provide an improved method of making punching apparatus.

Another object is to provide an apparatus of this kind having die carrier plates and punch carrier plates which have similar holes formed therein while the two plates are secured together, to receive the punch and die units.

Another object of this invention is to provide a single apparatus which will be capable of producing two or more different types of workpieces.

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 a hole punching apparatus embodying this invention, showing the parts thereof in operative relation to the bed and ram of a press, and in the positions which they occupy when the holes are punched.

Fig. 2 is a top plan view of the hole punching apparatus removed from the press.

Fig. 3 is a sectional elevation thereof, on line 3—3, Fig. 2, and showing the apparatus in the press with the ram in elevated position.

Fig. 4 is a front elevation of a hole punching apparatus of modified construction.

Fig. 5 is a top plan view thereof.

Fig. 6 is a sectional elevation thereof, on line 6—6, Fig. 5, and showing the apparatus in the press with the ram in elevated position.

Fig. 7 is a front elevation of a hole punching apparatus of another modified form.

Fig. 8 is a top plan view thereof.

Fig. 9 is a sectional elevation thereof, on line 9—9, Fig. 8.

15 represents the stationary bed of a press in which my apparatus may be used, and 16 is the ram of the press which is movable toward and from the bed. My improved hole punching apparatus is adapted to be inserted between the bed and the ram of the press after it has been completely set up or assembled outside of the press, and may be readily removed from the press when a job is completed and replaced by another hole punching apparatus for operating on another job. In this manner, the press remains idle only for very brief intervals of time.

My hole punching apparatus includes a die supporting or carrier plate 17 and a punch supporting or carrier plate 18. These two plates may be made of any suitable metal, or if desired, the plates may be of suitable non-metallic material, since, as will be hereinafter explained, neither of these plates carry any of the pressures or strains required for punching the work and for stripping the punches from the work. The two plates are spaced apart by means of supports or rails 19 arranged at opposite edges of the plates. The plates are bolted or otherwise secured to these rails, which space the plates apart so that the work 20 may be inserted between the two plates.

The lower or die carrying plate is provided

with apertures extending perpendicular to the faces of this plate, the holes being formed in the plates in accordance with the pattern desired on the work. The die units are preferably in the form of posts 22 having their upper ends drilled to form the die openings 23, and a suitable passage 24 is provided in the side of each post and connecting with the openings or holes 23, so that the slugs or punchings may pass out of the die. The die holes 23 in the posts are accurately formed coaxially with the outer cylindrical surface of the posts. The posts extend through the die supporting plate 17 and the lower ends thereof, consequently, may rest directly upon the bed 15 of the press. If desired, the lower ends of these die units may have heads or flanged portions 25 formed on the lower ends thereof of larger diameter than the holes in the die plates 17 so that the dies may be definitely located with reference to the die carrier plate. These flanged or larger portions 25 also serve to support the die plate from the bed 15.

The punch carrier plate 18 is also provided with holes adapted to receive the punch units and the holes in the punch carrier plate are spaced identically with the holes in the die carrier plate so that the punches will cooperate correctly with the dies. In the particular construction shown, each punch unit includes a punch guide sleeve 28 which is of such diameter as to slide freely but accurately in its hole in the punch carrier plate 18 and the upper end of the punch guide sleeve is provided with a flange or head 29. Each punch guide sleeve is provided with a central hole or bore through which the punch 30 extends and in which it is slidable. The upper end of the punch has an enlarged head 31 which is engaged by the ram 16 during the perforating operation. Between the flange 29 and the head 30 of the punch, a resilient stripping member is provided, which may be in the form of a sleeve or pad 32 of rubber, although it will be understood that springs of any suitable type may be employed, if desired. A relatively light lifting spring 33 is arranged between the punch carrier plate 18 and the head or flange 29 of the punch guide sleeve 28, the lifting springs moving the punch units upwardly so that the lower ends of the punch guide sleeves are preferably at or above the level of the lower surface of the punch carrier plate, so that they will not interfere with the insertion of the work between the punches and dies. The resilient stripper or rubber sleeve 30 is so proportioned that it normally draws the lower end of the punch into the punch guide sleeve 28. When the ram descends to perforate the work 20, it engages the heads of the punches and carries the punch units downwardly, thus compressing the light lifting springs 33 until the punch sleeves engage the upper surface of the work, whereupon further movement of the ram moves the punches relatively to the stripper sleeves through the work, thus compressing the stripper members 30. Upon upward or return movement of the ram, each resilient stripper member 30 expands while the punch sleeve remains in contact with the work, thus withdrawing the lower end of the punch out of the work and into the stripper sleeve, whereupon the lifting spring 33 carries the punch unit into the position shown in Fig. 3.

It will be noted that during this operation, the downward pressure exerted by the ram on the punches is transmitted through the work to the die units, and since the die units rest upon the bed 15 of the press, this downward pressure which is necessary for perforating the work and compressing the resilient stripper member 30, is transmitted by the die units directly to the bed of the press and none of the strains are transmitted either to the punch carrier plate 18, or to the die carrier plate 17. This fact, consequently, makes it possible to employ plates of non-metallic material, such for example, as plywood, pressed wood, lignon, plastic compositions, or the like.

The construction described makes it possible to easily produce a hole punching apparatus for any particular job. It will be obvious that since the holes in the plates for carrying the punch and die units must be in axial alinement, with each other, the two plates may be clamped or bolted together face to face in any suitable or usual manner, whereupon the holes may be simultaneously drilled and reamed through both plates according to the pattern required. When this hole-forming operation is completed, it is merely necessary to separate the plates and mount them in fixed spaced relation to each other with their corresponding holes in axial alinement, and then to insert the punch and die units into these holes. For example, the plates may be mounted on the rails or spacing members 19 so that the holes therein are in axial alinement with each other. The dies may then be inserted into the holes in the die carrier plate and the punches into the holes of the punch carrier plate.

Since the dies must fit snugly in the holes in the die carrier plate, and since the punch guide sleeves must have a sliding fit in the holes in the punch carrier plate, the die units are preferably made of slightly greater diameter than the punch guide sleeves, so that the die units will have a press fit in the holes of the die carrier plate, while the guide sleeves have a sliding fit in the holes of the punch carrier plate 18. If desired, the outer diameter of the die units and of the punch carrier sleeves may be made the same and the holes in the upper plate 18 may then be made slightly larger after the plates 17 and 18 have been separated.

When the holes in the punch and die plates for the punch and die units have been formed, the plates are separated and assembled on the rails, and bolts 331 are passed through previously formed holes in these plates and rails. The plates are then alined accurately by means of the pins 35, after which the bolts are tightened and if desired holes are then drilled through the plates and rails into which dowel pins are driven, as is customary in die making.

In the particular construction illustrated in Figs. 1 to 3, these pilot pins extend through holes in both of the plates which have been drilled in addition to those drilled for the punch and die units, these holes being positioned for properly locating the work with reference to the punches and dies. Consequently, the pilot pins 35 serve the two-fold purpose of correctly alining the two plates 17 and 18 and also these pilot pins serve as gages or stops against which the work 20 is placed for the correct positioning of the same.

When the desired number of work-pieces have been punched, the punching apparatus is removed from the press, and the punch and die units may be removed from their carrier plates so as to be usable on another punching apparatus, and if desired, the two plates 17 and 18 may also be disconnected from the rails 19,

whereupon other plates may be secured to the rails for forming a different hole punching apparatus for use on another job.

From the foregoing description, it will be obvious that by means of the construction described, a hole punching apparatus may be very efficiently constructed at a low cost and the actual time required for making punch and die carrier plates is approximately the same as that heretofore required to make a drill jig gage plate for stack drilling the work. The apparatus may rest on the bed of a press without being attached thereto, or it may be secured thereto by any suitable or well known means (not shown).

In Figs. 4 to 6 is shown a modified apparatus in which the slugs or punchings, instead of being discharged between the two plates 17 and 18, are discharged below the die supporting plate. In this construction, die units of slightly modified construction are shown which have heads or enlarged ends 38 of greater height than those shown in Figs. 1 to 3, and these die units have recesses or slots 39 cut in a side thereof which terminate in the heads and through which the slugs pass and are discharged below the die carrying plate 17. By means of this arrangement, the die units may be made somewhat shorter than those shown in Figs. 1 to 3. Consequently, also the space between the plates 17 and 18 may be less, and spacing rails 40 of less height are provided. The plates 17 and 18 may be connected to the rails 40 by means of bolts 41 extending through both plates and the rails and having a threaded engagement in small blocks or nuts 42, which may be of the same height as the head portions 38 of the dies, so that these nuts may also rest on the bed 15 of the press.

In Figs. 4 to 6, I have also shown gage means of modified construction, these means comprising set screws 45 engaging in threaded holes in the rails or supports 40. These gage screws may be adjusted as desired to correctly position the work with reference to the hole punching apparatus and may then be secured in their adjusted positions by means of lock nuts 46. By means of this construction, the drilling of holes in the plates 17 and 18 for the gage pins 35 is eliminated and the gage screws 45 take their place. In this construction, I show an additional spacer bar 48 at the rear of the apparatus which supplements the spacer bars 40 at opposite sides thereof and two of the set screws 45, in the construction shown, extend through this spacer bar. In alining the plates 17 and 18 before tightening the bolts 41, pilot pins, similar to the pins 35 shown in Figs. 1 to 3, may be used to cooperate with the holes drilled in these two plates for receiving the punch and die units.

In Figs. 7 to 9, I have illustrated my invention as applied to hole punching apparatus for use in connection with work of large dimensions. In the constructions shown in Figs. 1 to 6, the plates 17 and 18 are of relatively small size, and since this punch holding plate is required to support only its own weight and the weight of the punch units carried thereon and the compression of the very light lifting springs 30, no appreciable deflection of the punch carrying plate will occur. If, however, these punch carrying plates are large and supported only at two opposite edges, there will be a tendency of the plates to sag in the middle portions thereof. This sagging would move the punches out of axial alinement with the dies, and thus cause either defective work or the breaking of the punches.

Consequently, in Figs. 7 to 9, I have shown a modified construction for use in connection with large punch carrier plates. In this construction, the die carrier plate 55 and the punch carrier plate 58 are preferably arranged in a frame or trough-like structure including a base plate 53 having upright side walls or flanges 54 secured thereto. 55 represents a die supporting plate having die units 56 extending through holes therein as described in connection with the preceding figures. 58 represents the punch carrier plate on which punch units 59 are mounted, these punch units being substantially the same in construction as those heretofore described, except that the punch units in Figs. 7 to 9 are provided with stripper springs 60. The plates 55 and 58 have holes provided therein for the punch and die units as heretofore described. In place of using spacer rails or bars between the two plates 55 and 58, I provide other means for securing the plates in fixed relation to each other, in such a manner that the upper or punch carrier plate will be supported at portions intermediate of the ends thereof to prevent sagging or deformation of this plate due to its weight and to the weight of the parts mounted thereon. Any suitable means may be employed for this purpose, and in the construction shown by way of example, I provide one or more beams such for example as beams 62 and 63, 64 and 65. The beams, 62, 63 and 64 extend crosswise of the frame and have their ends secured on the upright walls or flanges 54 and the beam 65 extends crosswise and may be made in two parts which are welded or otherwise secured between two adjacent transverse beams. These frame members may be provided at intervals with hangers or clamping members 67 which are suitably mounted on the beams and which have screws 68 adapted to enter into threaded holes in the punch carrier plate 58 for supporting this plate from the beams. The hangers or clamps 67 may be of any suitable or desired form, those shown being angle-shaped pieces having one leg resting on top of the beam, and the other one extending downwardly along the beam, but the clamping screws 68 may extend through holes in the beams themselves or clamping means of any other suitable construction may be employed in place of those shown.

Since there will be a tendency of each beam to sag somewhat in the middle portion thereof due to its weight, and since this sag or deformation will be greater when the punch carrier plate is carried by the beams, the lower surfaces of the beams are preferably arc-shaped or concave, the arc being very slight and just sufficient so that when the punch carrier plate is secured to the beams, the lower edges of the beams will be horizontal. The extent to which the lower faces of these beams are concave is, of course, determined by the length of the beams and the weight which they must support and the deflection of the material of which the beams are made under the load imposed on them. When beams are formed in this manner, it is merely necessary to clamp the upper face of the punch carrier plate against the lower faces of the beams, and no delicate adjustments are necessary to mount this plate to relieve it of sag or distortion.

The lower or die carrier plate 55 rests on the base plate 53 of the frame and suitable means are provided for shifting this plate so that the apertures therein may be accurately alined with the apertures in the punch carrier plate, for example, by means of pilot pins as described in

connection with Figs. 1 to 3. This may be accomplished in any suitable manner, for example, by providing suitable set screws 70 which extend through the side walls or flanges 54 and which may be provided with the usual lock nuts for holding them in adjusted position. In the construction shown, these set screws engage clamping bars 71 extending lengthwise of the frame and disposed between the set screws and the die carrier plate 55. The punch carrier plate 58 may also be adjusted by means of the hangers or clamps 68, since, obviously, these clamps may be moved to any desired positions on the beams of the frame member, but when the set screws 68 thereof are tightened, the plate 58 will be rigidly held against the underfaces of the beams and thus will be in fixed relation to the frame. The die units 56 are pressed into the holes in the die carrier plate 58 before the plate is placed into the frame, and the punch units 59 are preferably placed into the holes of the punch carrier plate 58 after the same has been positioned on the frame. By means of the construction described, it will be obvious that the plates 55 and 58 may also be adjusted lengthwise and crosswise of the frame, so that the beams will be so positioned as to not extend across any of the holes provided for the punch units.

In order to facilitate the insertion of the work between the plates 55 and 58, I preferably provide guide bars or rails 73 which may be secured to the die carrier plate 55 and the upper edges of which are substantially on the same plane as the upper edges of the dies. Preferably these bars extend out of the frame toward the front edges thereof to a limited extent so that the work before being inserted between the plates 55 and 58 may rest on these guide bars to facilitate the insertion of the work into the frame.

Stop gages are preferably also provided to stop the work 74 in correct relation to the punches and dies. These stop gages may be of any suitable or desired construction, and by way of example, I have shown one of these stop gages in the form of a block 75 suitably secured to the die carrier plate 55 and two other stop gages 76 are in the form of posts extending upwardly from the guide tracks 73, although blocks secured to these bars may be employed. Any other suitable means for gaging the work may be provided.

In accordance with my improved method of perforating work, it will be obvious that in order to perforate work with a high degree of accuracy, it is merely necessary to employ two flat plates of metal or non-metallic rigid material and to form in these plates alined apertures while the two plates are clamped together face to face. As has been stated, if the apertures in the two plates are to be of the same diameter, these apertures may be completely formed while the two plates are clamped together, or the apertures in one of the plates may be enlarged after the plates are separated. After the forming of these apertures in the plates, it is merely necessary to assemble these plates in spaced relation to each other with the corresponding holes in accurate axial alinement, and to place the die units into the holes of one plate and the other punch units into the other plates. The apparatus is then ready to be put into a press.

Since the forces necessary to effect perforating of the work and stripping of the punches from the work are not transmitted to either of the two plates, it will be obvious that these plates can be made of relatively light or thin material, and consequently, when a job is completed, these plates can be easily stored for future use after removing the punch and die units therefrom for use on another job. By means of the construction shown in Figs. 7 to 9, it will be obvious that there is practically no limit to the size of work that can be punched by means of my apparatus, since if very large sheets are to be worked upon, the punch supporting plate may be held in correct flat position by means of supporting beams, and consequently, no sagging or distortion of the plates will result which would cause the punches to move out of axial alinement with the dies.

It will also be apparent that a single set of plates may be provided with holes for two or more different jobs, providing that the holes are so located in the two sets of plates that they do not overlap or interfere with each other. For example, there are four holes 31 shown in Fig. 5 for use on the work-piece 20. The same plates may be provided with additional holes 85 for use on another job. When the first job is being done, punch and die units are placed only into the holes 31 and when the second job is to be done by means of the same apparatus, all the punch and die units are removed from the holes 31 and are placed in the holes 85. It is preferable however to insert, by press fit, dies in all of the holes in the lower plate and allow them to remain there until the pattern becomes obsolete. In this way it is a simple matter to lift punching devices out of the top plate and insert them in other plates or in other apertures in the same plate. As the punching devices are a sliding fit in the apertures of the top plate this is accomplished rapidly and easily. This may require the use of other stop gages for positioning the work. In this manner, a number of different types of work can be produced by means of a single apparatus.

In the three embodiments of the invention shown in the drawings, the punch and die carrier plates may have the holes formed therein to receive the punch and die units after the plates have been secured to the supports 19 or 46 or in the frame shown in Figs. 7 to 9. When the holes are formed in this manner, they will be in axial alinement, and no further positioning of these plates relatively to each other by means of pilot pins will be necessary. However, if the plates thus drilled are disconnected from their supports or frames, then if they are again required to make more pieces of the same type of work, they must be correctly positioned relatively to each other by means of pilot pins or the like. Since the spacing supports between the plates as shown in Figs. 1 to 6 are relatively small, the plates are preferably left secured to the supports after a job is completed and the plates with the supports may be stored for later use after the punch and die units are removed therefrom. In many instances it is found more desirable to remove only the punch units which are loose but not to disturb the die units which are tightly assembled to their plate. Thus the plates secured to their supports are stored with the dies intact, but with the punching units removed if desired.

In all of the constructions shown, the perforating apparatus can be completely assembled on a bench and can then be quickly positioned on the bed of a press, thus reducing to a minimum the length of time that the press is idle.

It will also be understood that the punch and die elements may be used over and over from one

set-up to another. While one set-up is in operation in a press, others may be prepared, complete with punch and die elements, in anticipation of use. Any number of set-ups may be made ready in advance of placing in operation, either with or without the punch and die elements installed. The change from work of one type to another means merely sliding one set-up out of the press and the new one in, and then continuing the operation of the press.

By making all of these set-ups with supports of the same height, using plates of substantially the same thickness for the punch guide plates and punch and dies units of the same heights, the various set-ups will all be of substantially the same height. Consequently, the press need not be adjusted for different shut-heights, so that no delay in the adjustment of the ram is necessary when different set-ups of my apparatus are placed into the press. When the different set-ups differ in height, they may be made of uniform height by placing filler plates either above the punch units or between the set-up and the bed of the press.

I claim as my invention:

1. A method of perforating work, which includes simultaneously forming holes completely through a pair of plates while secured together face to face, the holes being arranged according to the pattern of holes desired in the work, separating said plates and mounting them in fixed spaced relation to each other with the corresponding holes in the plates in axial alinement, placing die units tightly into the holes of one plate and punch units, each consisting of a stripper and central punch through it, slidably into the holes of the other plate, placing the plates into a press, positioning work between said plates, and moving said punch and stripper units relatively to their plate toward the die units of the other plate by means of the ram of the press to perforate the work, each of said strippers, upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

2. A method of perforating work, which includes simultaneously forming holes completely through a pair of plates while secured together face to face, the holes being arranged according to the pattern of holes desired in the work, separating said plates, alining a plurality of corresponding holes of said plates by means of pilot pins, then securing said plates in fixed spaced relation to each other, placing die units tightly into the holes of one plate and punch units, each consisting of a stripper and central punch through it, slidably into the holes of the other plate, placing said plates into a press, positioning the work between said plates, and moving said punch and stripper units relatively to their plate toward the die units of the other plate by means of the ram of the press to perforate the work, each of said strippers, upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

3. A method of perforating work, which includes simultaneously forming holes in a pair of plates while secured together face to face, the holes being arranged according to the pattern of holes desired in the work, separating said plates and mounting them in fixed spaced relation to each other with the corresponding holes in the plates in axial alinement, placing die units into the holes of the lower plate with their lower ends extending below said plate, arranging punch units, each consisting of a stripper and central punch through it, slidably in the holes of the upper plate, placing the plate assemblage into a press with the lower ends of said die units supported by the bed of the press, positioning the work between said plates, and moving said punch and stripper units relatively to their plates toward the die units of the other plate by means of the ram of the press to perforate the work, each of said strippers, upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

4. A method of perforating work, which includes simultaneously forming holes in a pair of plates while secured together face to face, the holes being arranged according to the pattern of holes desired in the work, separating said plates and placing rails between opposite edge portions thereof, positioning said plates relatively to each other to place the holes of one plate in axial alinement with corresponding holes of the other plate, securing said plates to said rails with the holes in alinement, placing die units into the holes of one plate and punch units, each consisting of a stripper and central punch through it, into the holes of the other plate, placing the plates into a press, positioning work between said plates, and moving said punch and stripper units relatively to their plate toward the units of the other plate by means of the ram of the press to perforate the work, each of said strippers, upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

5. A method of perforating work, which includes simultaneously forming holes in a pair of plates while secured together face to face, the holes being arranged according to the pattern of holes desired in the work, separating said plates, mounting said plates in a frame one above the other with corresponding holes of the plates in alinement, supporting intermediate portions of upper plates to prevent sagging thereof, placing die units into the holes of one plate and punch units each including a punch and a guide sleeve into the holes of the other plate, placing said frame into a press, positioning work between said plates, and moving the punch units including their guide sleeves of one plate in their holes toward the die units of the other plate by means of the ram of the press to perforate the work.

6. A perforating apparatus for use in a press having a stationary bed and a ram movable toward and from the bed, and including a pair of flat plates spaced apart and held in fixed relation to each other and having holes therein, die units arranged in the holes of one of said plates and punch units each consisting of a stripper and central punch through it in the holes of the other plate, each punch unit being in axial alinement with a die unit, one of said groups of units being

movable by the ram of the press bodily relatively to its plate using its holes in its plate as guides, toward the units on the other plate to perforate work placed between said plates.

7. A perforating apparatus for use in a press having a stationary bed and a ram movable toward and from the bed, and including a pair of flat plates spaced apart and held in fixed relation to each other and having holes therein, die units arranged in the holes of one of said plates and punch units each including a punch and a punch sleeve in the holes of the other plate, each punch unit being in axial alinement with a die unit, said punch guide sleeves being slidable by the ram of the press in the holes in their plate toward and from said die units and said punches being movable in their guide sleeves by said ram to perforate work placed between said plates, each punch unit including a resilient member which normally urges the work penetrating end of the punch into its guide sleeve for stripping the punch from the work.

8. A perforating apparatus for use in a press having a stationary bed and a ram movable toward and from the bed, and including a pair of flat plates having holes formed therein according to the pattern of holes required in the work, means for rigidly supporting said plates in fixed relation to each other with each hole of one plate in axial alinement with a hole in the other plate, punch units including punches movable in punch guide sleeves, arranged in the upper of said plates with said punch guide sleeves slidable in said holes, lifting springs for holding said punch units, with their lower ends substantially flush with the lower face of said punch plate, and die units arranged in the holes of the other plate, said lifting springs being compressed by the ram of the press to move said punch units toward the work.

9. A perforating apparatus including a pair of flat plates having holes formed therein according to the pattern of holes required in the work, means for rigidly supporting said plates in fixed relation to each other with each hole of one plate in axial alinement with a hole in the other plate, punch units slidably arranged in the holes of one of said plates, and die units arranged in the holes of the other plate and extending at least to the lower face of said other plate, whereby when pressure is exerted on said die units by said punch units, said pressure will be transmitted by said die units to a support therefor without passing through said other plate.

10. A perforating apparatus including a pair of flat plates having holes formed therein according to the pattern of holes required in the work, means for rigidly supporting said plates in fixed relation to each other with each hole of one plate in axial alinement with a hole in the other plate, punch units including a punch guide sleeve slidably arranged in the holes of one of said plates, die units arranged in the holes of the other plate and having enlarged heads at their lower ends arranged below the lower face of said other plate and resting on a supporting surface when the punch units are moved toward the die units to perforate the work.

11. Die supporting means for use in a perforating apparatus and including a flat plate provided with holes extending through the same perpendicular to the faces thereof, said plate being of sufficient thickness to support in perpendicular relation and retain die units having substantially cylindrical portions extending upwardly through said holes and having die apertures in their upper ends and side openings connecting with said die apertures and through which the metal removed from the work by punching passes from said die units, the lower ends of said die units extending below said plate to rest on a supporting surface while the work is being punched.

12. Die supporting means for use in a perforating apparatus and including a flat plate provided with holes extending through the same perpendicular to the faces thereof, die units extending upwardly through said holes and held in operative position by press fits in said holes and having die apertures in their upper ends and side openings connecting with said die apertures and through which the metal removed from the work by punching passes from said die units, said side openings terminating at their lower ends above the upper surface of said plate to discharge metal removed from the work upon said plate, the lower ends of said dies having enlarged portions arranged below said plate in positions to rest upon a supporting surface when the metal is being perforated.

13. Die supporting means for use in a perforating apparatus and including a flat plate provided with holes extending through the same perpendicular to the faces thereof, single-piece die units extending upwardly through said holes and having die apertures in their upper ends, the lower ends of said dies having portions of larger diameter arranged below said plate and forming bases for supporting said plate in spaced relation to a supporting surface, and passages in said dies extending into said bases and terminating below said plate for discharging metal removed from the work below said plate.

14. Perforating apparatus including a pair of flat plates having holes formed therein perpendicular to the surfaces thereof according to the pattern of holes required in the work, punch units arranged in the holes of one of said plates and die units arranged in the holes of the other plate, and spacing bars relatively to which said plates may be shifted to place each hole of one plate in axial alinement with the hole in the other plate, and to which said plates are secured when said holes are so located said spacing bars being provided with threaded apertures in which set screws are arranged with their inner ends to engage the work fed to the apparatus for gaging the work therein.

15. Perforating apparatus including a pair of flat plates having holes extending through both plates and in axial alinement with each other, spacing bars relatively to which said plates may be shifted and to which said plates are removably secured, die units arranged in the holes of one plate, punch units arranged in the holes of the other plate, and a plurality of additional set of coaxial holes in said plates formed to receive pilot pins for locating said plates in correct relation to each other, said holes for said pilot pins being so placed that the pilot pins act as stop gages for the work, and means for securing said plates in fixed relation to each other when said pilot pins are in their holes in both plates.

16. A perforating apparatus including a pair of flat plates spaced apart and held in fixed relation to each other and having holes therein, die units arranged in the holes of one of said plates and punch units in the holes of the other plate, each punch unit being in axial alinement with a die unit, one of said groups of units being movable relatively to its plate toward the units on the

other plate to perforate work placed between said plates, and a frame including a base relatively to which one of said plates may be held, and means arranged above the other plate and to which the other plate may be secured for mounting the same in fixed relation to the plate on said base.

17. A perforating apparatus including a pair of flat plates having holes formed therein in accordance with the pattern of holes required in the work, a frame formed to receive said plates and including a base, upstanding parts at opposite sides thereof and beams extending across said frame and secured to said upstanding parts, die units extending through the holes of one of said plates, said plate being secured to said base of said frame, means for securing the other plate to the lower face of said beams with the holes thereof in axial alinement with the holes of the first mentioned plates, and punch units arranged in the holes of said plate which is supported from said beams.

18. In a perforating apparatus, the combination of a frame having a base, upstanding parts at opposite sides thereof, and a plurality of beams extending across the upper portion of said frame and secured to said upstanding parts, a pair of plates having holes drilled therein with each hole of one plate in axial alinement with the hole of the other plate, means for securing one of said plates in fixed relation to the base of said frame, and adjustable means for securing the other frame to the lower faces of said beams with corresponding holes of the two plates in axial alinement with each other, die units arranged in the holes of one of said plates, and punch units arranged in the holes of the other plate, the units of the plate secured to said beams being movable relatively to their plate and extending above said beams and being movable downwardly for perforating the work.

19. Perforating apparatus including a frame having a base and upstanding parts at opposite sides thereof, beams extending across the top of said frame and supported by said upstanding plate, a pair of plates each provided with a plurality of holes, each hole of one plate being in axial alinement with a hole of the other plate, die units extending through the holes of one of said plates, and punch units arranged in the holes of the other plate, said plate with said die units being positioned on said base with the lower ends of said die units resting on said base, and the other plate carrying the punch units being supported from the underface of said beams with each punch unit in axial alinement with a die unit.

20. A perforating apparatus according to claim 19, in which said upstanding parts are provided with set screws for adjusting said plate carrying said dies relatively to said base and for clamping said plate in adjusted position.

21. A perforating apparatus in accordance with claim 17, in which the lower faces of said beams are slightly concave when free from load to enable them to support the plate attached thereto without sagging.

22. Punching apparatus including a frame having a base, upstanding side walls, and beams extending across the top of said frame and secured to said side walls, a plate carrying die units resting on said base, a plate carrying punch units adapted to be positioned over said first mentioned plate and suspended from said beams, and angle-shaped members engaging the upper edges of said beams and having downwardly extending legs provided with screws engaging threaded holes in said punch carrying plate for drawing said punch carrying plate into engagement with the lower faces of said beams when said screws are tightened.

23. A perforating apparatus including a base, beams supported in fixed spaced relation to said base and above the same, a pair of plates having holes formed therein with each hole of one plate in axial alinement with a hole of the other plate, punch units arranged in the holes of one of said plates, and die units arranged in the holes of the other plate, means for holding one of said plates in fixed relation to said base, and means for supporting the other plate from said beams with each punching unit in axial alinement with a die unit.

24. A perforating apparatus including a base, beams supported in fixed spaced relation to said base and above the same, a plate carrying die units and resting on said base, and a plate carrying punch units and supported from said beams with each punch unit thereon in axial alinement with a die unit.

25. A perforating apparatus including a base, beams supported in fixed spaced relation to said base and above the same, a plate carrying die units and resting on said base, a plate carrying punch units and supported from said beams with each punch unit thereon in axial alinement with a die unit, and stop gages on one of said plates for engagement with the work fed to said gages.

26. A perforating apparatus including a base, beams supported in fixed spaced relation to said base and above the same, a plate carrying die units and resting on said base, a plate carrying punch units and supported from said beams with each punch unit thereon in axial alinement with a die unit, and guide rails on the lower plate along which the work to be perforated may be slid between said plates.

27. A method of perforating work-pieces of different types in a press, which includes assembling outside of the press for each different type of work, a perforating apparatus including a punch unit supporting plate carrying punch units and a die supporting plate carrying die units, said plates being spaced apart by supports and rigidly secured in fixed relation to each other, positioning an assembled apparatus in the press with the dies of the die supporting plate resting on the bed of the press, perforating the desired number of work-pieces by means of the apparatus in the press, then removing the apparatus from the press and replacing it by another apparatus, for perforating other work-pieces, and removing the punch and die units from the plates without separating the plates, whereby the idle period of the press between different jobs is shortened.

28. A method of perforating work-pieces of different types in a press, which includes assembling outside of the press for each different type of work, a perforating apparatus including a punch unit supporting plate carrying punch units, each consisting of a stripper and a central punch through it, and a die plate, carrying die units extending therethrough accurately securing said plates in fixed relation to each other while outside the press with each punch unit in axial alinement with each die unit, said plates being spaced apart by supports, making all of said perforating apparatus of substantially the same height, positioning an apparatus in the

press, perforating the desired number of work-pieces of one type by means of the apparatus in the press, then removing the apparatus and replacing it by another apparatus of the same height for a work-piece of another type, whereby changing of the shut-height of the press is unnecessary.

29. A method of perforating work, which includes mounting a pair of plates one over the other in spaced relation to each other, forming holes simultaneously in both of said plates according to the pattern of the holes desired in the work, accurately securing said plates in spaced relation to each other with each hole of one plate in axial alinement with a hole of the other plate, placing die units into the holes of one plate from the outer face thereof and placing punch units each consisting of a stripper and a central punch through it, into the holes of the other plate from the outer face thereof, the units of one plate being movable relatively to its plate toward and from the other units having a press fit in the holes of the other plate, placing said plates with said units mounted thereon in a press, placing work to be perforated between said plates, and actuating the press to move said movable units to perforate the work.

30. A method of perforating work, which includes mounting a pair of plates one over the other in spaced relation to each other, forming holes simultaneously in both of said plates according to the pattern of the holes desired in the work, pressing die units into the holes of the lower plate and placing punch units each consisting of a stripper and a central punch through it into the holes of the upper plate with a sliding fit in such holes, the punch units being movable bodily relatively to the upper plate, toward and from said die units, accurately securing said plates in fixed relation to each other while outside the press with each punch unit in axial alinement with each die unit, placing said plates with said units mounted thereon in a press, and actuating said punch units by means of the press to perforate work placed between said plates.

31. A method of perforating work, which includes providing a pair of spaced plates rigidly secured to each other with holes to receive punch units and die units arranged according to the patterns of holes desired for a plurality of pieces of work, placing punch and die units into the holes in said plate according to one of said patterns, perforating the desired number of pieces of work according to such pattern, removing the punch units and die units from the holes of such pattern and placing them into the holes for another pattern, without separating said plates, and perforating work-pieces according to said other pattern.

32. A perforating apparatus including a punch carrier plate and a die carrier plate rigidly secured to each other in spaced relation, each of said plates having a series of holes formed therein according to the pattern of holes required in one work-piece, and another series of holes formed in said plates according to the pattern of holes required in another work-piece, and punch and die units usable alternately in either of said series of holes, whereby the same apparatus may be used for producing different types of work by placing punch and die units in different series of holes.

33. A perforating apparatus including a punch carrier plate and a die carrier plate rigidly secured to each other in spaced relation, each of said plates having a series of holes formed therein according to the pattern of holes required in one work-piece, and another series of holes formed in said plates according to the pattern of holes required in another work-piece, die units in the holes of one plate, and punch units removably arranged in one series of holes for operating on work of one type, and in another series of holes for operating on work of another type.

34. A perforating apparatus including a punch carrier plate and a die carrier plate rigidly secured to each other in spaced relation, each of said plates having a series of holes formed therein according to the pattern of holes required in a work-piece, each hole of one plate being in axial alinement with a hole of the other plate, a plurality of pairs of punch and die units each formed to be in accurate alinement with each other when positioned in an alined pair of holes, one of said units of each pair being insertable into operative position in its hole in its plate from the bottom of the plate and the other unit being insertable into its operating position in its hole from the top of the other plate.

35. A perforating apparatus including a punch carrier plate and a die carrier plate rigidly secured to each other in spaced relation, each of said plates having a series of holes formed therein according to the pattern of holes required in a work-piece, each hole of one plate being in axial alinement with a hole of the other plate, a plurality of pairs of punch and die units each formed to be in accurate alinement with each other when positioned in an alined pair of holes, said units having cylindrical portions formed to fit in said holes to hold said units in axial alinement with said holes, said die units being placeable into their operative positions by inserting them into the holes of the lower plate from the bottom face of the lower plate and said punch units being inserted into their operative positions from the upper face of the upper plate.

36. A method of perforating work which includes forming holes, in axial alinement, completely through a pair of plates while secured in spaced relation to one another, the holes being arranged according to the pattern of holes desired in the work, placing die units tightly into the holes of one plate and punch units, each consisting of a stripper and a central punch through it, into the holes of the other plate, placing this assemblage into a press, positioning work between said plates and moving the punch units relatively to their plate toward the units of the other plate by means of the ram of the press to perforate the work, each of said strippers upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work, after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

37. A method of perforating work, which includes forming holes completely through a pair of plates while secured in spaced relation to one another, the holes being arranged according to the pattern of holes desired in the work, placing die units tightly into the holes of the lower plate with their lower ends extending below said plate, arranging punch units, each consisting of a stripper and a central punch, slidably in the holes in the upper plate, placing this assemblage into a press with the lower ends of said die units supported by the bed of the press, positioning the work between said plates, and moving said punch

units in their holes in the upper plate toward said die units by means of the ram of the press to perforate the work, each of said strippers upon the upward movement of the ram, withdrawing their punches from the work while said strippers continue to press upon said work, after which said stripper and punch units are lifted away from said work and retained in elevated relation to said die units.

38. A method of perforating work-pieces of different types in a press, which includes assembling outside of the press for each different type of work, a perforating apparatus including a punch unit supporting plate carrying punch units and a die supporting plate carrying die units, said plates being spaced apart by supports and rigidly secured in fixed relation to each other, positioning an assembled apparatus in the press, with the dies of the die supporting plate resting on the bed of the press, perforating the desired number of work-pieces by means of the apparatus in the press, then removing the apparatus from the press and replacing it by another apparatus, for perforating other work-pieces, and removing the punch units from the assemblage without separating the plates.

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