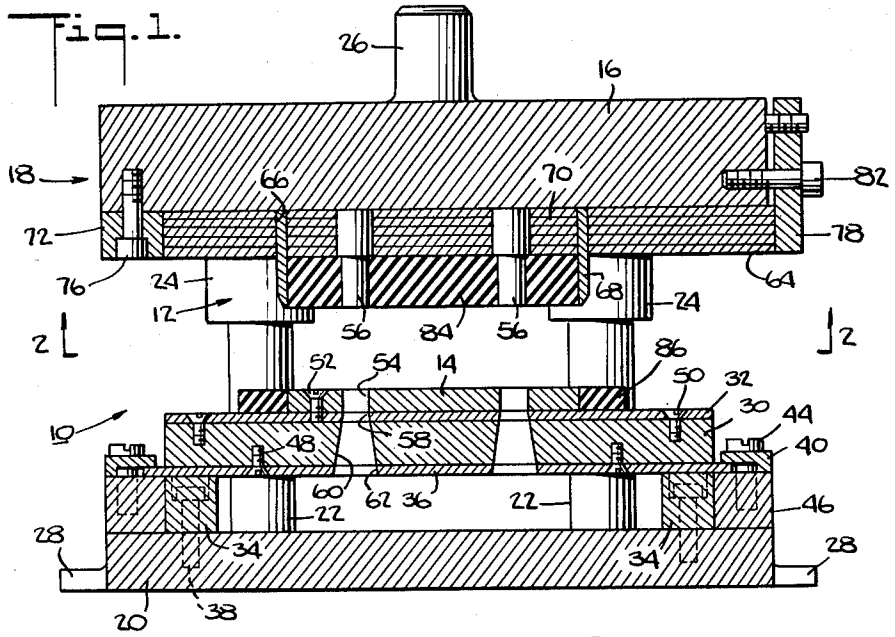
Sept. 29, 1964 M. BERLIN ETAL 3,150,550

RULE DIE AND PUNCH UNIT AND METHOD OF RESETTING THE SAME

Filed March 28, 1961 3 Sheets-Sheet 1

Fig. 1.



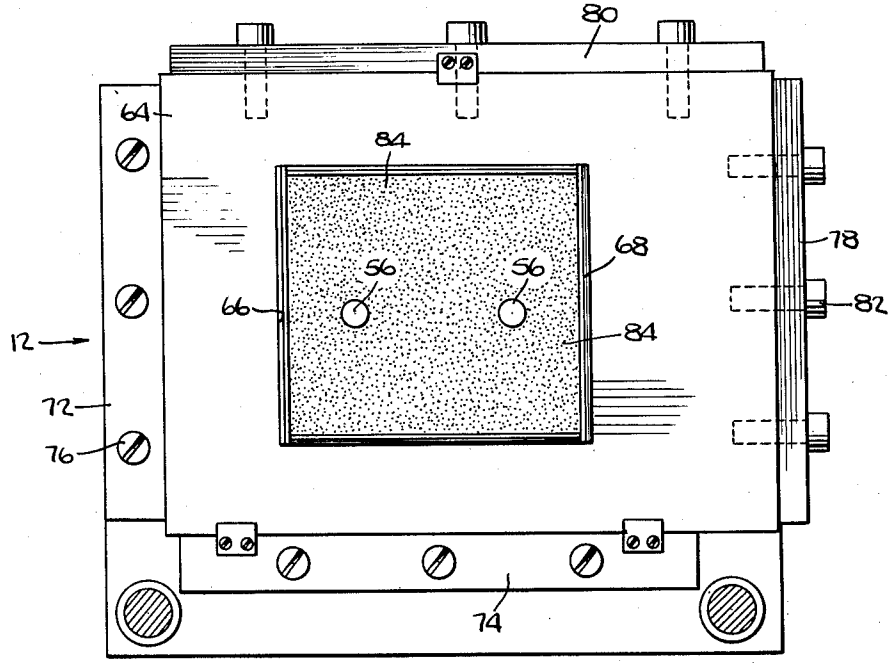


Fig. 2.

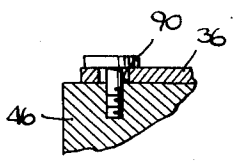


Fig. 3.

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Sept. 29, 1964 M. BERLIN ETAL 3,150,550

RULE DIE AND PUNCH UNIT AND METHOD OF RESETTING THE SAME

Filed March 28, 1961 3 Sheets-Sheet 2

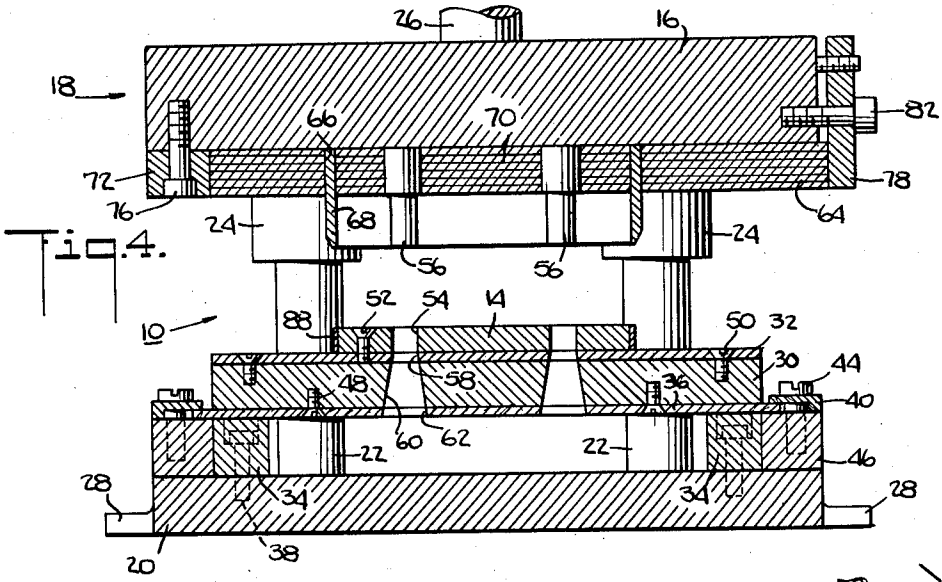


Fig. 4.

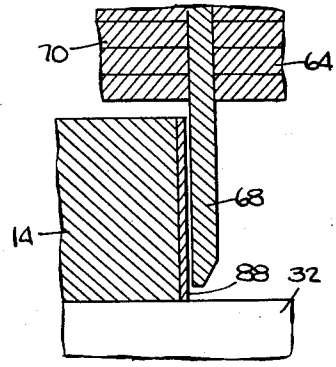


Fig. 5.

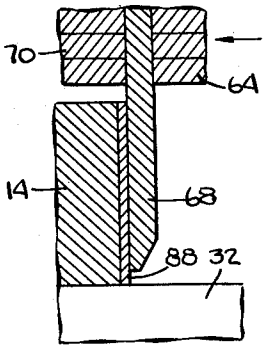


Fig. 6.

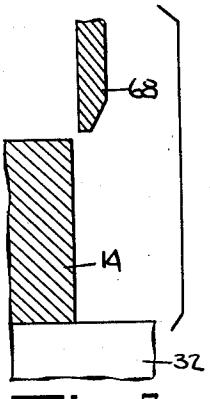


Fig. 7.

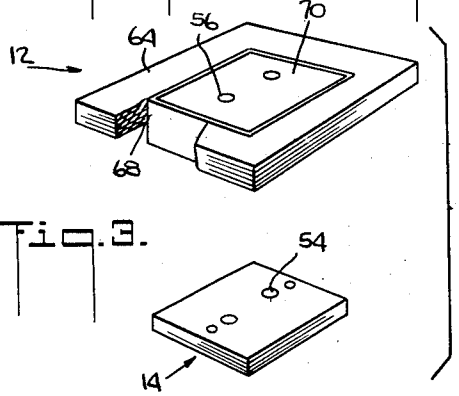


Fig. 8.

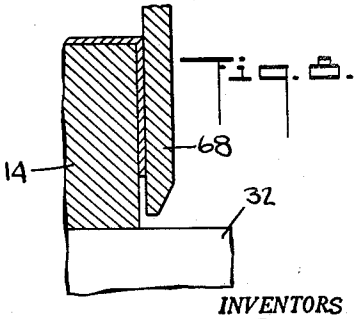


Fig. 3.

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Sept. 29, 1964 M. BERLIN ETAL 3,150,550

RULE DIE AND PUNCH UNIT AND METHOD OF RESETTING THE SAME

Filed March 28, 1961 3 Sheets-Sheet 3

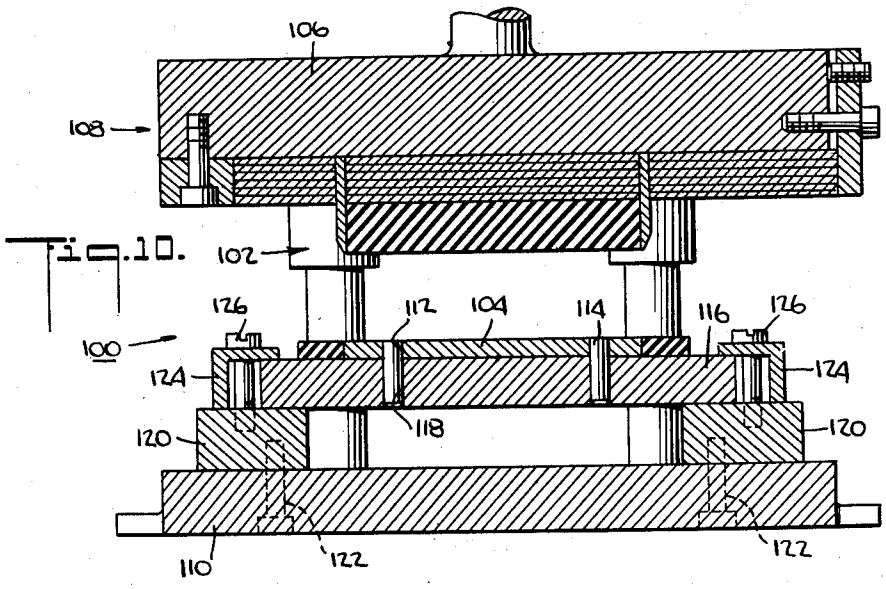


Fig. 10.

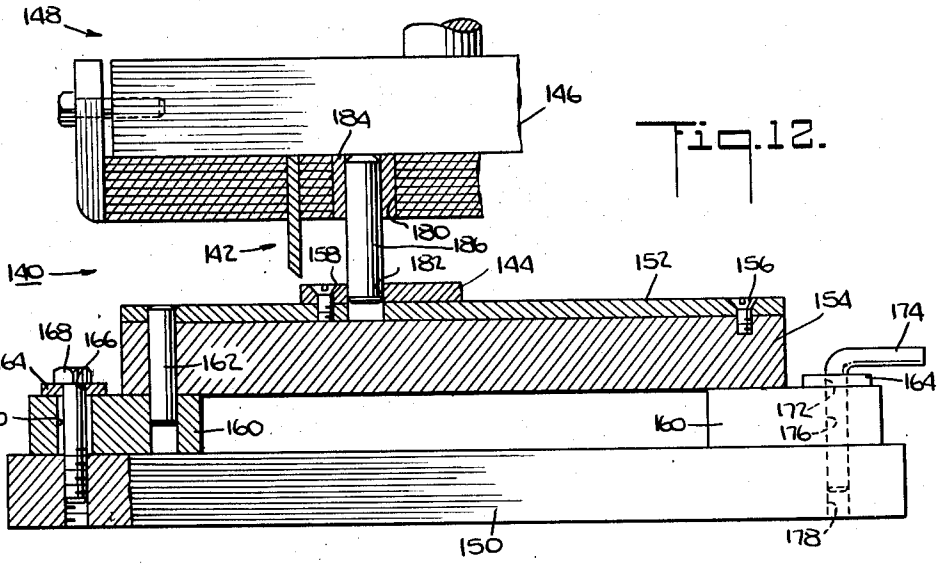


Fig. 12.

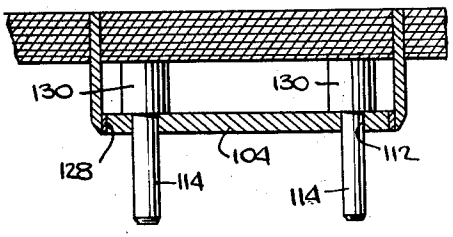


Fig. 11.

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United States Patent Office 3,150,550
Patented Sept. 29, 1964

3,150,550

RULE DIE AND PUNCH UNIT AND METHOD OF RESETTING THE SAME

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Filed Mar. 28, 1961, Ser. No. 98,866
18 Claims. (Cl. 83—13)

This invention relates to a rule die and punch unit and to a method of resetting the same after it has been made and taken apart.

The unit to which the present invention pertains is of the type shown, described and claimed in our United States Letters Patent No. 2,850,096 for Rule Die Set and Method of Making Same, issued September 2, 1958. In general said unit is characterized by the provision of a shaped male punch member and of a female die member relatively mounted as by a die set to reciprocate into and away from operative (nesting) engagement.

In particular the female die member of said unit is constituted by a pair, at least, of compressible die blocks made, for example, of die maker's plywood, with one (inner) block nested within an opening in the other (outer) block so as to mutually form an endless slot (a slot defining the perimeter of a closed shape) in which there is located a die blade (usually made up of plural sections) having a longitudinal edge portion protruding beyond one set of surfaces of the die blocks. The other edge of the die blade and the corresponding other surfaces of the die blocks are coplanar and are abutted against a rigid backing member, e.g. a shoe of the die set. The closed shape formed by the die blade approximately matches and is in approximate alignment with the shaped male punch member and is brought into proper match and alignment for shearing purposes by constricting the outer die block with a compression means that is carried by the rigid backing member and is adapted to squeeze the two blocks and the contained portion of the die blade. Such action additionally serves to rigidify the die blocks and the contained portion of the die blade. Said unit is customarily provided, by proper shaping, with clearance between the punch and the compressed die which clearance is suitable for the stock to be sheared, principally taking into account the thickness and material of the stock and also considering as a factor, the nature and height of the raised edge (burr) that will be tolerated in the piece to be fabricated.

After the unit has been made and has been used for a specified purpose, e.g. to shear, inter alia, a certain number of pieces and thereafter is to be stored for future use, or after the unit has been made at a plant and is to be shipped to another plant for use, the unit usually is dismantled, that is to say, disconnected from the die set, i.e. taken apart. This is done for several reasons. For example, die sets are too expensive to be tied up in storage (even in a single plant punch and die units are stored by the hundreds and often by the thousands) and the additional bulk and weight of the die set would aggravate the storage problem. Moreover, the weight and size of the die set would unduly complicate and increase the cost of shipment.

Present practice is to reset a unit of the character described in a fresh die set after a period of inactivity caused either by idleness between runs or by shipment. The resetting involves two problems, to wit, rematching the shape of the die to that of the punch, and realigning the die and punch. The need for rematching is occasioned by the release of compression on the blocks and the necessity of the realignment is due to both said release of compression and to the separation of the punch and the die from the original die set.

Prior to the present invention resetting of a unit of the character described has been a time consuming and sometimes unrewarding task. Thus assuming the blocks had been properly recompressed to secure the exactly correct original shape of the female die, when the punch and the die were brought together in the fresh die set the female die easily could be damaged if alignment was incorrect and if the die set were closed too far, since the female die, being composed of a die blade, was not sufficiently sturdy, as was, for example, a solid female die (a female die carved out of a block of die maker's steel), to withstand an improper mating of the punch and the die. Accordingly great care had to be exercised in order to secure correct alignment as well as proper clearance on all sides of the punch. Moreover, proper recompression was most difficult because of many variables. For instance, the order in which the compression bolts were retightened varied the compressed shape of the female die and so did changes in temperature and humidity and exposures to different conditions during shipment or storage, so that even if the compression bolts were retightened to their original settings (the original torques being repeated) it was unlikely that the blocks would be recompressed to a condition in which the exactly correct original shape of the female die would be reconstituted. Therefore, as will be appreciated, the resetting of a unit was a tedious and lengthy operation.

It is an object of our present invention to provide a unit of the character described and method of resetting the same which avoids all the foregoing drawbacks.

It is another object of our present invention to provide a unit and method of the character described which enable a punch and rule die to be quickly and easily reset to correct clearance, alignment and match after the unit has been disassembled.

It is another object of our invention to provide a unit of the character described which avoids damage to the unit upon resetting by obtaining correct clearance, alignment and match before allowing the punch and die to be meshed prior to compressing the die blocks.

Other objects of our invention in part will be obvious and in part will be pointed out hereinafter.

Our invention accordingly consists in the features of construction, combinations of elements, arrangement of parts, and series of steps which will be exemplified in the devices and methods hereinafter described, and of which the scope of applicatiton will be indicated in the appended claims.

In the accompanying drawings, in which are shown various possible embodiments of our invention,

FIG. 1 is a vertical sectional view through a unit constructed in accordance with our present invention, the same being shown as it appears when initially fabricated, i.e. as initially aligned and matched;

FIG. 2 is a bottom plan view of the female rule die, the same being taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is a perspective partially broken-away view of the female rule die and the shaped male punch member as they appear when removed from their die set and auxiliary supports, as for the purpose of storage or shipment;

FIG. 4 is a view similar to FIG. 1 but showing the unit during an early stage of resetting;

FIGS. 5, 6 and 7 are detailed sectional views of the unit to a larger scale than FIG. 4, and illustrating progressive steps, subsequent to that shown in FIG. 4, which are practiced during resetting;

FIG. 8 is a view similar to FIG. 6 of a modified form of our invention;

FIG. 9 shows a further modified form of our invention; and

FIG. 10 is a view similar to FIG. 1 of another modified

form of our invention, the female rule die and shaped male punch member being illustrated as they appear when initially fabricated;

FIG. 11 is a vertical sectional view of the female rule die and shaped male punch of FIG. 10 but illustrating the same during an earlier stage of resetting; and

FIG. 12 is a view similar to FIG. 1 of a female rule die and shaped male punch embodying still another form of our invention.

In general we carry out our invention so as to achieve the several objects thereof by providing a compressible female rule die member and a shaped rigid male punch member wherein one or the other of the members is floatable when the punch and die unit is reset. That is to say, such member is shiftable relative to the other member in any direction for resetting in a plane perpendicular to the direction in which said members move relative to another for mating engagement, said floating action being cancellable at will so that once a certain relationship has been achieved between the two members (the unit properly reset), said relationship may be maintained for the duration of a run.

The desired relationship is one in which three conditions are present. First, the shape of the compressible female rule die member should match the shape of the rigid male punch member. The shapes match when they are, so to speak, similar, "similar" being employed in its geometrical sense to indicate of the same contour but not necessarily the same dimensions. The shapes will be identical where no clearance is to be present and the shape of the female rule die member will be slightly (up to a few thousanths of an inch) larger than the shape of the rigid male punch member when clearance is to be provided. Second, a proper desired clearance should be provided assuming, as indicated above, that it is desirable to have clearance in any given punch and die unit. Third, the female rule die member and the shaped rigid male punch member should be aligned so that they can be meshed or mated for whatever purposes the punch and die unit is to be used.

It will be observed that these three conditions i.e. matching of shape, clearance and alignment necessary to achieve a desired relationship, represent a balance between the compression of the female rule die member and the relationship between the two members obtained by shifting the floating member. The compression of the female rule die member enables shapes to be matched and the proper theoretical clearance to be obtained. The shifting of the members relative to one another enables alignment to be achieved and the clearance to be properly distributed around the peripheries of the two members.

When a punch and die unit incorporating correctly coordinated punch and die members is taken apart the compression of the female rule die member is lost as is the proper relationship between the two members and these must be reestablished if the punch and die unit is to be reused. As a practical matter it will suffice if the desired three conditions are effective reestablished, i.e. reestablished with an excellent degree of approximation of the original conditions. To simplify the description of our invention we will hereinafter refer to the substantially exact reestablishment of said conditions as a "fine" readjustment and to a closely approximate reestablishment of conditions as "coarse" readjustment. A course readjustment usually will suffice for realignment, match and clearance where clearances are not critical, that is to say where a slight variation in clearances will be tolerated or acceptable. This type of readjustment will suffice for run of the mill fabricating operations which constitutes the major portions of punch and die work. A fine readjustment is employed where parts being made have to be formed to extremely close tolerances or where tough or hard materials are to be blanked or where an absence of burr is required. (viz. motor laminations).

In general, coarse readjustment is secured as hereinafter will be pointed out in detail in connection with our invention, by the use of pin and hole readjusting means which are brought into play before the floating member is tied down i.e. clamped in an adjusted position. Fine readjustment is obtained by the use of shims. We will, hereinafter, in describing our invention, first outline methods of fine adjustment and thereafter detail a method of coarse readjustment.

Referring now to FIGS. 1 and 2, we there have shown an almost conventional rule die and punch unit **10**; the single improvement in the apparatus will be pointed out hereinafter. Said unit comprises a female rule die **12** and a rigid male punch **14**. The die **12** is securely mounted in the upper shoe **16** of a die set **18**. The punch **14** is securely mounted in the lower shoe **20** of said die set **18**. The two shoes of the die set are interconnected for relative translatory movement toward and away from one another as by a pair of parallel guide pins **22** rigidly fastened and projecting from one of the shoes, e.g. the lower shoe **20**, and linearly slidably received in tubular antifriction bearings **24** rigidly anchored in the other shoe. The bearings **24** or the pins **22** may include ball bearing sleeves or bushings to minimize friction. The die set is adapted to be actuated by any suitable reciprocating power machine, e.g. a press with, conventionally, the upper shoe **16** affixed to the press ram and the lower shoe **20** affixed to the press anvil. To expedite the connection to the press the upper shoe may be provided with an upwardly extending shank **26** and the lower shoe with laterally extending ears **28**.

The shaped rigid male punch **14** is a thin, flat piece of metal, preferably steel, that is adapted to support, in elevated position that portion of a panel or strip of sheet stock which conforms to the piece to be blanked, i.e. said portion is supported by the punch and the remainder of the panel or strip overhangs the punch. Said punch has substantially the contour of the piece to be blanked, i.e, is of identical shape and dimensions save for punch and die clearances that are well known to the tool maker. The punch is rigidly secured to and is supported by the lower shoe through various intermediate (auxiliary) members which, by and large, are conventional, with an exception to be noted, said members being employed for several reasons, e.g. to avoid mutilations of the shoe caused by drilling of new holes for every new size and shape of punch and to avoid mutilation of the shoe caused by the cutting of new holes for passing every new size, shape and position of scrap from holes to be punched out of pieces being sheared. The conventional intermediary (auxiliary) members constitute a flat primary adapter plate **30**, a flat secondary adaptor plate **32** and a pair of parallel bars **34**. An additional auxiliary member, which may, at this stage, be employed pursuant to our invention although, as soon will be appreciated, is not now essential, is a flat floating base plate **36**.

The parallel bars **34** are spaced apart from one another and rest on the lower shoe, being secured thereto by parallel bar tie down bolts **38**. The floating base plate **36** rests on the parallel bars and thereby provides a clear space therebeneath over the lower shoe into which scrap may fall and from which it may be removed.

The base plate must be firmly held to the lower shoe or to the parallel bars and any suitable arrangement can be utilized to this end. For example, the base plate can be fastened by screws to the parallel bar, these being secured by the bolts **38** to the lower shoe. Preferably a pair of opposite edges of the base plate protrude outwardly from under the corresponding edges of the primary adaptor plate and are fixed in position by a series of base plate clamps **40**. These clamps are essentially L-shaped elements having the long legs thereof overlying the upper faces of the marginal protruding zones of the base plate and having the short legs thereof substantially vertically disposed outwardly and alongside of the opposite protruding edges of said base plate. The long legs of the clamp are formed with vertical through openings that

receive the shanks of bolts **44** the heads of which press down against the clamps and the threaded shanks of which are clear of the base plate and are screwed into tapped openings in clamp base blocks **46** that are secured as by bolts (not shown) to the lower shoe **20** of the die set.

The primary adaptor plate **30** rests on the floating base plate **36**, being securely affixed thereto as by screws **48**. The secondary adaptor plate **32** rests on the primary adaptor plate, being securely affixed thereto as by screws **50**. The shaped rigid male punch **14** rests on the secondary adaptor plate, being securely affixed thereto as by screws **52**.

The punch **14** includes openings **54** adapted to cooperate with punches **56** which may be provided as necessary and which, when provided, are functionally integral with the rule die **12**. Said openings **54** are in registry with aligned openings **58**, **60** and **62** in the secondary adaptor plate, the primary adaptor plate and the floating base plate respectively so as to pass scrap punched out of blanks sheared by the unit **10**.

The female rule die **12** is entirely conventional. It includes an outer die block **64**, having an opening **66** therein. The opening is lined with one or more rule die blades **68** that define a hollow, closed die shape which matches the shape of the male punch **14**. An inner die block **70** is positioned within the opening **66** and is a tight fit against the inner surface of the die blades.

Customarily the two die blocks are formed as by cutting through a panel with a band saw that leaves a kerf the width of which is slightly less than the thickness of the die blades so that the edge of the opening **66** complementally matches the periphery of the inner die block **70**. The upper (concealed) edges of the die blades **68** and the upper (concealed) faces of the die blocks **64**, **70** are copanar and abut against the lower face of the upper shoe **16** which functions as a rigid backing member. The width (height) of the die blades exceeds the thickness (height) of the die blocks so that longitudinal edge portions of the die blades protrude, usually uniformly, beyond the lower faces of the die blocks toward the rigid male punch **14**.

The die blocks are made of solid compressible material, customarily die marker's plywood. In order to rigidify the portions of the die blade sections that are wedged in the slot (kerf) between the die blocks, to exactly match the die shape to the punch shape (the initial shape of the female die as solely determined by the shape of the kerf, is larger than the outline of the male punch), to exactly align the punch and die, and to provide the proper clearance between the punch and die, the female rule die **12** is provided with a peripheral compression means that is arranged to constrict, i.e. to squeeze, the two blocks and the contained portions of the die blades.

Said compression means is carried by the upper die shoe. For convenience the upper die shoe and the compression means are rectangular and the compression means includes two fixed banks **72**, **74** that are perpendicular to one another and are secured as by bolts **76** to two perpendicularly related edges of the upper shoe. The compression means further includes two movable banks **78**, **80** that are perpendicular to one another and are adjustably secured as by bolts **82** to and in slightly spaced relationship from the two remaining perpendicularly related edges of the upper shoe. Thus each movable bank is parallel to and is adjustable toward and away from a different fixed bank. By variably tightening the bolts **82**, the die blocks and the die blades are subjected to the desired degree of compression. Adjacent portions of the die blades are spaced apart from one another initially to a slight extent so as not to interfere with such compressing action.

Conventionally the female rule die is provided with an internal stripper **84** constituting, for example, one or more pads of or a block of resilient material; and the male punch is provided with a circumscribing stripper **86** which may take on the form of one or more pads of or a block of resilient material.

The unit **10** is made is any well-known manner. For example, the female die can be made first from a pattern and then the male punch fashioned with the aid of the female die; or the male punch can be made first from a pattern and the female die then fashioned with the aid of the male punch; or both the female die and the male punch can be made at the same time from a common pattern.

Thus, by way of illustration, a pattern is laid on a plywood panel and an oversized outline thereof transferred onto the panel. The outline is cut with a band saw to make the inner and outer die blocks. Die blades are inserted in the opening in the outer block or around the periphery of the inner block and the inner block is forced into the opening; the assembly of the two blocks and the die blades is seated upon an upper die shoe and the movable banks are forced toward the fixed banks to secure the desired rigidification and the desired shape of the female die.

The male portion now can be fashioned from the female die in any desired manner. One way is to press the female die against punch stock so as to transfer the shape of the die to the stock and thereafter to cut the stock to the desired matching shape making certain to leave proper clearances. Another way is to cast the punch with a solidifiable fluid material, e.g. a epoxy resin or a low melt metal in the female die, using the latter as a mold and, here too, providing proper clearances as by trimming the finished (cast) punch or lining the die, e.g. with a removable film, before casting. Still another way is to form the punch from the die as by electro-erosion as is illustrated and described in our copending application Serial Number 41,617 filed July 8, 1960 for Rule Die Set and Method of Making Same.

If the male punch is made first as by transferring the shape of the piece to be cut, or the pattern, to punch stock and cutting the stock to make the punch before the female die is made, the shape of the punch subsequently is transferred to a plywood panel and the female die then made by the steps above described.

Both the punch and the die can be made together by simultaneously transferring the shape of the piece to be cut, or the pattern, to punch stock and to a plywood panel or by cutting both the punch and the panel simultaneously, and by thereafter using the steps described above to complete the punch and the die.

In any event, the punch and the die as originally (initially) made will, in effect, be hand fitted to one another so as to secure precise match and precise alignment of the punch and the die as mounted in the die set and so as to secure proper selected clearances between the punch and the die as thus mounted. Moreover as originallly made, the female die occupies a definite orientation with regard to the upper die shoe of the original die set, being so held by the fixed and movable banks; and the male punch occupies a definite orientation with regard to the lower die shoe of the original die set, being so held by the plates **30**, **32**, **36** and the bars **34**.

It may be mentioned that the primary and secondary adaptor plates **30**, **32** and the bars **34** are employed as a matter of convenience and could, if desired, be omitted to leave an operable, although not as commercially desirable, unit **10**. Also, as originally made, the unit **10** need not include the floating base plate **36**, although it is desirable to interpose at least one plate between the rigid male punch and the lower die shoe. Such interposed plate can be immovably secured to the lower shoe as with screws and may constitute the plate **36** described in the combination above, but nonshiftably held to the base block **46** with screws or bolts without adjustment clamps. Indeed, in the combination described, when the unit originally is made the clamps **40** are not

used for adjustment, but rather are set in some given position to form part of a nonshiftable support for the male punch. However we prefer to use a base plate **36** in the unit **10** as initially made, principally to accustom a mechanic to its presence.

After the unit **10** is completed it is disassembled. Sometimes it is disassembled as soon as it is finished, this being the case where the unit is made at one plant for use at another plant and is disassambled to expedite shipment to such other plant. Obviously, the unit will be tested by one or more trial runs before such disassembly. Other times the unit will be placed in production for as long as required, and after the run is completed will be disassembled for storage. In either event, by virtue of the disassembly, the unit **10** loses the nice individually fitted interrelationship between its various parts, and in particular between the punch and the die. It loses the correct compression of the die that secured the desired degree of rigidification of the die blocks and of the blade sections and on the basis of which there was secured the desired match between the punch and the die, as well as the proper all around clearance at all portions of the punch and the die. It also loses the precise alignment between the punch and the die. The disassembly involves releasing the die blocks **64, 70** from the banks **72, 74, 78** and **80** and releasing the punch **14**, plates **30, 32** and **36** and bars **34** from the lower die shoe **20**.

As stored or shipped the female die **18** minimally comprises the outer and inner die blocks **64, 70** and the blade sections **68**; the upper stripper member **84** may or may not be included. As stored or shipped the punch minimally comprises the rigid male punch; the lower stripper member **86** may or may not be included, the bars **34** usually are not included; the floating base plate **36** may not be present in the unit as originally made but, if present, usually is included with the disassembled punch; the primary and secondary adaptor plates **30, 32** may or may not be included with the disassembled punch. The minimal punch and die for storage or shipment is illustrated in FIG. 3.

Heretofore the unit **10** was reassembled in an empirical fashion which was somewhat hit-or-miss. It was the custom to note the torque applied to the adjusting bolts **82** when the female die was made up originally and to reapply the same torque in a fresh die set for reassembly, trusting that the original shape thereby would be reimparted to the female die. The male punch was mounted in the lower shoe of the fresh die set, lining it up with the female die by eye. Then the die set was partly closed to check alignment. If alignment was incorrect, the position of the male punch was shifted or the bolts **82** of the female die were reset to vary alignment. When alignment seemed to be satisfactory the unit was tested by cutting sheet stock to ascertain whether the all around clearances were proper for correct shearing. When, as usual, the clearances were improper, the shape of the female die was varied by readjusting the bolts **82** until eventually the requisite clearances all around the unit were once again achieved. This process was clearly tedious and time consuming and, on occasion, marred the die or punch when the die set was closed too hastily for checking alignment, match and/or clearance.

We have by the present invention avoided the aforesaid cut-and-try method and, in lieu thereof, provided a process that enables a mechanic quickly and accurately to reassemble the unit **10** in a fresh die set with the punch and the die correctly matched and aligned. One embodiment of such process is illustrated in FIGS. 4–7 wherein we have illustrated a method of fine readjustment. In said figures all parts of the reassembled unit have been denoted by the same reference numerals as those previously employed in describing the unit as originally made despite the fact that in the reassembled unit some other parts may have been used, it being understood that these other parts are of essentially the same construction as the original similarly numbered parts.

The female die **12** is mounted on the upper shoe **16** of the fresh die set and the bolts **82** lightly tightened to hold the die firmly but without appreciably compressing the outer and inner die blocks **64, 70**. Desirably the upper stripper **84** is removed (if it still is present) in the process of reassembling the unit **10**.

The male punch **14** is mounted on the lower shoe **20** of the fresh die set, using the old plates **30, 32, 36** (or new ones if desired) and using the old bars **34** (or supplying fresh ones). If no floating base plate **36** was used in making the unit **10** originally (and this frequently may be the case) a new base plate **36** is provided in the reassembled unit. The male punch is rigidly fastened to the adaptor plate (or plates) and the adaptor plate (or plates) is rigidly fastened to the floating base plate **36**. The bars **34** (if such are employed) are rigidly fastened to the lower die shoe **20**. The clamp base blocks **46** (if used) likewise are rigidly fastened to the lower die shoe. The floating base plate rests on the bars **36** and blocks **46**, being freely movable horizontally over the same in two orthogonal directions at right angles to the direction of relative movement of the two die shoes inasmuch as the clamp bolts **44** are at this time loose. Thus, in effect, the male punch is secured to the floating base plate and said base plate is freely shiftable in any horizontal direction (within limits, e.g. as determined by the location of the shanks of the clamp bolts) over the horizontal upper face of the lower die shoe. The intermediary members **30, 32, 34** are conventional and form no part of our present invention being employed simply for convenience. Desirably the lower stripper **86** is removed prior to reassembly of the unit **10**.

Further pursuant to the form of our invention now being described, a shim is circumscribed around the vertical peripheral edge of the now floating (laterally shiftable in any horizontal direction) rigid male punch **14** to secure fine readjustment. It should be observed that at this time the female die, because it is substantially uncompressed, defines a closed shape that is larger than the punch **14** by an appreciable amount although of substantially a similar contour; we should make it clear that the term "appreciable" as just used herein has as a base of reference the original punch and die clearance so that the space between the substantially uncompressed die and the punch is, preferably, in the reassembled unit a few times larger than the original clearance, e.g. the clearance at such time is in the order of several thousandths of an inch (the original clearance is in the order of a few thousandths of an inch, for instance three thousandths of an inch or less at any point).

In the form of our invention now being described the shim for the rigid male punch comprises a strip **88** (or strips) of soft, i.e. or readily bendable or deformable, material such as soft copper, soft iron, soft steel, soft aluminum, soft brass, tin, lead, paper, soft synthetic plastic sheeting, fibre, cloth or canvas stock, desirably foil or shim stock, that is to say, pliable sheet stock of uniform exact predetermined thickness. The width of the shim strip preferably is about equal to or less than (or if desired substantially greater than) the height of the rigid male punch **14** and said strip is placed about the periphery of the punch, being bent, optionally by hand pressure, against the periphery of the punch, so as to snugly and closely conform to the contour thereof.

The thickness of the shim strip is equal to the clearance which is to be present in the reassembled unit **10** between the punch and the die. The shim strip is applied about the edges of the punch while the fresh die set is in open position as shown in FIG. 4. The shim strip will retain its position around the punch by virtue of the slight rigidity (self-form-maintaining characteristic) of the shim stock and because the shape imparted thereto by bending to conform to the punch reinforces said stock. If desired, the shim stock may have an adhesive coated (pressure-

sensitive) face to aid in temporarily securing it to the punch. Although the shim strip need not cover the entire periphery of the punch, it should, as soon will be appreciated, cover substantially the entire periphery in order to accomplish its desired function.

Now the floating rigid male punch, ensheathed with the shim strip, is approximately aligned, e.g. visually, with the female die and the die set thereupon is closed as is shown in FIG. 5. The alignment is performed by hand or if the punch unit is heavy, with the aid of screws, cams, wedges, etc. There is no real danger of harming the rule die blades by such closure since the then existing clearance between the punch and the die is considerable (appreciable) and since the punch is effectively ensheathed in a compartively soft material (soft in relationship to the material of the die blades) that is incapable of damaging the die. The then existing clearance is so large that there will be a clear space (see FIG. 5) between the outer surface of the ensheathing shim strip **88** and the inner surface of the die blades **68** that define the female die. This clear space allows the ensheathed rigid male punch to shift within the confines of the then oversized female die.

Next the compression bolts **82** are tightened. The torque necessary to turn these bolts increases gradually as the movable banks compress the die blocks and die blades and will increase sharply (suddenly) when the die blades exert clamping pressure on the ensheather periphery of the punch which is far less yieldable than the die blocks, in other words when the die blades constrict upon and grip the ensheathed rigid male punch, i.e. when all portions of the die blades engage and press against the shim strip which is wrapped about the periphery of the punch, such condition being illustrated in FIG. 6. This marks the proper degree of compression so that the compression bolts **82** are tightened no further. As the bolts **82** are being tightened, the ensheathed rigid male punch is free to shift about horizontally in any direction so as to accommodate its position to the constricting shape of the female die; i.e. as the contour of the female die decreases some part thereof will touch a portion of the periphery of the ensheathed rigid male punch and said punch then will be moved by said part of the die as the size of the die is further reduced until no further movement is possible because the entire periphery of the ensheathed rigid male punch is being squeezed and gripped by the female die (the shim stock is relatively incompressible in comparison to the compressibility of the die blocks). It will be appreciated that at such moment not only is the clearance between the punch and the die proper and not only is the shape of the die properly matched to the shape of the punch, but the alignment between the punch and the die also is proper for operation.

After the compression bolts **82** have been tightened to bring about the conditions just described the clamping bolts **44** are tightened to actuate the clamps **40** and thus to prevent further lateral (horizontal) movement of the floating base plate so that said plate and the punch **14** are fixedly tied to the lower shoe **20** of the fresh die set in correct alignment with the female die that is itself fixedly tied to the upper shoe **16**. Thereby the female die is simultaneously matched and aligned with the male punch while the proper clearances automatically are provided through the medium of the shim strip.

Finally, the die set is opened and the shim strip **88** is removed as indicated in FIG. 7. The upper and lower strippers **84**, **86** are replaced (or fresh strippers supplied) and the unit **10** is ready for operation.

The proper clearance can be added around the periphery of the rigid floating male punch by means other than the shim strip **88** preparatory to constricting the female rule die around the same. For example, said periphery can be coated with a fluidifiable material that is solid at room temperatures by any controlled procedure that will leave a film of an exact predetermined thickness. Such material can comprise a solution or a dispersion of a solid in a volatile liquid carrier, or a low melt fluid, e.g. a heat fluidifiable thermoplastic resin, or a heat fluidifiable waxy material, or a low melt metal alloy. The edge coating of the rigid male punch can be formed by dipping, brushing or spraying so as to effect a controllable uniform thickness.

Alternatively, and as shown in FIG. 8, a sheet of a soft pliable shim material of the proper thickness for clearance may be draped over the top of the rigid male punch, the sheet being larger than the punch so that its marginal portions can be turned down to ensheath the periphery of the punch; however the sheet should be preshaped so as to prevent the accumulation of excess material at any part of the periphery or base of the punch. Said marginal turned down portions are pressed against the edge of the punch to accomplish the desired peripheral ensheathing. Thereafter the process is carried out as above described, FIG. 8 illustrating the appearance of punch and die after constriction of the female rule die on the punch.

We desire to point out that the physical arrangement utilized to selectively tie the floating base plate to the lower shoe **20** of the die set may assume other forms. For instance, the base plate may be selectively held in a fixed manner to the blocks **46** in the absence of clamps by bolts **44** having their shanks located beyond the periphery of the floating base plate and spaced therefrom, and having their heads arranged to overhang the marginal edge zones of said plate for direct engagement therewith; or the shanks of the bolts can be located in oversized slots (not shown) in the sides of the floating base plate so as to allow free movement (between limits) of said plate until the bolts are tightened to clamp the plate in any adjusted position; or the shanks of said bolts **44** can be located in oversize openings **90** in the base plate **36** for the same purpose and use.

If desired, we may obtain fine readjustment in a different manner, to wit, by ensheathing the rigid male punch in a shimming peripheral layer, by compressing the female rule die about the ensheathed rigid male punch, and only thereafter by coupling the clamped male punch to a floating element carried by a shoe of the die set to which shoe said floating member subsequently is clamped. Such an alternate arrangement and method is illustrated in FIGS. 10 and 11. FIG. 10 illustrates the punch and die unit as it is made originally and FIG. 11 illustrates a step in the reassembly of the same after it has been taken down.

Referring to FIG. 10, the reference numeral **100** denotes the punch and die unit. Said unit comprises a female rule die **102** and a rigid male punch **104**. The die **102** is securely mounted on the upper shoe **106** of a die set **108**. The punch **104** is securely mounted in the lower shoe **110** of said die set. The two shoes of the die set are interconnected for relative translatory movement toward and away from one another by a pair of parallel guide pins and antifriction bearings (not shown). The die set is adapted to be mounted on the ram and base of a reciprocating power machine, e.g. a press.

The shaped rigid male punch **104** is a thin flat piece of metal, preferably steel, in the shape of the piece to be blanked. To carry out this embodiment of our invention, the punch is formed with a pair of openings **112** in which are snugly slidedly fitted the upper ends of alignment pins **114**. Said alignment pins project below the undersurface of the punch and, desirably, their lower ends are tapered, e.g. rounded or chamfered.

The punch **104** is supported by a flat adaptor plate **116** having a pair of vertical openings **118** that snugly slidably receive the alignment pins **114**. The adaptor plate **116** rests upon a pair of spaced blocks **120** that are firmly secured to the lower shoe **110** as by bolts **122**.

The adaptor plate **116**, together with the rigid male punch **104**, can be shifted over the blocks **120** in a plane

perpendicular to the direction of relative movement of the two die shoes toward and away from one another, this being the floating action that is desired and was mentioned heretofor. The adaptor plate can be fixed, i.e. tied down, in any position by clamps **124** which are L-shaped pieces having one set of horizontal legs thereof overlying the upper face of the adaptor plate **116** adjacent the edges thereof and having the other set of vertical legs thereof substantially vertically disposed outwardly and alongside of the edges of the adaptor plate. The horizontal legs of the clamps are formed with through openings that receive the shanks of bolts **126** the heads of which press down against the clamps and the threaded shanks of which are clear of the adaptor plate and are screwed into tapped openings in the block **120**.

The female die rule **102** is identical to the female die rule **12** and, therefore, will not be described in detail. It includes the customary inner and outer die blocks of compressible material and the shaped rule die blades that project from the die blocks to form the hollow female die rule. It also includes the compression means, i.e. the fixed and movable banks.

Initially the compressible female die rule **102** and the rigid shaped male punch **104** are hand, i.e. individually, fitted to one another so as to secure precise match, precise alignment and the proper selected clearance and are provided with upper and lower resilient strippers.

When it is desired to reset the punch and die after they have been disassembled, fine readjustment can be obtained as follows:

The female rule die **102** is inserted in the upper shoe of a fresh die set and the compression means is made up lightly, just enough to hold said die to the upper shoe, e.g. the bolts of the compression means are made up finger tight. The adaptor plate **116** is placed on the blocks **120** of the fresh die set with the bolts **126** loose enough to allow said adaptor plate to float, i.e. shift, in a horizontal plane with respect to the blocks. If desired, the bolts **126** can be tightened lightly so as to prevent the adaptor plate **116** from slipping accidentally and yet allow it to be moved about deliberately. All of the foregoing is accomplished with the fresh die set open.

The shaped rigid male punch **104** is separated from the adaptor plate **116** and is ensheathed with a shim layer **128** which may be shim stock or foil or a solid layer of material applied in a fluid state, the thickness of said layer being equal to the desired clearance. The thus ensheathed punch is inserted in the female rule die which is still not fully compressed, the appearance of the unit at this time then being as indicated in FIG. 11. It will be observed that in the aforesaid stage of operations the stripper of the female rule die need not be, and preferably is not, present. It further should be mentioned that in the preferred embodiment of this form of our invention the ensheathed rigid male punch is located at the rim of the female rule die in which position it may be blocks. To obtain and maintain any desired spacing we spaced from the compressible die blocks depending upon the extent to which the die blades project from the may place spacer blocks **130** on the upper surface of the ensheathed rigid punch **104** before telescoping the same into the female die, the spacers being of the proper height to locate the punch at the desired level in the female rule die.

Now the bolts of the compression means associated with the movable banks of the female rule die are tightened, e.g. by hand or with torque wrenches, to compress the die blocks and to constrict the die blades into clamping engagement with the periphery of the ensheathed rigid punch thereby to once again reset the shape of the female die rule to its proper contour and dimensions, this being defined by the ensheathed punch acting as a fine readjustment templet.

During the foregoing operations the die set remains open.

It will be apparent that the punch and die now have been finally readjusted. However, the punch is unsupported, that is to say it neither rests on nor is tied to the lower die shoe. To accomplish this we, in the next step, insert the alignment pins **114** into the openings **112**, it being observed that the prevent loss or misplacement of parts it is within the scope of our invention to allow said pins to remain in these openings when the punch and die unit are disassembled for storage or shipment.

At this stage of reassembly the upper die shoe holds the compressed female rule die which in turn is constricted about the ensheathed rigid punch from which there depend the two alignment pins **114**. The adaptor plate **116** is located below the alignment pins on the blocks **120**. Said plate is shifted, e.g. manually, until to the eye of the operator, the holes **118** in the plate appear to be directly beneath the alignment pins. The ram of the reciprocating power mechanism is lowered slowly and said alignment pins will enter the openings **118**. If the registry between said pins and openings was not exact it is readjusted by the operator during the lowering process or if, as indicated, the lower ends of the pins are tapered said tips will enter the openings **118** and shift the adaptor plate to its proper readjusted position.

Thereafter the bolts **126** are firmly tightened to tie, i.e. lock, the floating base plate **116** to the lower shoe. The die set now is opened and the shim layer **128** removed whereupon the punch and die unit are ready for operation.

In the constructions thus far described, we have shown how a fine readjustment of the originally hand matched punch and die unit can be secured; but, as noted heretofore, this extreme exactness frequently is not required and in many instances a coarse readjustment will suffice. This can be obtained with the use of a floating member in a punch and die unit including a compressible female rule die with a somewhat simpler arrangement and with a somewhat simpler series of steps which do not entail the use of a shim layer but instead use a pin and hole readjusting means. Such an arrangement and the concomitant process now will be described.

In FIG. 12 we have illustrated a punch and die unit **140** which is specially constructed and arranged so that it is readily resettable by a coarse readjustment, that is to say so that it is resettable in a manner such that match, contour and clearance will once again be set back into the unit with sufficient exactitude to meet ordinary commercial requirements.

Said unit **140** includes a female rule die **142** and a rigid male punch **144**. The die **142** is securely mounted in the upper shoe **146** of a die set **148**. The punch **144** is securely mounted in the lower shoe **150** of said die set. The two shoes of the die set are interconnected for relative translatory movement toward and away from one another as by a pair of parallel guide pins and cooperating bearings (not shown). The die set is adapted to be connected to a ram and anvil of a reciprocating power machine.

The female rule die **142** is essentially similar to the rule die **12** and therefore will not be described in detail. It includes the usual outer and inner compressible die blocks, the die blades and the peripheral compression means including for example, fixed and movable rectilinear banks. The female die rule **142** further includes another element which is not present in the die rule **12** and which is provided pursuant to the present phase of our invention, but the description of this element will be reserved for a later point in the specification where it will be detailed in connection with a corresponding element of the punch **144**.

The shaped rigid male punch **144** is a flat piece of metal, preferably steel. It has the contour of the piece to be blanked or formed by the unit **140**. The punch **144**

is supported on a flat secondary adaptor plate **152** which rests on a flat primary adaptor plate **154**. The two plates are tied together, as with screws **156**, and the punch **144** is tied to the secondary adaptor plate, as with screws **158**, so that the punch and the two adaptor plates can be shifted together as a unit in any horizontal direction.

The primary adaptor plate rests on a pair of spaced blocks **160** that rest upon the lower shoe **150** of the die set. The adaptor plates are tied to the blocks **160**, as by pins **162**, whereby said blocks, said two adaptor plates and the punch are shiftable horizontally as a single punch unit. If desired the punch can be tied directly to both the adaptor plates or to both the adaptor plates and the blocks.

Means is included which is selectively operable, i.e. at the will of the operator, to lock, i.e. clamp, the aforesaid punch unit to the die set, that is to say, to tie the aforesaid unit to the lower shoe **150** so that it is immovable with respect thereto. Such clamping means comprises a pair of elongated flat washer plates **164** one on the exposed surface of each block **160**. Each washer plate includes two openings **166** which snugly slidably receive the shanks of one or more bolts **168**, the heads of which rest on the top of the washer plate and the threaded lower ends of which are screwed in tapped openings in the lower shoe **150**. The shanks of said bolts furthermore pass through oversize openings **170** in the blocks **160**. Optionally, individual washer plates can be used, one for each bolt.

It will be apparent that when the bolts **168** are loosened the blocks, adaptor plate and punch can be shifted as a unit in any horizontal direction within the limits allowed by the size of the overly large openings **170** and that when the bolts **168** are tightened this punch unit will be securely clamped to the lower shoe.

Moreover, to facilitate resetting by means of a manipulative step subsequently to be described, we provide a centering means on each of the washer plates **164**. Said centering means includes an opening **172** in each washer plate in which there is snugly slidably received the vertical shank of a centering pin **174** the lower end of which preferably, although not necessarily, is tapered. Each block **160** furthermore includes a vertical opening **176** which likewise snugly slidably receives the shank of the pin. In addition a vertical opening **178** is formed in the lower die shoe to snugly receive the shank of the centering pin. When the two centering pins **174** pass through the registered openings **172, 176, 178** the blocks **160** are centered on the shoe **150**. That is to say, the shanks of the bolts **168** are centered in the oversized openings **170** thereby permitting movement of the blocks **160** in any direction when the centering pins are removed. The centering pins provide the further advantage of temporarily locking together the shiftable punch unit and the lower shoe.

As originally made the punch and die are hand, i.e. individually, fitted to one another to secure precise match, precise alignment and a proper selected clearance. Moreover in accordance with the phase of our invention now being described, the punch and die as originally made are provided with the means which enables coarse readjustment to be practiced after the punch and die units have been disassembled and is to be reset. Such further means essentially comprises at least two pins and at least two pairs of associated matching openings in the compressed die blocks and in the punch, it being understood that in this context the punch includes all parts tied thereto and which are shiftable with the punch with respect to the lower shoe, i.e. all parts of the punch unit, that is to say such openings in the punch may constitute openings in the punch **144** proper or openings in the adaptor plates **152, 154**. Moreover the openings in the compressed die blocks may be openings either in the inner die block or in the outer die block, that is to say said openings may be within the die area or outside of the die area. The term "die area" denotes the area defined by the die blades of the female rule die.

The two openings of each pair of openings must be matched. That is to say the openings of any one pair of openings which is located in the punch must be aligned with the other opening of said pair of openings in the compressed die block and the center-to-center spacing of the openings in the punch must be the same as the center-to-center spacing of the openings in the compressed die blocks. It should be observed that although the minimum number of pins and pairs of openings is two it is within the scope of our invention to use more than two pins and pairs of matched openings, to wit, three pins and pairs of matched openings or even four pins and pairs of matched oepnings. The greater the number of pins and associated pairs of openings the more accurate will be the coarse adjustment and, correspondingly, the more difficult it will be to reestablish adjustment.

It should be mentioned that any transverse shapes of pins and holes can be used, i.e. circular, triangular, hexagonal, square, oval and random shapes. Also the holes of each pair of holes need not be of the same shape or size although, as indicated, their centers must be in precise alignment.

The pairs of holes can be made in any fashion whatsoever after the female rule die and punch have been individually fitted to one another. For example, said pairs of holes can be formed simply by drilling through the aligned and otherwise finished punch and compressible blocks of the female rule die. Obviously, the holes of each pair of holes thus formed will be in true center-to-center alignment.

Another suitable method is to form the holes in any suitable location in the compressed die blocks, to insert shearing pins in these holes in the die blocks, and with said shearing pins to blank out holes in the punch and or adaptor plates which will thereby be in precise center-to-center alignment with the holes in the die blocks. In this case the holes in the die blocks can be formed before the punch is made and, even, before the die blocks are compressed.

This last method can be carried out in reverse. That is to say the holes originally can be provided in the punch or adaptor plates which then have shearing pins set into them and the shearing pins are used to form holes in the die blocks.

Still another method is to provide holes in either the punch or the die blocks then to insert marking pins in said holes, next to bring the punch and die blocks toward one another so as to transfer through the marking pins the centers of the holes to the opposite member. These centers then will be used to locate holes to be drilled in the opposite member. In said latter method if the holes first are made in the die blocks they can be made before the punch is made or before the die blocks are compressed.

Yet another method is to provide holes in the die blocks or in the punch and to insert drills or drilling chucks in these holes and therewith to drill holes in the opposite member.

A different method is to jig bore the holes in both the die blocks and the punch that is to say with a tool which accurately locates the work with respect to drill bits, to drill duplicate holes in the die blocks and punch, the center-to-center alignment of which is precise.

Yet another method is to insert between the previously fitted punch and compressed die blocks a jig constituting at least two pins having marking points on their opposite ends. The punch and die unit is closed on this jig to leave center markings in the compressed die blocks and punch that thereafter are used to locate holes formed as with drills.

It will be appreciated that, regardless of the method used, we provide thereby at least two pairs of matching openings in the fitted compressed die blocks and punch. The openings in the punch will retain their accurate sizes inasmuch as they are openings in metal. However the openings in the die blocks may vary in size and configura-

tion since they are openings in a compressible material, therefore in the preferred embodiment of this form of our invention the openings in the die blocks are reinforced, as by metal bushings, e.g. steel, said openings being made oversized in the first place and thereafter being reduced to a desired size by the insertion of metal bushings (ferrules or sleeves). The bushings may be press fits in the compressed die blocks; however we prefer to utilize a securing means as for example, cement or adhesive. We wish, nevertheless, to make it clear that the presence of bushing is not essential.

In FIG. 12 I have shown a single opening **180** in the compressed inner die block and a registered single opening **182** in the punch which matches, i.e. is aligned with, the opening **180**. The opening **180** in the die block is oversize to receive a steel bushing **184** which is held in place in the inner die block, as with rubber or an epoxy cement. The openings in the die block and punch are in exact central alignment, said openings having been formed after the female rule die and punch have been fitted to one another with the female rule die compressed.

In said unit **140** there are two pairs of such matched openings the other pair being omitted for convenience of illustration. The center-to-center spacings of said openings are identical. The openings in the bushing and punch are, in the example shown, both circular and both of the same diameter. Each pair of openings has associated therewith and is adapted to snugly slidably receive an alignment pin **186** which is long enough to be inserted in either opening and to extend into the other opening. Although the ends of the alignment pins may be square our method is carried out more easily if at least the protruding ends, and optionally both ends, of the alignment pins **186** are tapered or rounded. Desirably the alignment pins are made of metal, e.g. steel and, as noted they are dimensioned to secure a close sliding fit in the openings of both the bushing and the punch.

It may be mentioned at this point that the punch and die units **100, 140** have not been illustrated with punches such as the punches **56** of the unit **10** inserted into the female die rule member in order to simplify the drawings and explanation.

The unit **140** also includes strippers for the punch and the die; these, however have not been illustrated in FIG. 12 in order to avoid confusion.

After the punch and die unit **140** has been initially made and provided with the pin and hole alignment means, which includes the aligned plural pairs of openings in the die blocks and in the punch, the unit may be used for a run and then disassembled or it may be immediately disassembled for the purpose of shipment. The strippers preferably are not removed.

Subsequently, to reset the unit, it first is coarsely readjusted using the alignment means above described. It will be appreciated that when the unit is disassembled the peripheral compression of the female rule die is relaxed so that the center-to-cener spacing of the alignment holes in the die blocks is altered. Such spacing increases due to expansion of the die blocks. If this center-to-center spacing can be precisely reestablished it will be found that the matching clearance and alignment of the female die rule and the punch are almost exactly the same as when the unit first was made. Indeed, if more than two pairs of alignment openings are utilized, e.g. three or four pairs, the match, clearances and alignment of the die and punch will be substantially as good as in the case where fine adjustment is employed utilizing a shim layer.

To reset a punch and die unit by the coarse readjustment method the following steps are practiced.

The punch and die unit are placed in a fresh die set. That is to say, the female die rule is placed in a compression means carried by the upper die shoe of a fresh die set and the clamping bolts of the movable banks lightly tightened, e.g. finger tightened, so as to prevent the die blocks from falling off of the upper shoe. The punch **144** secondary adaptor plate **152** and primary adaptor plate **154** are placed on the blocks **160** of the fresh die set or are utilized in connection with the old blocks **160**. In either event the blocks **160** are supported on the lower shoe of the fresh die set with the bolts **168** loose or very lightly tightened so that the punch, two adaptor plates and blocks can shift as a unit over the upper surface of the lower shoe **150**.

Now the alignment pins **186** are slipped into the openings of either the bushings or the punch (preferably the bushings). Since the fit is a close one the alignment pins, although easily receivable in the bushings, will remain therein with their tips protruding below the compressible die blocks and extending toward the openings in the punch **144**. The die set is open at this time to leave room for the projecting portions of the alignment pins. Said alignment pins may, if desired, be of different lengths so as to protrude for different extents from their bushings. The punch unit is shifted to approximately visually register the openings therein with the alignment pins. This shifting may be accomplished manually or, if the punch adaptor plates and blocks are heavy, through the use of screws e.g. micrometer screws.

Now the compression means of the female rule die is actuated to approximately restore the initial compression to the compressible die blocks. This compression may be carried out with the use of torque wrenches which reset the original predetermined torques or it may be simply and practically done manually by hand tightening the compression bolts of the movable banks with the aid of wrenches, e.g. Allen wrenches, of certain predetermined length which will enable the machinist easily to restore the correct compression. At this time if the approximate registry visually imparted to the punch during resetting is not correct the punch again is slightly shifted so as to visually match the alignment pins in the now compressed die blocks with the openings in the punch.

The die set next is partially closed to bring the lower ends of the alignment pins which are friction held in slip fits in their bushings into proximity with the punch and the registry of the holes is checked by sliding the alignment pins downwardly. If the compression has been just exactly correct and if the punch has been correctly aligned visually, the alignment pins will freely slip into the alignment holes in the punch. This however usually will not be the case and it will be necessary to minutely shift the punch unit so as to perfect registry. It further may be necessary to readjust the compression bolts of the movable banks to aid in reattaining the exact registry between the matched openings in the die blocks (the alignment pins) and the punch.

It will be appreciated that such readjustment of the compression means varies the center-to-center spacing of the alignment opening in the compressible die blocks and thereby enables them to be registered with the openings in the punch which have a fixed center-to-center spacing. The attainment of a correct center-to-center spacing of the alignment holes in the compressible die blocks (as by registry with the openings in the punch) indicates that the female rule die has been compressed to the proper extent to recover its original shape. The correct registry of the alignment blocks also indicates substantial recovery of their original clearance. It also may be mentioned that where the tips of the alignment pins are tapered, lowering the alignment pins so that said tips enter the alignment openings in the punch customarily will function to slightly shift the punch whereby to bring its alignment openings into true alignment with the openings provided by the bushings **184**.

During the time that the punch is being aligned it is free floating on the lower shoe. That is to say the centering pins **174** will have been removed and the bolts **168** will not be tight enough to lock the blocks **160** to the lower shoe **150**. Desirably when the punch initially is placed

on the lower shoe the centering pins are in position with their shanks in the openings **176**, **178** and with the alignment openings **182** in the punch approximately in registry with the alignment opening in the bushings **184**. Thereafter when the centering pins are removed to allow the punch to float the punch can be moved in any direction since the shanks of the bolts **168** are approximately at the centers of the oversized openings **170**.

In the ordinary use of our invention it will be found that the machinist usually will by eye almost exactly center the alignment openings in the punch with the alignment openings in the recompressed die blocks and that when the alignment pins are slid down they will seem to enter the alignment openings in the punch quite easily. However the punch actually will shift in almost every instance and it will be observed that in the coarse realigned position the centering pins no longer can drop from the openings **176** into the openings **178**, this being an indication of the floating movement of the punch which leads to the realignment. Finally the bolts **168** are tightened to rigidly lock the end-to-end punch assembly to the lower die shoe, the alignment pins **186** are removed and the unit **140** is ready for operation.

It thus will be seen that we have provided punch and die units and methods of reassembling the same which achieve the objects of this invention and which are well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments above set forth, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, we claim as new and desire to secure by Letters Patent:

1. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: mounting said members on the reciprocatable parts of such a device so that at least one member is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, manipulating the compression means to constrict the die blade, relatively shifting said one member in said two orthogonal directions so as to align the two members, and subseqently fixedly securing said one member to its associated part.

2. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: mounting said members on the reciprocatable parts of such a device so that at least one member is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, manipulating the compression means to constrict the die blade, utilizing alignment means affected by the operation of the compression means to relatively shift said one member in said two orthogonal directions so as to match the shape of the female die member to the shape of the rigid male punch member with the preselected clearance therebetween and to align said two members, and subsequently fixedly securing said one member to its associated part.

3. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: mounting said members on the reciprocatable parts of such a device so that at least one member is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, placing a layer of solid material of a predetermined thickness equal to a desired clearance around the periphery of the rigid male punch member, nesting the punch and die members, manipulating the compression means to constrict the die blade on the layer-circumscribed rigid male punch member while permitting the two members to relatively shift in said two orthogonal directions whereby to match the shape of the female die member to the shape of the rigid male punch member with the preselected clearance therebetween and to align said two members, subsequently fixedly securing said one member to its associated part, and then removing said layer.

4. A method of resetting a female rule die and a rigid male punch which previously were matched, aligned and mounted as a unit in a die set having two relatively reciprocatable shoes, wherein said rule die comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: fixedly securing the female rule die to one of the shoes of the die set, mounting said rigid male punch on the other shoe so that said punch can shift relative to its shoe in two orthogonal directions perpendicular to the direction of relative motion of said shoes, ensheathing the periphery of the rigid male punch with a layer of solid material of a predetermined thickness equal to a desired clearance, nesting the punch and die, manipulating the compression means to constrict the die blade on the ensheathed rigid male punch while permitting the punch to shift in said two orthogonal directions whereby to match the shape of the female rule die to the shape of the rigid male punch with the preselected clearance therebetween and to align the punch and die, subsequently fixedly securing the punch to its shoe, and then removing said ensheathing layer.

5. A method as set forth in claim 4 wherein the layer of solid material is pliable shim stock.

6. A method as set forth in claim 4 wherein the layer of solid material is ensheathed around the periphery of the rigid male punch by draping a sheet of pliable shim stock around said punch.

7. A method as set forth in claim 4 wherein the punch and die are disengaged from one another before removing the ensheathing layer of solid material from the rigid male punch.

8. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming

an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: mounting one of said members on a reciprocatable part of such a device, mounting a support for the other of said members on the other part so that said support is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, placing a layer of solid material of predetermined thickness equal to a desired clearance around the periphery of the rigid male punch member, nesting the punch and die members, manipulating the compression means to constrict the die blade on the layer-circumscribed rigid male punch member, shifting the support to engage the punch member in predetermined relative positions, subsequently fixedly securing said support to its associated part, and then removing said layer.

9. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: mounting one of said members on one of the reciprocatable parts of such a device, providing means for detachably coupling the other member and a support for such other member, mounting said support on the other reciprocatable part of said device so that said support is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, placing a layer of solid material of a predetermined thickness equal to a desired clearance around the periphery of the rigid male punch member, nesting the punch and die members with the punch member uncoupled from its support, manipulating the compression means to constrict the die blade on the layer-circumscribed rigid male punch member, coupling the rigid male punch member and its support while relatively shifting said support and its associated part in said two orthogonal directions, subsequently fixedly securing said support to its associated part, and then removing said layer.

10. A method of resetting a female rue die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: providing plural pairs of registered openings in the compressed die blocks and punch member, mounting said members on the reciprocatable parts of such a device with the compression at least partially released and so that at least one member is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, manipulating the compression means to constrict the die blade, inserting alignment pins into one opening of each pair of openings, bridging each alignment pin between its pair of associated openings so as to relatively shift the two members in said two orthogonal directions and thereby match the shape of the female die member to the shape of the rigid male punch member with the preselected clearance therebetween and to align said two members, and subsequently fixedly securing said one member to its associated part.

11. A method of resetting a female rule die member and a rigid male punch member which previously were matched, aligned and mounted as a unit in a device having two relatively reciprocatable parts, wherein said rule die member comprises an outer compressible die block and an inner compressible die block mutually forming an endless slot in which there is located a die blade that has a longitudinal edge portion protruding beyond the die blocks, and wherein said rule die member further comprises a compression means for constricting the two blocks and the contained portion of the die blade, said method including the steps of: forming registered pairs of alignment openings in the punch member and compressed die blocks, mounting said members on the reciprocatable parts of such a device with the compression at least partially released and so that at least one member is shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative movement of said parts, manipulating the compression means to constrict the die blade and compress the die blocks so as to match the center-to-center spacing of the openings of each pair of openings, inserting alignment pins into one opening of each pair of openings, bridging the alignment pins between each pair of openings to relatively shift the two members in said two orthogonal directions whereby to match the shape of the female die member to the shape of the rigid male punch member with the preselected clearance therebetwen and to align said two members, and subsequently fixedly securing said one member to its associated part.

12. A resettable punch and die unit for a device having two parts and means securing said parts to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement, said unit comprising: a rigid male punch member, a female rule die member including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and having a longitudinal edge portion protruding beyond the die blocks, and a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies the shape and size of the female rule die member and varies the absolute position of the female rule die member, the shape being varied to make it similar to the shape of the male punch member and the size being varied to provide clearance with respect to the male punch member; and means mounting said members on said parts so that at least one member is bodily shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative motion of said parts so as to compensate for the change in absolute position of the female rule die member consequent upon manipulation of the compression means whereby to align the compressed female rule die member with the male punch member, said mounting means including means to releasably fixedly secure said one member to its associate part in any combination of said two orthogonally shifted directions with the female rule die member and the male punch member in alignment.

13. A resettable punch and die unit for a die set having two shoes and means securing said shoes to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement, said unit comprising: a rigid male punch a female rule die including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and protruding beyond the die blocks, and a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies

the shape and size of the female rule die and varies the absolute position of the female rule die, the shape being varied to make it similar to the shape of the male punch and the size being varied to provide clearance with respect to the male punch; a floating support fixedly secured to said punch; means fixedly securing the female die rule to one of the shoes; and releasable clamping means for selectively fixedly securing the floating support to the other shoe so that when the clamping means is released said floating support is bodily shiftable relative to its shoe in two orthogonal directions perpendicular to the direction of relative motion of said shoes to compensate for the change in absolute position of the female rule die consequent upon manipulation of the compression means whereby to align the compressed female rule die with the male punch and so that clamping means can be rendered effective when the compressed female die is in alignment with the male punch.

14. A resettable punch and die unit for a die set having two shoes and means securing said shoes to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement, said unit comprising: a rigid male punch, a female rule die including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and protruding beyond the die blocks, and a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies the shape and size of the female rule die and varies the absolute position of the female rule die, the shape being varied to make it similar to the shape of the male punch and the size being varied to provide clearance with respect to the male punch; a support; disengageable coupling means for interengaging said punch and said support; means fixedly securing the female die rule to one of the shoes; and releasable clamping means for fixedly securing the support to the other shoe so that when the clamping means is released the support is bodily shiftable relative to its shoe in two orthogonal directions perpendicular to the direction of relative motion of said shoes to compensate for the change in absolute position of the female rule die consequent upon manipulation of the compression means whereby to align the compressed female rule die with the male punch and so that clamping means can be rendered effective when the compressed female die is in alignment with the male punch.

15. A resettable punch and die unit for a die set having two shoes and means securing said shoes to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement, said unit comprising: a rigid male punch, a female rule die including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and protruding beyond the die blocks, and a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies the shape and size of the female rule die and varies the absolute position of the female rule die, the shape being varied to make it similar to the shape of the male punch and the size being varied to provide clearance with respect to the male punch; a floating support fixedly secured to said punch; means fixedly securing the female die rule to one of the shoes; releasable clamping means for selectively fixedly securing the floating support to the other shoe so that when the clamping means is released said floating support is bodily shiftable relative to its shoe in two orthogonal directions perpendicular to the direction of relative motion of said shoes to compensate for the change in absolute position of the female rule die consequent upon manipulation of the compression means whereby to align the compressed female rule die with the male punch and so that clamping means can be rendered effective when the compressed female die is in alignment with the male punch; and at least two pin and opening alignment means associated with said punch and die blocks for resetting said unit, the center-to-center spacing of said pin and opening means being coincident when the compression means has the die blocks under proper compression, said floating support permitting alignment of said pin and hole means, said pins being removable after alignment to permit operation of said punch and die unit.

16. A resettable punch and die unit for a die set having two shoes and means securing said shoes to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement, said unit comprising: a rigid male punch, a female rule die including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and protruding beyond the die blocks, and a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies the shape and size of the female rule die and varies the absolute position of the female rule die, the shape being varied to make it similar to the shape of the male punch and the size being varied to provide clearance with respect to the male punch; a floating support fixedly secured to said punch; means fixedly securing the female die rule to one of the shoes; releasible clamping means for selectively fixedly securing the floating support to the other shoe so that when the clamping means is released said floating support is bodily shiftable relative to its shoe in two orthogonal directions perpendicular to the direction of relative motion of said shoes to compensate for the change in absolute position of the female rule die consequent upon manipulation of the compression means whereby to align the compressed female rule die with the male punch and so that clamping means can be rendered effective when the compressed female die is in alignment with the male punch, said punch and compressed die blocks having at least two pairs of registered openings; and pins bridging each pair of openings, said pins being removable after alignment to permit operation of said punch and die unit.

17. A partially reset punch and die unit, said unit comprising: a device having two parts and means securing said parts to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement; a rigid male punch member; a female rule die member including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and having a longitudinal edge portion protruding beyond the die blocks, a compression means for constricting the two blocks and the contained portion of the die blade whereby manipulation of the compression means varies the shape and size of the female rule die member and varies the absolute position of the female rule die member, the shape being varied to make it similar to the shape of the male punch member and the size being varied to provide clearance with respect to the male punch member; a layer of solid material of a predetermined thickness equal to a desired clearance around the periphery of the rigid male punch member; said members being nested and said compression means constricting the die blade on the layer-circumscribed rigid male punch member whereby the shape of the female die member is matched to the shape of the rigid male punch member with a preselected clearance therebetween and whereby the absolute position of the female rule die member is shifted; and means mounting said members on said parts so that at least one member is bodily shiftable relative to its associated part in two orthogonal directions perpendicular to the direction of relative motion of said parts to compensate for the change in absolute position of the female rule die member consequent upon manipulation

of the compensation means whereby said two members with the female die constricted on the male die are aligned, said mounting means including means for releasibly fixedly securing said one member to its associated part, said layer being removable after alignment to permit operation of said punch and die unit.

18. A partially reset punch and die unit, said unit comprising: a die set having two shoes and means securing said shoes to one another for relative movement toward and away from one another and in fixed mutual relationship in orthogonal directions perpendicular to their direction of relative movement; a female rule die including an outer compressible die block and an inner compressible die block mutually forming an endless slot, a die blade located in said slot and having a longitudinal edge portion protruding beyond the die blocks, a compression means for constricting the two blocks and the contained portion of the die blades; a rigid male punch; a layer of solid material of a predetermined thickness equal to a desired clearance around the periphery of the rigid male punch; means fixedly securing the female die rule to one of the shoes; means releasibly securing the punch to the other shoe so that when said last named means is bodily

released said punch is shiftable relative to its shoe in two orthogonal directions perpendicular to the direction of relative movement of said shoes; said punch and die being nested and said compression means constricting the die blade on the layer-circumscribed rigid male punch whereby the shape of the female die is matched to the shape of the rigid male punch with a preselected clearance therebetween and whereby said punch and die are aligned; said layer being removable after alignment to permit operation of said punch and die unit.

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