Dec. 28, 1965 A. K. SCHOTT ETAL 3,225,636

PUNCHING MACHINE AND STRUCTURE THEREFOR

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FIG. 1

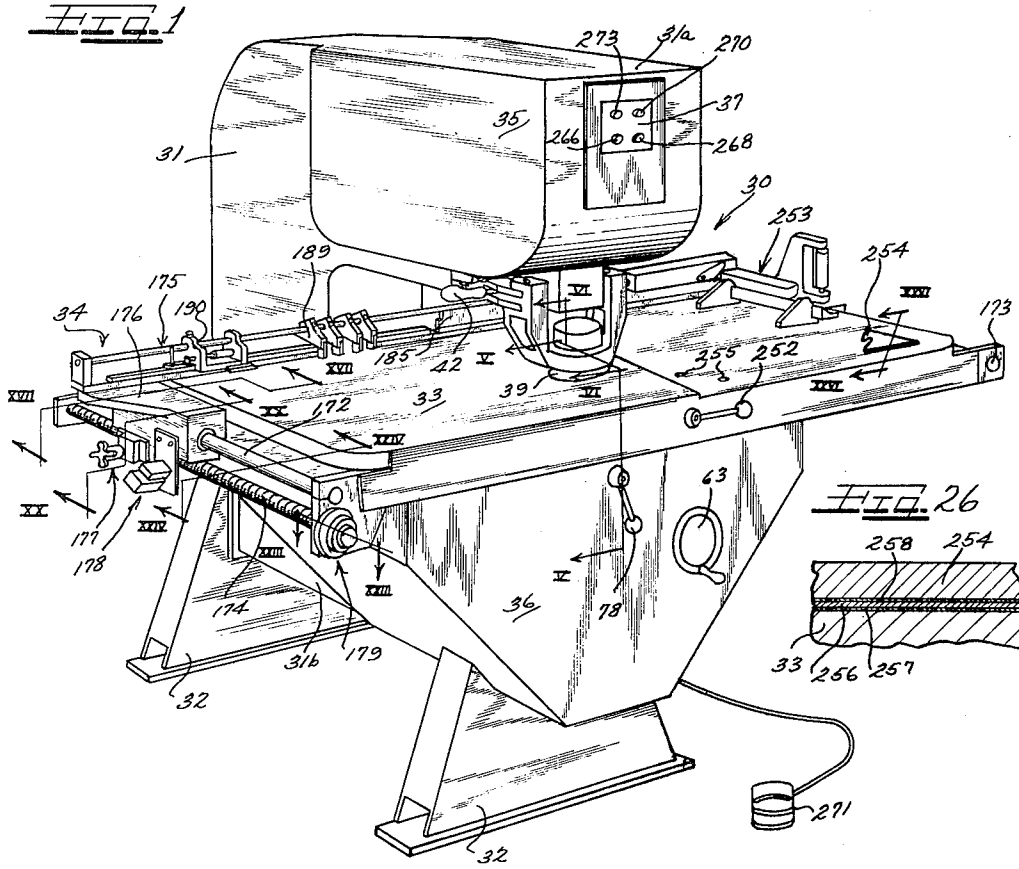
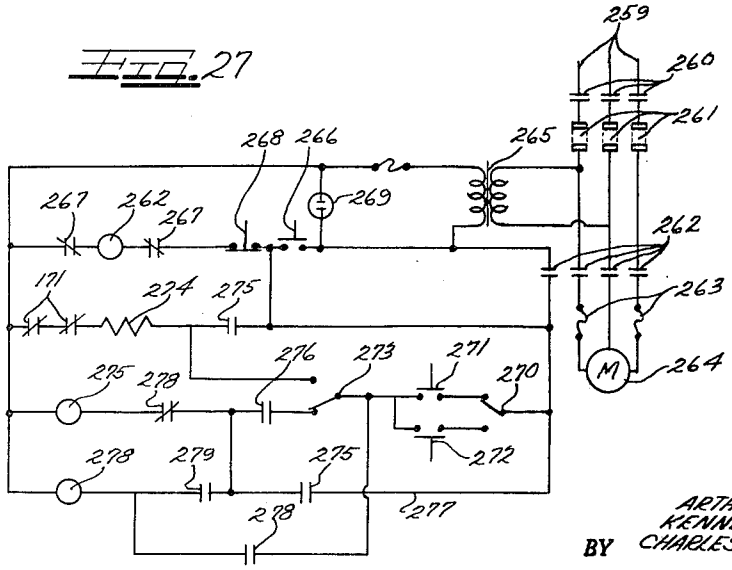


FIG. 26

FIG. 27



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PUNCHING MACHINE AND STRUCTURE THEREFOR

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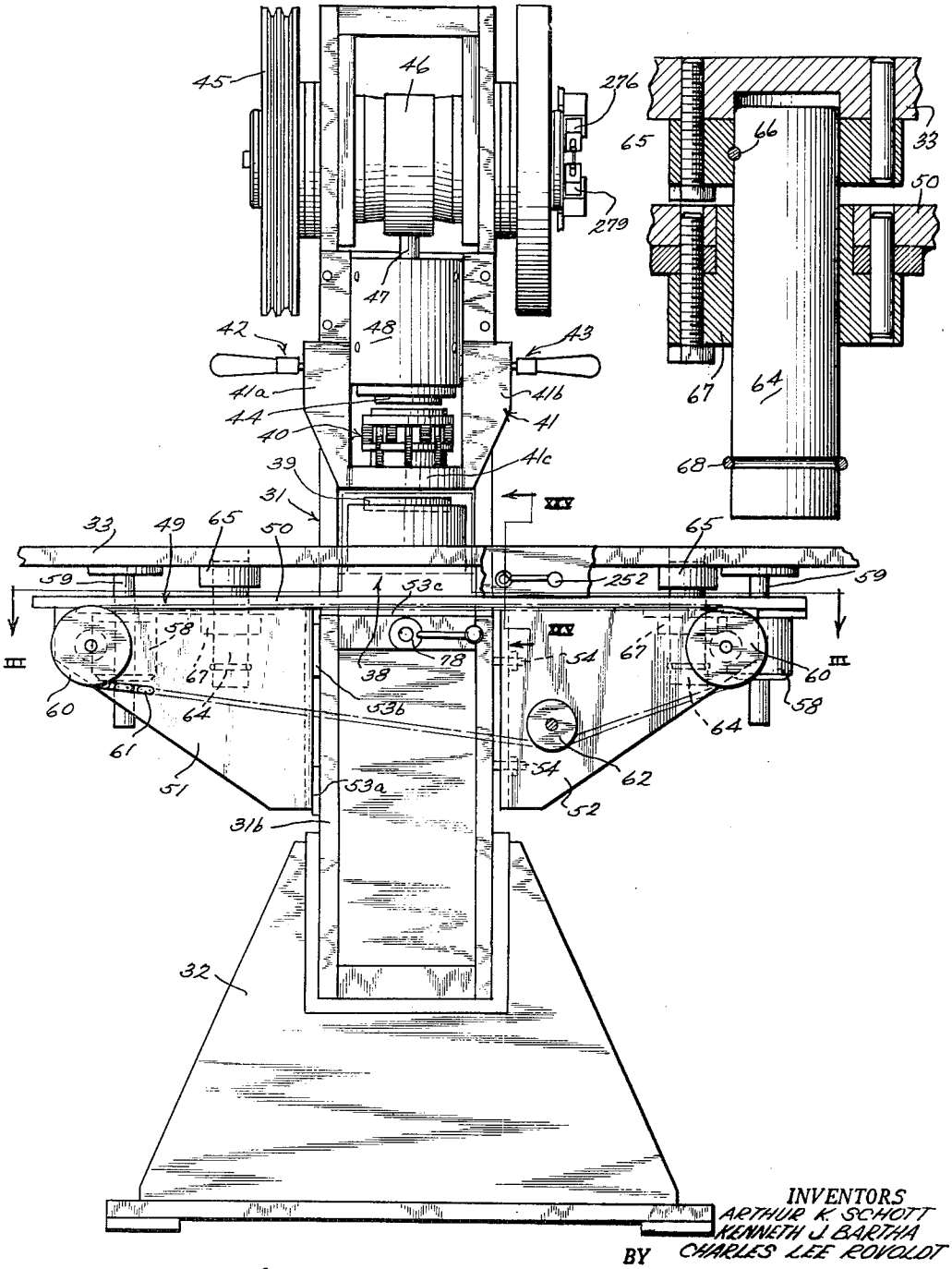
Fig. 2 Fig. 4



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PUNCHING MACHINE AND STRUCTURE THEREFOR

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FIG. 3

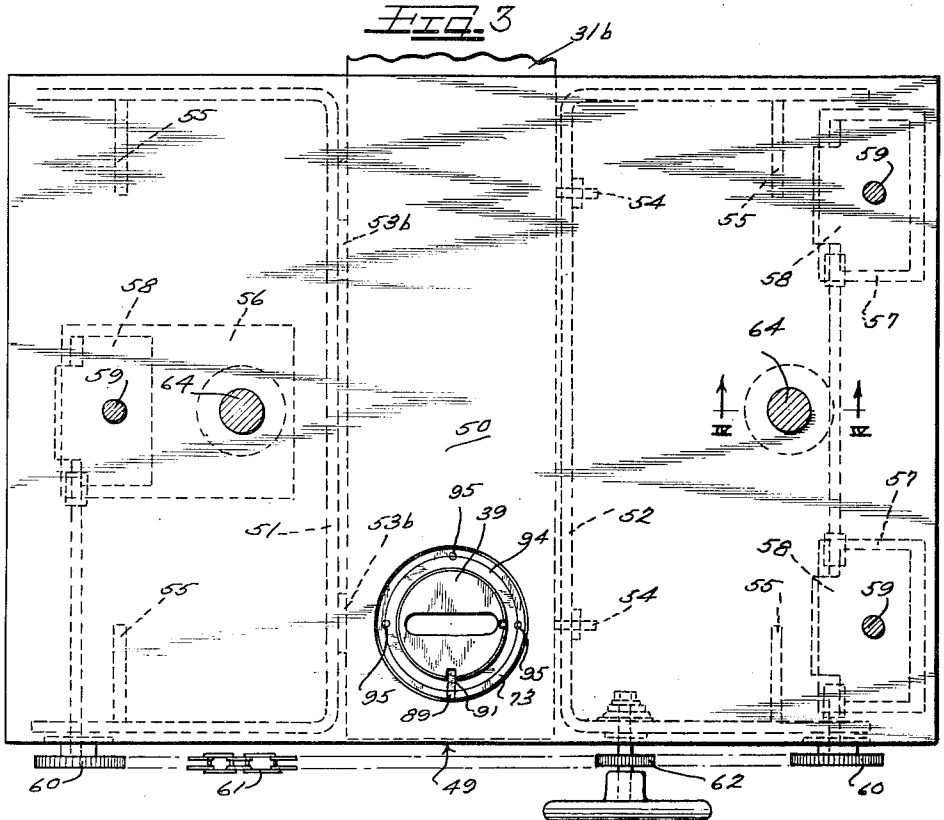

FIG. 17

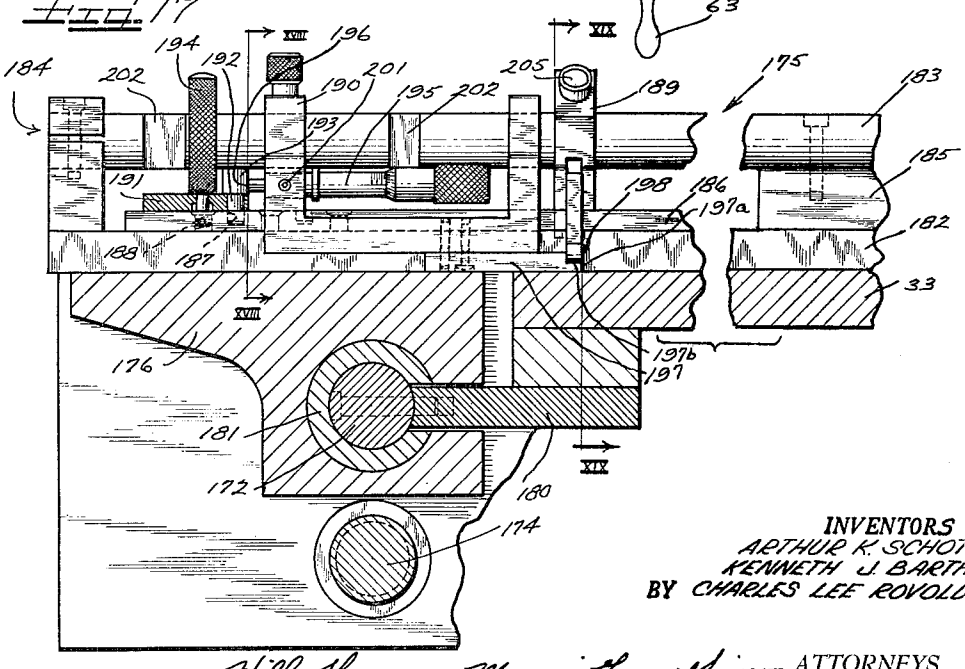

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FIG. 5

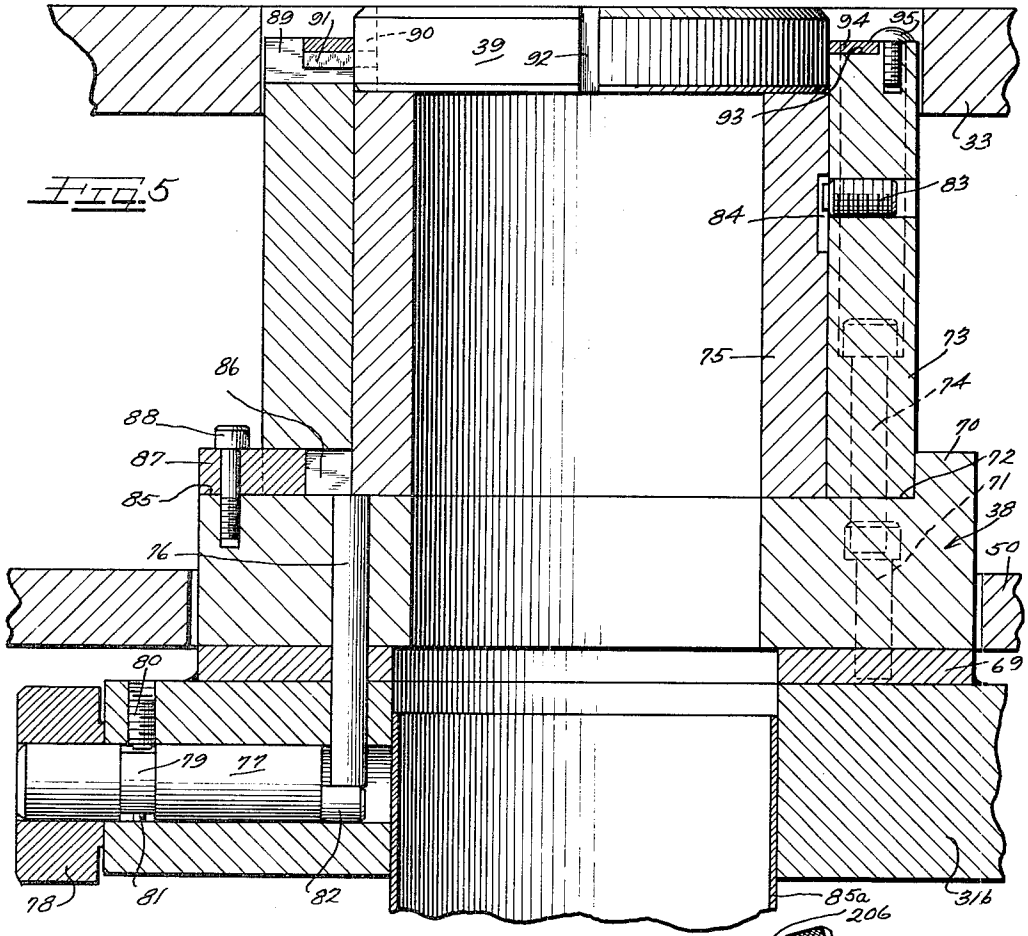

FIG. 18

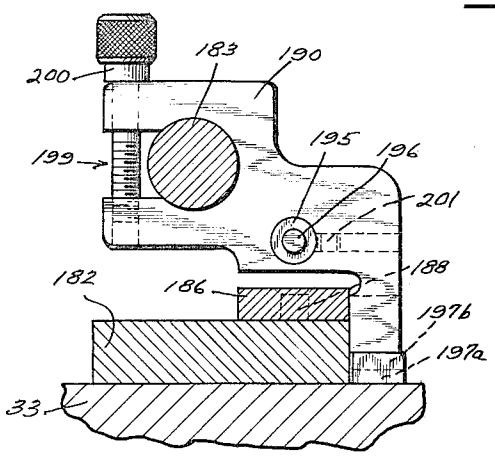

FIG. 19

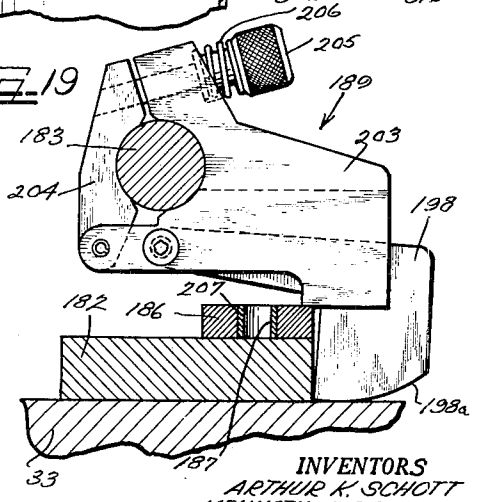

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Fig. 6

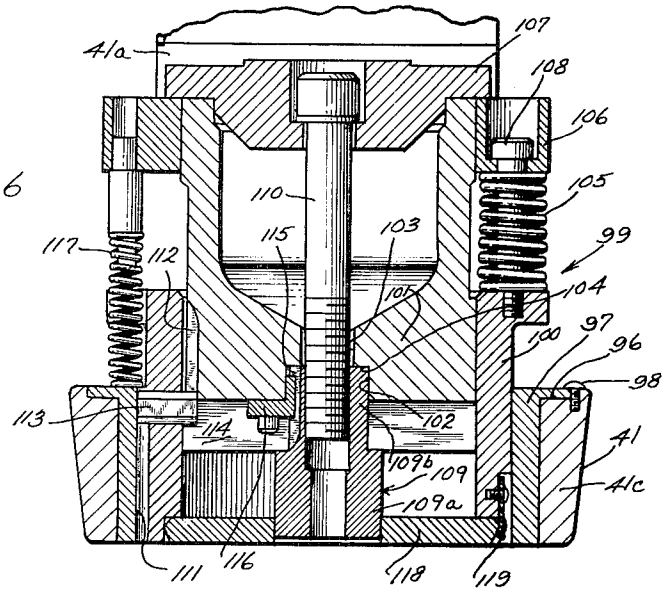

Fig. 7

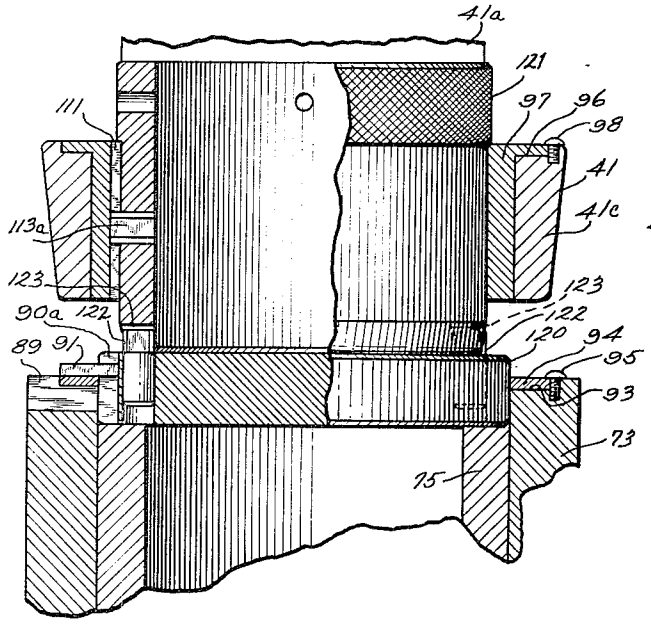

Fig. 8

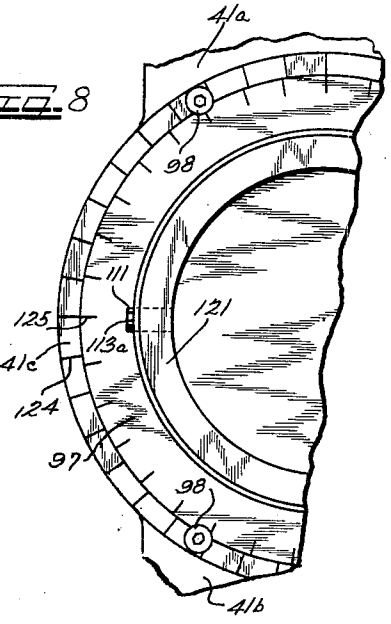

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FIG. 9

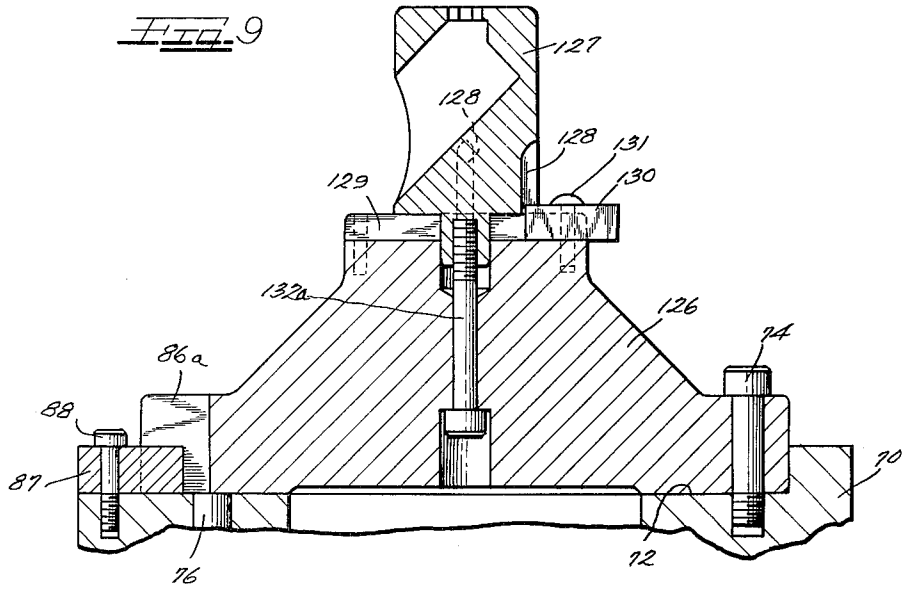


FIG. 11

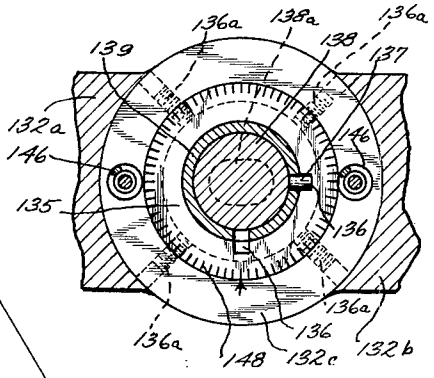
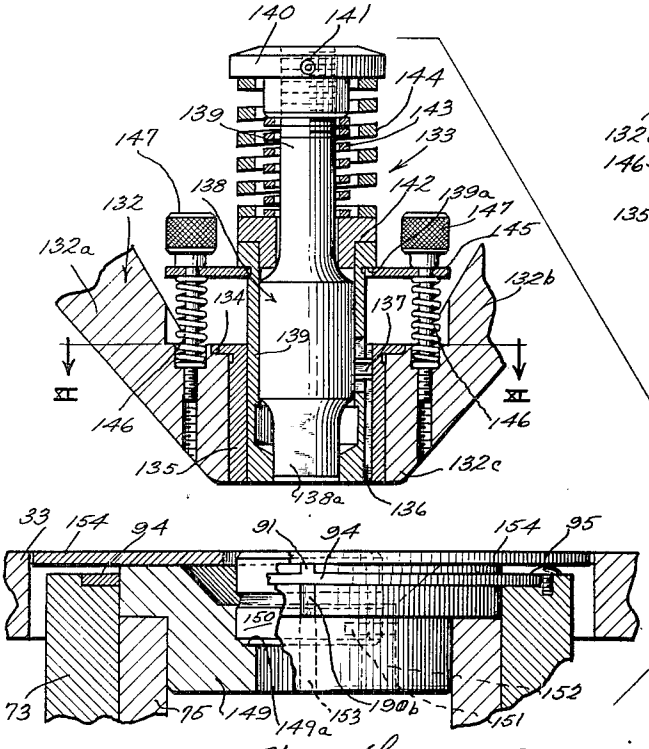


FIG. 10



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PUNCHING MACHINE AND STRUCTURE THEREFOR

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FIG. 12

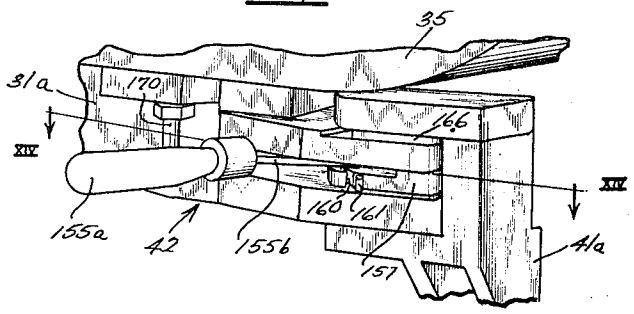

FIG. 13

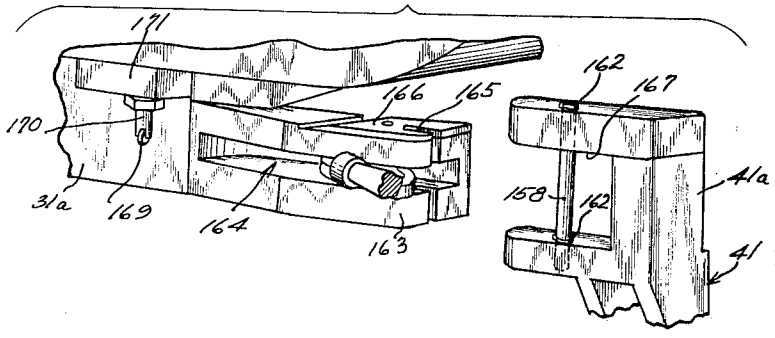

FIG. 16

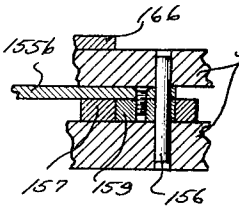

FIG. 15

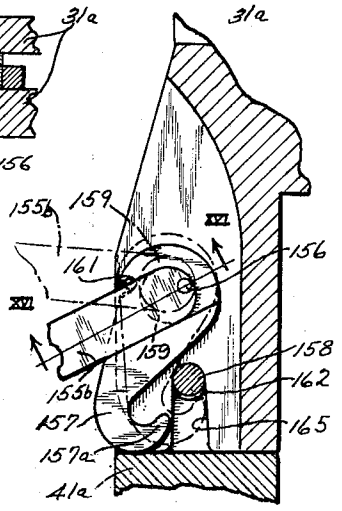

FIG. 14

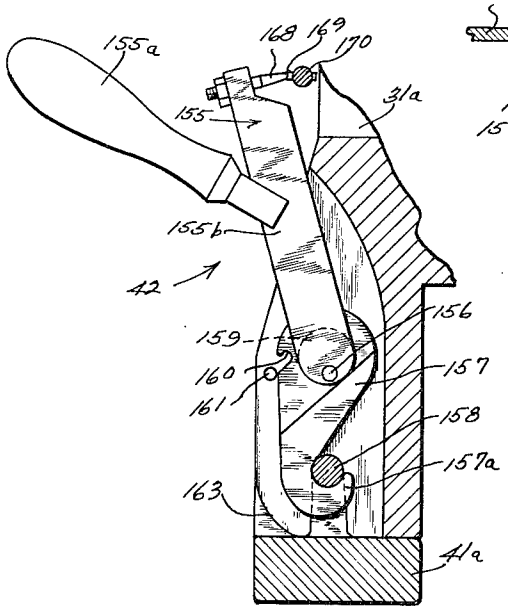

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FIG. 20

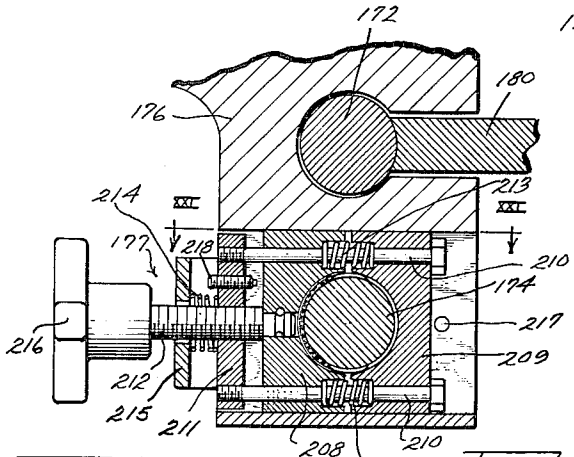


FIG. 21

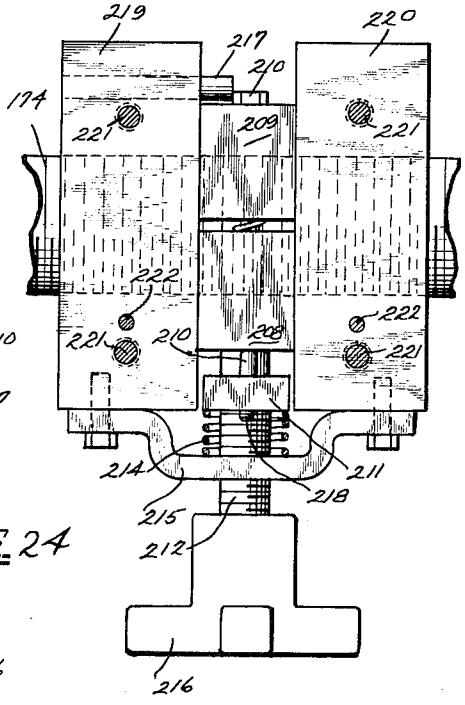


FIG. 22

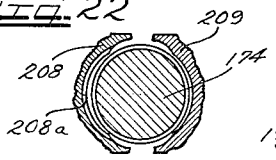


FIG. 24

FIG. 23

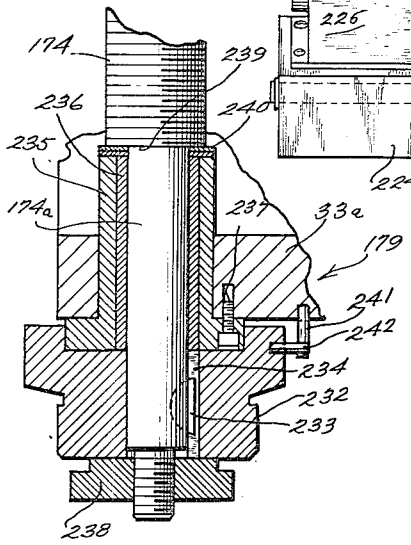
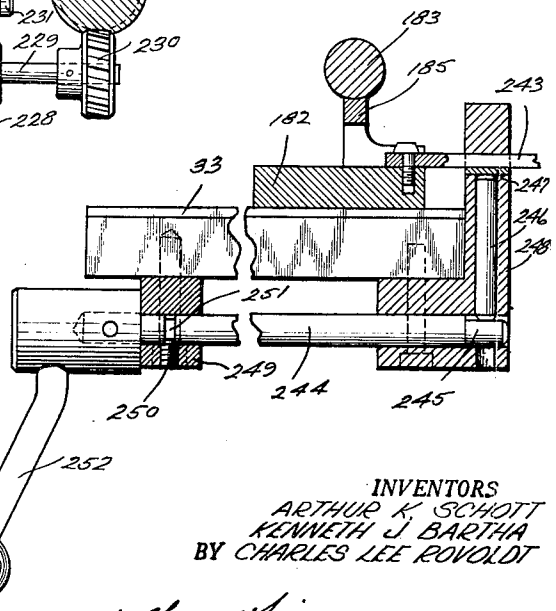


FIG. 25



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United States Patent Office 3,225,636 Patented Dec. 28, 1965

3,225,636
PUNCHING MACHINE AND STRUCTURE THEREFOR

Arthur K. Schott, Kenmore, Kenneth J. Bartha, Tonawanda, and Charles Lee Rovoldt, Getzville, N.Y., assignors to Houdaille Industries, Inc., Buffalo, N.Y., a corporation of Michigan

Filed Nov. 1, 1960, Ser. No. 66,639
33 Claims. (Cl. 83—468)

This invention relates generally to punching machines, and more specifically to an improved punching machine embodying numerous novel coacting features, combinations, and sub-combinations thereof.

Although the principles of the present invention may be included in various punching machines and devices, a particularly useful application is made in a punching machine of the type of that acts on a single workpiece, the workpiece being positioned by either adjustable gaging carried on the machine, or by a template follower, the machine being provided with appropriate punch and die means for effecting punching, notching, and nibbling on the workpiece.

The present invention contemplates the utilization of a workpiece-supporting table which is vertically adjustable with respect to the punch and die means, the table being provided with gaging structure engageable with adjacent edges of a workpiece and adapted to indicate desired dimensions numerically directly. A further important feature of the instant invention includes a pair of pivotable clamping mechanisms by which a tool support is maintained and returned, when removed, to a position of alignment with other tooling, to a position corresponding to its own prior position, and to a position wherein relationships established by the gaging mechanism is maintained. The punching machine of the present invention also includes a novel punch and stripper assembly adapted to accommodate punches of shaped or non-circular cross-section, together with means for orienting the punch and die to any selected angular position about the punching axis. This feature requires novel keying structure and alignment tooling which is also provided herein. The electrical control circuit is adapted to effect both single stroke operation and continuous or nibbling operation, and is provided with interlock means between it and the means by which the punch and die means are aligned to insure that the machine may only be operated when everything is in proper adjustment.

Accordingly, it is an object of the present invention to provide an improved punching machine.

Another object of the present invention is to provide a punching machine embodying numerous novel coacting features, combinations, and sub-combinations thereof.

Yet another object of the present invention is to provide a novel clamping structure for a tool support which structure maintains various relationships between features of the punching machine of this invention.

A still further object of the present invention is to provide a novel clamping structure.

A still further object of the present invention is to provide gaging structure for accurately positioning the workpiece to be worked on in relation to a predetermined point.

Many other advantages, features, and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is a perspective view of a punching machine provided in accordance with the principles of the present invention;

FIGURE 2 is an enlarged front elevational view of the punching machine of FIGURE 1 with certain parts removed therefrom;

FIGURE 3 is an enlarged view of the sub-table and die taken generally along line III—III of FIGURE 2;

FIGURE 4 is an enlarged sectional fragmentary view taken along line IV—IV of FIGURE 3;

FIGURE 5 is an enlarged sectional view of a die and supporting structure therefor taken generally along line V—V of FIGURE 1;

FIGURE 6 is an enlarged cross-sectional view of a punch and stripping assembly taken along line VI—VI of FIGURE 1;

FIGURE 7 is an enlarged sectional view taken along the lines V—V and VI—VI of FIGURE 1 with aligning tools substituted for the punch and die means;

FIGURE 8 is a fragmentary top view of the structure shown in FIGURE 7;

FIGURE 9 is a cross-sectional view of a pedestal die supported on structure shown in FIGURE 5;

FIGURE 10 is a cross-sectional view of a punch and die mechanism, the die being supported by an adaptor on the structure shown in FIGURE 5, and the punch being supported on a tool support of a size smaller than described heretofore herein;

FIGURE 11 is a cross-sectional view taken along line XI—XI of FIGURE 10;

FIGURE 12 is an enlarged fragmentary perspective view of a portion of FIGURE 1 showing a clamping mechanism;

FIGURE 13 shows the structure of FIGURE 12 with the major components thereof disconnected;

FIGURE 14 is an enlarged sectional view taken along line XIV—XIV of FIGURE 12;

FIGURE 15 corresponds to FIGURE 14 with the components illustrated in the position that they are placed immediately prior to a disconnection such as shown in FIGURE 13;

FIGURE 16 is an enlarged fragmentary cross-sectional view taken along line XVI—XVI of FIGURE 15;

FIGURE 17 on sheet 3 is an enlarged front view, partly in section, taken along line XVII—XVII of FIGURE 1, and illustrating certain gaging structure;

FIGURE 18 on sheet 4 is an enlarged cross-sectional view taken along line XVIII—XVIII on FIGURE 17;

FIGURE 19 is an enlarged cross-sectional view taken generally along the broken line XIX—XIX on FIGURE 17;

FIGURE 20 on sheet 8 is an enlarged cross-sectional view of certain gage clamping structure taken along line XX—XX of FIGURE 1;

FIGURE 21 is an enlarged sectional view taken along line XXI—XXI of FIGURE 20;

FIGURE 22 is a fragmentary portion of FIGURE 20 showing certain parts in a retracted position;

FIGURE 23 is an enlarged sectional view taken along line XXIII—XXIII of FIGURE 1;

FIGURE 24 is a fragmentary front elevational view taken along line XXIV—XXIV of FIGURE 1, partly in section, showing a gaging indicating mechanism;

FIGURE 25 is an enlarged fragmentary cross-sectional view taken along line XXV—XXV of FIGURE 2 and showing a gage clamping mechanism;

FIGURE 26 on sheet 1 is an enlarged fragmentary cross-sectional view taken along line XXVI—XXVI of FIGURE 1; and

FIGURE 27 is a schematic diagram of the electrical

circuit employed to operate the machine shown in FIGURE 1.

As shown on the drawings:

The principles of this invention are particularly useful when embodied in a punching machine such as illustrated in FIGURE 1, generally indicated by the numeral **30**. The machine **30** includes a rigid frame **31** of both hollow an C-shaped construction having an upper arm **31***a* and a lower arm **31***b*. The lower arm **31***b* is provided with a pair of bases **32**, **32** which support the frame **31** on the floor. Also prominent in FIGURE 1 is a horizontal workpiece-supporting table **33** supported in a manner presently to be described. To the table **33** there is secured adjustable gaging means generally indicated at **34**, and to be described in detail later herein. Certain components of the device are covered by an upper shroud **35** and a lower shroud **36**, a control panel **37** being secured to the upper arm **31**.

Referring now to FIGURE 2, there is shown a front elevational view of the structure of FIGURE 1 wherein the upper shroud **35**, the control panel **37**, the lower shroud **36**, and the gaging **34** have been removed for clarity of illustration. On the lower arm **31***b* of the frame **31** there is provided a bed **38** on which tooling means such as the die **39** are supported. In alignment with the die **39**, there is a punch and stripping assembly generally indicated at **40** which is supported by an upper tool support generally indicated at **41** which is secured to the frame **31** by a pair of clamping mechanisms generally indicated at **42** and **43**. It will be noted that the upper tool support **41** comprises a generally U-shaped member or yoke having spaced arms **41***a*, **41***b* extending along opposite sides of the tool **40** supported on a bight **41***c* which connects the arms **41***a* and **41***b*.

Also disposed between the arms **41***a* and **41***b* is a ram **44** which is reciprocably driven. A motor shown diagrammatically in the circuit diagram of FIGURE 27 operates continually through belts to drive a pulley-flywheel assembly **45** which includes an eccentric **46** which continually reciprocates a shaft **47**. The continuously reciprocating shaft **47** is selectably connected to the ram **44** by an electrically actuated press clutch **48** which includes a solenoid shown schematically in FIGURE 27. The structural details of the clutch are shown in the copending application of Arthur K. Schott and Charles E. Wilson on a "Press Clutch," U.S. Serial No. 825,028, now U.S. Patent No. 2,979,905.

The workpiece-supporting table **33** is supported on the frame **31** by structure shown in FIGURES 2–4. Means are provided by which the table **33** may be vertically adjusted and by which the table **33** is locked against any horizontal or angular movement. To this end, a sub-table assembly **49** is provided which includes a sub-table **50** which is apertured so that the bed **38** which supports the die **39** is independent thereof. The sub-table **50** is provided with a pair of generally U-shaped brackets **51**, **52** which are welded thereto and which jointly comprise a saddle which rests on suitable bearing surfaces **53***a*, **53***b*, and **53***c*. Clamping screws **54** rigidly hold the sub-table assembly **49** in a fixed position with respect to the rigid frame **31**. If desired, each of the U-shaped members **51**, **52** may be provided with stiffening means **55**. Attached to the lower surface of the sub-table **50**, there are three suitable pads **56**, **57**, and **57**, to each of which is attached a screw jack assembly **58**. The detailed structure of each screw jack is known and forms no part of this invention. The screw jacks **58** each include a shaft **59** secured to the workpiece supporting table **33**. Raising and lowering of the table **33** is effected by simultaneous operation of the various screw jacks **58**. Each of the screw jacks **58** is connected by appropriate shafting to a sprocket wheel **60**. A roller chain **61** connects the sprocket wheel together and to an additional sprocket wheel **62** which is supported on a shaft for co-rotation with a handle **63**. When the jointly driven screw jacks are manually adjusted, operated, or actuated, the position of the table is adjusted vertically. It is thus apparent that the adjustment mechanism also secures and supports the table **33** on the sub-table **49**. By manipulation of the handle **63**, the table **33** may be made coplanar with the upper surface of the die **39** as shown in FIGURE 1, a position which is particularly advantageous for flat workpieces, and the table **33** may be vertically spaced from the die **39** as shown in FIGURE 2, a position which is particularly advantageous for punching certain channel forms and other non-flat workpieces.

To keep the table **33** in laterally fixed position, to preclude both any lateral displacement and any angular movement about a vertical axis, there is provided a pair of guide pins **64**. Each guide pin **64** is secured to a support ring **65** by a pin **66**, the support ring **65** being secured to the table **33** by a screw and pin arrangement. The guide pin **64** is slidably received in a guide bushing **67** which is secured to the sub-table **50** by a similar screw and pin arrangement extending through a pad corresponding to the pad **56**. The guide pin **64** is provided with a stop ring **68** of the snap-ring type which limits upward movement or adjustment of the table **33**.

One purpose for adjusting the table **33** so that its upper surface is coplanar with the die **39** is to provide adequate support for the workpiece so as to be able to position it accurately and also so as to position it coplanarly with the die **39**. In practice, it has been found that some oil will be present quite frequently on the workpiece, a fact which makes picking up the finished workpiece from the table **33** even more difficult than may be expected. By rotation of the crank **63**, the table **33** may be lowered slightly independently of the die support means so that the die will act on the unpunched portion of the workpiece to raise the same from the upper surface of the table **33** to facilitate grasping the same. Thus the table adjusting mechanism comprises selectively actuatable means for effecting relative vertical movement between the tool supported on the bed **38** and the table **33** to space the work piece upwardly from the table **33** to facilitate grasping and to overcome the folding force of any oil present.

Referring now to FIGURE 5, there is shown the structure by which the lower tool or die **39** is supported. The lower tool support or die support comprise components which are rigidly secured to the lower arm **31***b* of the frame **31**. These include the bed generally indicated at **38** which includes a bed pad **69** welded to the frame **31** independently of the sub-table **50** which is spaced from the workpiece supporting table **33**. To the bed pad **69** there is secured a bed block **70**, by a plurality of screws such as **71**. The bed block **70** has an upwardly directed circular recess **72** in which is received a cylindrical member **73** which is secured to the bed block **70** by a plurality of screws such as **74**. Within the cylindrical member **73**, there is slidably supported and received a slidable element **75** which also rests at its lower end on the bed block **70** within the recess **72** as shown. The axial extent of the sliding element **75** is less than the axial extent of the cylindrical member **73** so that at their upper ends, they jointly define a nest-like tool receiving structure within which the die **39** is supported. To this end, the slidably mounted element or member **75** is normally stationary, but means are provided to selectively reciprocate it. To this end, there is provided a pin **76** which is guided in the bed **38** for reciprocation. A horizontal shaft **77** is rockably guided in the lower arm **31***b* of the frame **31**, and at its inner end is provided with an eccentric or cam **82** by which the pin **76** is selectively reciprocated. To the outer end of the shaft **77** there is provided a handle **78**, seen also in FIGURES 1 and 2, the shaft having an annular groove **79**. A set screw **80** is received in the groove **79** to limit axial movement of the shaft **77**. A stop pin **81** is carried by the shaft **77** in fixed alignment with the eccentric or cam end thereof

82 for abutting the set screw 80 at such an angular position that the eccentric 82 can never be positioned in dead center. Actuation of the handle 78 causes the eccentric 82 to raise the pin 76 which acts through the normally stationary member 75 to raise the tool or die 39. Raising the tool has a two-fold purpose. One of these is to facilitate removal of the tool from the nest defined by the upper end of members 73 and 75. A further purpose of this structure is to raise the workpiece from the upper surface of the workpiece supporting table 33, as already described, so that this mechanism constitutes not only a tool lifting means, but a selectively actutatable means for effecting relative vertical movement between the tool support on the bed and the table 33 to space the workpiece upwardly from the table 33. In this instance, as illustrated, there is effected an upward movement of the tool support means on the bed.

If the eccentric 82 were left in a raised dead-center position, and forgotten there, subsequent operation of the punching machine would likely damage the tool raising mechanism. Since the stop pin 81 prevents such positioning of the eccentric 82, even if the eccentric is left in a raised position during subsequent punch operation, the force acting on the slidable element or member 75 would merely return the eccentric to the illustrated position without damage to the same. To retain the slidable element 75 within the cylindrical member 73, there is provided a set screw 83 and slot 84 in the members 73 and 75. If desired, a liner 85*a* may be provided to guide punchings from the die 39.

In this embodiment, additional structure has been provided to accommodate shaped dies or tools. The term "shaped" as used herein refers to dies having cutting apertures and punches having cutting edges cooperating therewith which are of non-circular cross-section.

As best seen in FIGURE 3, the die 39 has been provided with a shaped opening of oblong configuration. When a shaped punch and die are employed, it is imperative that structure be provided to prevent rotation of the die. As best seen in FIGURE 5, and to this end, there is provided in the bed block 70 a radially extending keyway 85 which communicates with the recess 72. Likewise, the cylindrical member 73 has been provided with a radially extending keyway 86 aligned with the keyway 85, the keyways 85 and 86 jointly receiving a key 87 secured therein by a screw 88. The fits between these components is snug so that any rotation of the cylindrical member 73 about its axis is precluded by the key 87 acting jointly with the keyways 85 and 86. Similarly, the upper end of the cylindrical member 73 has been provided with a radial keyway 89, and the tool or die 39 has been provided with a keyway 90 aligned therewith. Within these keyways, there is received a key 91 which precludes any angular movement of the die 39 about the axis of the cylindrical member 73. A second keyway 92 may be provided in the tool or die 39 at a position spaced ninety-degrees from the keyway 90 to permit positioning the shaped opening thereof in a position spaced angularly ninety-degrees from that illustrated. Each of the keyways 90 and 92 extends in a direction parallel to the axis of the cylindrical member 73 throughout the length of the die 39, and the slidable pin 76 is receivable into the keyway 86, so that the provision of the keying structure does not in any way interfere with the die lifting mechanism.

In addition to these two preselected angular positions of the die 39, there is provided structure by which the die 39 may be keyed into any angular position. To this end, there is provided in the lower tool support, and more specifically in the cylindrical member 73, an upwardly directed recess 93 within which there is disposed an annular member or ring 94 to one side of which the key 91 is secured. When the ring 94 is inverted from the position shown, it will be apparent that the key 91 will still register with the keyway 90, but will not extend into the keyway 89. Thus when the annular member 94 is so inverted, the die 39 and the annular member 94 with its key 91 may rotate about the axis of the cylindrical member 73 to any selected position, and be there jointly locked by locking means comprising a series of screws 95. It is also to be noticed that when the die or tool 39 is so located, the die lifting mechanism still operates the same. Thus variously shaped punching means may be disposed and supported in a manner wherein each may be freely removed vertically for replacement with a tool of a different size or shape. Since the gaging structure is carried by the table 33 which is secured through the sub-table assembly 49 to the frame 31, and since the die 39 is thus also secured through the structure of FIGURE 5 to the frame 31, it is apparent that the infinitely adjustable keying structure will lock a shaped die into a selected angular relationship with respect to the gaging structure 34. In FIGURE 3, the ring and key assembly 94, 91 has been shown in the inverted position which permits such universal keying.

In order for a shaped die to be adjustable about a vertical axis, it is necessary that the punch which is to cooperate therewith also be adjustable about the same axis. To this end, there is shown in FIGURE 6 a cooperating structure by which the punch and stripping assembly may be positioned at any selected angle about a vertical axis. The bight portion 41*c* of the upper tool support 41 has been provided with an upwardly directed recess 96 within which there is disposed a flange or ring portion of an annular member 97. Lock means comprising a group of screws 98 acts between the upper tool support 41 and the annular member 97 to lock the same in any selected angular position, thereby rendering the annular member 97 non-rotatable. A punch and guide assembly generally indicated at 99 is provided with keying presently to be described which corresponds in angular position to the keyways 90 and 92 in the die 39 by which the punch and stripping assembly 99 is always angularly fixed with respect to the annular member 97.

The punching and stripping assembly 99 includes a sleeve 100 which is vertically slidably received in the annular member 97. Within the sleeve 100, there is disposed a cylindrical punch driver 101 which is slidable within the hollow sleeve 100. At its lower end, the punch driver 101 has a concentric recess 102 which forms a part of its lower face and which has an axial opening 103 of smaller diameter than the diameter of the recess 102 whereby a shoulder 104 is defined which is directed downwardly or toward the die. A series of stripping springs 105 acts between the upper end of the sleeve 100 and a ring 106 which encircles the upper end of the punch driver 101 and which engages, with the punch driver 101, the lower surface of a punch head 107. The springs 105 urge the ring 106 against the head 107 and screws 108 retain the stripping springs 105 in the assembly. As such, the stripping springs 105 act between the punch driver 101 and the sleeve 100. There is also provided a punch bit 109 having a lower end 109*a* of a cross-section corresponding to that of the die 39, and an upper threaded end 109*b* received in the recess 102 in abutting relation with the shoulder 104, the shoulder 104 being a part of the lower face of the punch driver 101. Screw means 110 extend axially through the driver head 107 and driver 101 into threaded engagement with the upper end 109*b* of the punch bit 109, so that these components move as a unit. The annular member 97 is provided with an elongated keyway 111, and the punch driver is provided with an elongated keyway 112 which confront each other in spaced relation to each other with the sleeve 100 disposed therebetween. It is apparent that during operation, the annular member 97, being locked, is in effect a rigid part of the upper tool support 41. A key 113 is rigidly secured in a radial aperture in the sleeve 100 and has ends which project radially therethrough and into the keyways 111, 112 with a close sliding fit. The punch driver 101 is thereby angularly keyed to the tool

support **41**. The punch driver **101** is provided with an additional keyway **114** which extends horizontally across the lower face of the punch driver and is aligned with a horizontally opening keyway **115** in the upper end **109***b* of the punch bit **109**. An additional key **116** is removably secured as by a screw to the punch driver **101** and is disposed in the keyways **114**, **115** to angularly lock the position of the punch bit **109** with respect to the punch driver **101**, thereby maintaining the angular relation of the punch as determined by the setting of the annular member **97**. A series of lifting springs **117** acts between the annular portion **97** of the upper tool support **41** and the punch and stripping assembly **99** to bias the assembly as a unit away from the die. If desired, a stripping plate **118** may be employed in the lower end of the stripping sleeve **100** and held therein by a spring clip **119** as shown. If such a stripping plate be employed, it is provided with an aperture closely corresponding in size and configuration to the punch bit **109** so as to engage the workpiece immediately adjacent to the peripheral edge thereof. It is thus apparent that the upper tool support is likewise adapted to support selectively-replaceable relatively-reciprocable tool means for cooperation with the tool means supported on the lower die support.

Where the punch bit **109** and the die **39** have shaped configurations, not only must the one be aligned and locked with the other to achieve interfitting, but the relative angular alignment must be made to a comparatively high degree of accuracy so that the peripheral clearance surrounding the punch bit **109** will be substantially uniform. To achieve this result, the die **39** and the punch and stripping assembly **99** are respectively slidably removed and replaced with a lower aligning tool **120** and an upper aligning tool **121** shown in FIGURE 7. The lower aligning tool **120** has an external configuration corresponding to the die **39** including a keyway **90***a* extending in a direction parallel to the axis of the slidable element **75**, and corresponding to the keyway **90** in the die **39**. The keyway **90***a* receives the key **91** carried by the annular member **94**.

Similarly, the upper aligning tool **121** is provided with and supports a key **113***a* corresponding to the key **113** in the punch and stripping assembly **99**, the key **113***a* being slidably received in the keyway **111** in the annular member **97**. The lower aligning tool **120** is provided with a pair of upwardly extending alignment pins **122**, and the lower edge or face of the alignment tool **121** is provided with slightly tapered grooves or recesses **123**, **123** which receive the alignment pins **122**.

Preferably the outside diameter of each of the alignment tools **120**, **121** is made a few thousandths of an inch larger than the corresponding punch and die means, and the keyway **90***a* and key **113***a* likewise are sized to substantially eliminate freedom of lateral and angular movement. Owing to a wedging relation between the alignment pins **122** and mating grooves or slots **123**, coupled with the substantial elimination of clearances, the alignment tools **120**, and **121**, when mated, comprise a rigid unit which is made to such precision that when the annular members **94** and **97** are positioned thereby and locked, any punch and die means inserted thereafter will cooperate with each other with a substantially uniform distribution of punch clearance about its periphery. It is thus apparent that the aligning tools are respectively received by the annular members and keyed by the corresponding keying structures, and are provided with interfitting structure directed toward the other for strict corotation, whereby alignment of the keying structures may be made accurately with respect to each other and locked.

Referring to FIGURE 8, it will be noted that the bight portion **41***c* of the upper tool support has been provided with indices such as **124**, and that the upper face of the annular member **97** has been provided with mating indices such as **125** to cooperate therewith for indicating the relative angular position of the annular members with respect to the punching machine and workpiece support table. In this illustration, the indices are arranged in a vernier manner.

By detaching the screws such as **74**, shown in FIGURE 5, the cylindrical member **73** and the slidable element **75** may be removed from the recess **72** of the bed block **70**. In place thereof, as shown in FIGURE 9, there may be provided an upwardly extending rigid pedestal **126** which has a lower portion corresponding to the lower part of the cylindrical member **73** which fits in the same manner in the recess **72**. Similarly, a keyway **86***a* receives the key **87** as before to provide angular orientation for use of shaped dies. Also shown in FIGURE 9 is a pedestal die **127** arranged to discharge slugs laterally from a shaped opening of T-shaped configuration. The die **127** is provided with a pair of horizontally directed keyways **128**, **128**, and the upper face of the pedestal **126** is provided with a keyway **129** adapted to receive a key **130** at either end thereof for selectively registering with one of the keyways **128**. The key **130** is held in a locked position by a screw **131**. It is thus apparent that the die **127** may be angularly locked in any one of four positions. The die **127** may be replaced by other pedestal dies during operation of the device. Preferably, the pedestal **126** includes an axial aperture so that a die locking screw **132***a* may be employed when desired, as shown.

By use of a pedestal die support **126** and pedestal die **127**, the punching machine **30** may be adapted to perforate channels and other formed workpieces. Thus the workpiece supporting table **33** may be lowered to a point where it would engage the top of the screw **88**, thereby causing the die **127** to project a substantial distance from the workpiece supporting surface.

It is apparent that the punch and stripping assembly **99** of FIGURE 6 may be employed with an appropriately shaped punch bit to cooperate with the structure of FIGURE 9. However, the structure of FIGURE 9 is particularly advantageous with dies having a relatively small cutting aperture. Accordingly, there is provided additional structure such as shown in FIGURES 10 and 11 which is particularly adapted to use smaller sized punches. This structure includes an additional upper tool support **132** having arms **132***a* and **132***b* extending upwardly on opposite sides of the ram **48**, and having a bight portion **132***c* which receives and slidably supports a punch and stripper assembly **133**. To this end, the upper tool support **132** is provided with an upwardly opening recess **134** in which there is disposed an annular member **135** which is rotatable about its axis to any selected angular position. Locking screws **136***a* are provided in the bight portion **132***c* to lock the position of the annular member **135**. In the annular member **135** there is provided a vertically extending keyway **136** which receives a key **137** rigidly secured to a punch **138**. The punching and stripping assembly **133** includes the punch **138** which is slidably supported at an enlarged central portion by the inner surface of a sleeve **139** which is slidably guided at its outer surface by the inner surface of the annular member **135**. The punch **138** has a lower end portion **138***a* of oval configuration, and a threaded stem portion **139** surmounted by a punch head **140** secured thereto and locked thereto by a set screw **141**. The upper end of the sleeve **139** is provided with a downwardly directed shoulder **139***a*, and a spacer **142** rests on the upper end of the sleeve **139**. A pair of stripping springs **143**, **144** acts between the punch head **140** and the spacer **142** to retract the punch **138** from the workpiece into the sleeve **139**. In this structure, there is also provided an apertured lifting plate **145** which receives the sleeve **139**, the upper surface of the lifting plate **145** engaging the shoulder **139***a* at a point remote from the lower end of the sleeve. Lifting spring means **146** act between the lifting plate **145** and the upper tool support **132** at a point adjacent to the recess **134**. A pair of preloading and guiding screws **147**, **147** serve to keep the plate **145** from rotating. The

punching and stripping assembly **133** together with the annular member **135** is rotatable as a unit with respect to the lifting plate **145** to any selected angular position. The upper surface of the annular member **135** is also provided with a set of indices **148** for indicating the angular position. These are shown in FIGURE 11. The annular member **135** is provided with two of the vertically extending keyways **136** so that the key **137** may be received in either of two angularly spaced positions for each locked position of the member **135**.

The small dies may also be employed with relatively smaller punches by placing an adapter ring **149** in the nest defined by the cylindrical member **73** and slidable element **75**. The outer periphery of the adapter member **149** is substantially similar to that of the die **39**, and is provided with a vertically extending keyway **90***b* in which the key **91** is received. Thus the adapter ring may be locked in a fixed preselected position when the annular member **94** has its key **91** directed downwardly as shown in FIGURE 5, or the adapter ring may be set to any selected angular position and locked, when arranged as shown in FIGURE 10. The adapter ring **149** is provided with a die seat **149***a* in which a slidably removable die **150** is received. The die **150** has an oval aperture corresponding to the lower end **138***a* of the punch **138**. The die **150** is provided with a radially extending key **151** which is received within a keyway **152** in the die adapter **149**. A second keyway **153** is also provided in the die adapter. The keyways **152** and **153** angularly correspond to the keyways **136**, **136** for the punch key **137**. Since the aperture in the workpiece supporting table **33** is relatively large compared to the size of the aperture in the die **150**, there is also provided a filler plate **154**, shown resting on the adapter **149**, the filler plate **154** jointly with the table **33** and the die **150** providing a substantially smooth support surface for the workpiece.

In order to angularly align the punching and stripping assembly **133** with the die **150**, alignment tools such as shown in FIGURE 7, but of proportionately smaller size, are employed. Thus an upper aligning tool replaces the punch and stripping assembly **133** and employs identical interfitting structure carried by a lower alignment tool which replaces the die **150**. Thus again, the annular members **135** and **94** may be rotated to a selected position and locked.

The upper end or supporting portions of the upper tool supports **132** and **41** are identical, and the structure employed on the right arms **132***b* and **41***b* is a mirror image of that employed on the left arms **132***a* and **41***a*. Thus in FIGURES 12–16 there is shown one clamping mechanism by which the upper tool support is located, guided, clamped, aligned, and pivoted.

Thus the clamping mechanism **42** is illustrated in FIGURES 12—16 is representative of all such structure included in the punching machine of this invention. However, it is to be understood that in the preferred embodiment of the invention, two such structures are employed which are not concentric with each other, each of which is individually manually detachable and pivotable.

Each of the clamping mechanisms, such as **42**, is secured to the frame **31***a* and is individually and jointly releasable. In FIGURE 12, it is shown that the clamping mechanism receives and clamps mating structure of the upper tool support **41***a*, presently to be described, and in a similar manner, mating structure of the upper tool support **132** is received and clamped.

When the clamping structure **42** is manually released, as shown in FIGURE 13, the mating structure of the upper tool support may be removed and reinserted. The details by which clamping and release are effected are best shown in FIGURES 14–16. The clamping mechanism **42** includes a handle-lever **155** having a handle portion **155***a* rigidly secured as by welding to a lever portion **155***b*. The handle-lever is pivoted to the frame **31***a*, also termed herein a "member," by a pivot pin **156** for pivoting about an axis which in this embodiment is vertical. There is also included a slidable floating hook **157** which has a hook end **157***a* which is movable into and out of engagement with a support pin **158** which comprises part of the mating structure of the upper tool support **41**. FIGURE 14 illustrates how the hook end **157***a* clamps the support pin **158** into engagement with the end of a slot in the frame **31***a*. As best seen in FIGURE 15, the hook **157** is slidable to a position shown in solid lines where the hook end **157***a* is both released from the support pin **158** and is displaced away from the slot into the frame so that the tool support arm **41***a* may be removed therefrom, from the position shown in FIGURE 15 to the position shown in FIGURE 13. Similarly, FIGURE 15 illustrates the position taken by the tool support after it has been reinserted into the frame slot, immediately prior to its being clamped. In order to effect such movement of the hook, cam means are provided which coact between the handle-lever **155** and the hook **157**. In this embodiment, the cam means comprises a disc-like cam **159** secured to the handle-lever **155** by any convenient means, a screw being shown for such purpose only in FIGURE 16. The disc-like cam **159** has its center disposed laterally of the pivoting axis of the pin **156** so that the outer periphery of the disc-like cam is responsive to pivoting of the handle-lever **155**. The hook **157** at the end remote from the hook end **157***a* is provided with a recess or aperture in which the disc-like cam **159** is received. Thus the inner surface on the hook which defines such recess is in effect a cammed surface which is engaged by the cam **159** to regulate hook hook movement to effect clamping and detaching relation between the hook end **157***a* and the support pin **158**.

When it is desired to release the clamping mechanism from the position shown in FIGURE 14, the handle-lever **155** is pivoted about the axis of the pin **156**. During approximately the first half of the pivotal movement of the handle-lever, the disc-like cam **159** applies a lateral force to the hook **157** at the end remote from the hook end **157***a* to cause it to pivot in a counterclockwise direction as viewed in FIGURE 14, the pivoting being about an axis on or in the pin **158**. Since the disc-like cam moves in an arc, there is also a displacement simultaneously of the hook **157** in a direction which disengages the hook end **157***a*, as shown in broken lines on FIGURE 15. This displacement continues until an abutment **160** on the hook **157** engages a fulcrum means or pin **161** carried by the frame **31***a*. Further counterclockwise movement of the handle-lever **155** causes the disc-like cam **159** to act on the hook at a point between the fulcrum pin **161** and the axis of the pin **156**, thereby causing the hook to pivot about the fulcrum pin **161** in a clockwise direction to the position shown in solid lines in FIGURE 15. It is thus apparent that this latter movement is in a direction transverse to the initial disengaging movement of the hook **157**. Thus the transverse shift of the hook end is effected by engagement between the fulcrum pin **161** and the abutment **160** on the hook **157**, the fulcrum pin **161** being located laterally of the hook member **157** and being engaged thereby after the hook end **157** has disengaged the support pin **158**.

The support pin **158** is rotatably supported by bearing means **162** in the upper tool support **41**, and the frame **31***a* is cut back as at **163**, so that when one of the clamping mechanisms is released, the other clamping mechanism serves as a pivotal connection, thereby permitting the tool support which is released at one of its arms to pivot about the support pin **158** at the other of its arms. Thus the position of the structure indicated by solid lines in FIGURE 15 permits the tool support **41** to pivot about the clamping mechanism **43** shown in FIGURE 2. When both clamping mechanisms are released, the tool support may be removed as a unit. Conversely, when the clamping mechanism **43** is released, the tool support **41** may be pivoted about the support pin **158** when the parts are disposed as shown in FIGURE 14. Such alternative pivoting is particularly advantageous for various oper-

ators of the machine who may be respectively right-handed or left-handed, the pivoting being performed to swing the punch and stripper assembly out from under the ram **48** to permit substitution of other punch components.

The frame **31***a* is provided with a horizontal groove **164** within which the handle-level **155** and the hook **157** are disposed. The groove **164** is intersected by the slot **165** into which the support pin **158** is received. Since there are two clamping mechanisms **42, 43**, and since each has a slot **165** spaced apart by a fixed distance, the tool support is constructed with two support pins **158** spaced apart a like distance. Each of the clamping mechanisms is provided with a support pad **166** arranged in coplanar relation with each other against which a surface **167** of the tool support **41** engages and rests.

The clamping mechanisms **42, 43** with their mating structures comprise pivotal connections between the frame **31***a* and the tool support. This particular clamping mechanism thus accurately aligns and locates the tool support in a predetermined position for maintaining its relationship, and hence the angular relationship of a shaped punch supported thereon, with the gaging structure **34** secured to the workpiece supporting table **33**. While the slots **165** in the frame **31***a* receive and guide the support pins **158**, the frame acting through the support pads **166** also supports the tool support **41**, even though both clamping mechanisms **42, 43** may be in a released position. When the clamping mechanisms are thus tightened, the tool support is guided thereby to a position of accurate alignment with respect to the ram, in which position the clamping mechanism reestablishes the alignment between the punch and the die, as governed by the universal keying, reestablishes the alignment between the punch and the die concentrically even though no keying be used for a round punch, and reestablishes the distances between the center line of the punch and die means and the various reference surfaces in the gaging, presently to be described.

When it is desired to reclamp the support pin **158**, the handle-lever **155** is moved from the solid line position shown in FIGURE 15 in a clockwise direction to the position shown in FIGURE 14. During the initial part of that movement, the cam **159** pivots the hook **157** about the fulcrum pin **161** to swing the hook into the position shown in broken lines. Further pivoting of the handle-lever **155** effects a further sliding of the hook into embracing engagement about the pin **158**, and simultaneously, a disengagement of the fulcrum pin **161** so that the hook **157** pivots on the support pin **158** during the latter part of the hook movement. The handle-lever **155** has an adjustable finger **168** which engages a roller **169** on a plunger **170** of an electric switch **171**. The switch **171** is normally open, such as in FIGURE 13, and when the handle-lever **155** is placed in a clamped position as shown in FIGURES 12 and 14, the finger **168** raises the plunger **170** to close the switch **171**. Such a switch is provided for each clamp mechanism **42, 43** and is included in the electrical control circuit, thereby insuring against its operation when either clamp mechanism is not fully closed.

The gaging mechanism **34** with respect to which the disclosed punch and die means are accurately located, is shown in perspective in FIGURE 1. The gaging means **34** are secured directly to the workpiece-supporting table **33**, and have a number of reference surfaces against which workpieces and gage components engage. The gaging means **34** also includes structure for directly numerically indicating the distance from these reference surfaces to the center line of the punch and die support means.

More specifically, the gaging means **34** includes a pair of spaced side rail bars **172, 173** which are fixedly secured to the table **33** at opposite sides thereof in a parallel relation to each other. A rack-like member **174** is also supported on the table **33** in parallel relation to the side rail bar **172**, and in a preferred embodiment, includes an elongated threaded portion comprising the major central portion thereof, supported for rotation in end bearing portions adjacent to the side rail bar **172**.

An elongated rigid means or gage bar assembly **175** is slidably supported by slide bloiks **176** rigidly secured thereto at its ends, on the side rail bars **172, 173**, the gage bar assembly **175** extending transversely, namely perpendicularly to, the side rail bars **172, 173**. The gage bar assembly **175** is disposed on the upper surface of the table **33**. The gage bar assembly **175** is provided with a number of stops which are slidably adjustably supported thereon. The left slide block **176** supports a mechanism generally indicated at **177** for engaging the threaded portion of the member **174**. The left slide block **176** also supports a counter mechanism indicated at **178**. On the forward end of the member **174** there is a knob assembly generally indicated at **179**.

Referring now to FIGURE 17 on sheet **3**, certain portions of the gaging means are shown in greater detail. The side rail bar **172** is supported by a flange **180** which extends substantially coextensively therewith and which insures against any significant deflection thereof, the flange **180** being secured to the table **33** in any convenient manner. The slide block **176** is provided with bearing means **181** which actually engage the side rail bar **172**. Similar structure is provided at the opposite side of the table. The elongated rigid means generally indicated at **175** is secured to the slide block **176** by any convenient manner (not shown) and is slidable along the upper surface of the workpiece-supporting table **33**. The elongated rigid means **175** includes a rigid base member **182** above which and parallel to which there is disposed a rigid back rail bar **183** which at one end is clamped as at **184** and which is supported by a web flange **185** along approximately the right one-half of its length. The forward face of the base **182** comprises a workpiece engaging reference surface which limits the front-to-rear location of a workpiece with respect to the punch and die means. Secured to the base **182** is a gage bar **186** which has a series of gaging apertures **187** uniformly spaced, for example at one inch intervals, and a series of threaded aperatures **188** disposed intermediate the gaging apertures **187**. The rigid back rail bar **183** extends in parallel relation to the reference surface on the elongated base **182** and slidably supports a number of stops thereon. These include a number of finger stops **189** and a micrometer-supporting-bracket stop **190**.

To position the stops **189** and **190**, there is provided a gage plug assembly which includes a plate **191** disposed in flatwise relation to the gage bar **186** and overlying a pair of holes **187, 188**. A gage plug **192** is rigidly attached thereto and has a lower end which projects into one of the gaging holes **187**, and an upper end which projects therefrom to provide a gaging surface **193** disposed above the gage bar **186**. The support plate **191** is further provided with an elongated thumbscrew **194** which has a threaded portion received in the threaded hole **188** which serves to lock the structure in position. While a gage plug **192** alone could be used, the present structure is preferable since it provides a higher degree of accuracy. The gage plug **192** being held against rocking, whatever clearance may be present between the lower end thereof and the hole **187** will not be amplified by a rocking type of movement at the gaging surface **193**. Thus with the present structure, whatever clearance is present at the hole **187** with respect to the lower end of the gage plug **192**, such will be the greatest error in location of the gaging surface **193**. It is to be understood that the gage plug assembly can be moved throughout the length of the gage bar **186** and positioned in any one of the numerous pairs of spaced gaging and threaded holes.

The bracket **190** supports a direct reading gage such as a straight tubular micrometer **195** by its barrel, and

the spindle **196** thereof abuts the gaging surface **193** of the gage plug **192**. It is apparent that as the micrometer is set to various settings, the bracket **190** may be moved along the back rail bar **183** to various positions in each of which the spindle **196** engages the reference surface **193**. An abutment member **197** is screwed and pinned to the bracket **190** and has a reference surface **197***a* for being engaged by an edge of the workpiece adjacent to that which engages the reference surface **182**. In addition, the abutment member **197** has an instep providing a second abutment surface **197***b* which is spaced from the surface **197***a* by the thickness of an abutment member **198** forming a part of the finger stop **189**. Thus the bracket stop **190** may be employed both for setting individual finger stops **189** and thereafter for directly being abutted by the workpiece. Each of the stops **189** and **190** is provided with clamp means for securing the same rigidly to the back rail bar **183** so that gaging impacts applied by the workpiece thereto will not be transmitted to the comparatively more delicate mechanism of the micrometer **195**. The details of the micrometer **195** are known in the art and form no part of the present invention.

The reference surfaces **197***a*, **197***b*, and the reference surfaces on the abutment finger **198** are all parallel to one another, and to the side rail bars **172**, **173**, and perpendicular to the reference surface on the base member **182**.

Referring now to FIGURE 18, there is shown an end view of the bracket stop **190**. The bracket **190** comprises a C-shaped section having a radial opening **199** which is smaller in extent than the diameter of the back rail bar **183**. This relationship normally prevents removal, and a clamping screw **200** acts to lock the stop assembly **190** in position on the back rail bar **193**. The micrometer assembly **195** is locked in position so that its calibration reads directly, with the position of the gage plug **192**, the exact distance from the reference surface **197***a* to the fore and aft center line passing through the punch and die support means. A setscrew **201** maintains this relationship once it has been established. In order to remove the bracket stop **190** as a unit, the clamping screw **200** is removed first, and then the stop **190** is moved as a unit to a position of alignment with a pair of flats **202**, **202** in the back rail bar **183**, the flats **202**, comprising portions of reduced size smaller than the radial opening **199**. Since these flats are disposed at right angles to the opening **199**, it is necessary to rotate the bracket stop **190** about the axis of the back rail bar **183** for an angle of 90°, thereby permitting the stop **190** to be vertically detached from the back rail bar **183**.

Referring now to FIGURE 19, the finger stop **189** is shown in greater detail. The finger stop **189** includes a bifurcated body **203** to which a threaded clamp portion **204** is pivoted. A clamping screw **205** biased by a spring **206** keeps the clamping portion **204** and the body **203** in snug engagement with the back rail bar **183**, to permit sliding. Further tightening of the screw **205** precludes movement of the finger stop **189**. The abutment member **198** is also pivoted within the bifurcation of the body **203** and extends down to the workpiece supporting table **33**. Its forward edge is curved as at **198***a* to permit a workpiece to enter and raise the abutment member **198** and to engage the reference surface on the rigid base **182**. In this figure, it is also illustrated that the gage holes **187** may be provided by suitable inserts **207**.

It has been indicated that the gage bar assembly **175** is slidable as a unit in a fore and aft direction. Such sliding movement may be precluded, facilitated, or augmented by a clamping structure illustrated in FIGURES 20–22, and generally indicated by the numeral **177**. This mechanism, disposed at one end of the gage bar assembly, has selective threaded engagement with the threaded portion of the elongated member **174**. To this end, there is provided a pair of confronting clamping blocks **208**, **209**. Each of these blocks is adjacent to the elongated member **174** and they are disposed on opposite sides thereof. It will be noted that only the clamping block **208** is provided with threads **208***a* for engaging the elongated member **174**. In order to move the blocks toward and from each other, and toward and away from the elongated member **174**, there are provided manually operated means which engage the blocks jointly to effect such movement. A U-shaped member comprising a pair of parallel bolts **210**, **210** and a block **211** supports a manually operated screw **212**. The arms or bolts **210** of the U-shaped member have engagement in a direction parallel to their axes with the block **209** through their heads and with the block or bight portion **211**, surrounding the threaded portion of the elongated member **174**. The threads of the manually operated screw **212** engage with threads in the block or bight portion **211**, and the inner end thereof drivingly engages the other block **208**. A pair of springs **213**, **213** acts to urge the blocks **208**, **209** apart, and an additional spring **214** acts between a portion or bracket **215** which is rigid with respect to the gage bar assembly **175**, and the manually operated means in such direction as to urge engagement between the threads of the block **208** and the elongated member **174**. It is apparent that rotation of a knob **216** which is corotatable with the screw **212** will effect simultaneous advance and retraction of the blocks **208** and **209** with respect to each other. In the event that friction should bind one of the blocks, the other block will continue to move until it engages a stop pin. A stop pin **217** is provided for the block **209**, while an adjustable stop pin **218** carried by the block **211** is provided for the block **208**. The stop pins **217** and **218** also limit the extent which the blocks may be retracted.

As the knob **216** is rotated to bring the blocks **209**, **208** together, energy is stored in the springs **213**, and some energy is released from the spring **214**. As the blocks are moved in the opposite direction, the springs **213** yield up energy to assist in block separation, some energy being then stored in the spring **214**.

A particular advantage of the spring **214** is that it insures that the block **209** is the first to be released and the last to be engaged with respect to the elongated member **174**.

In a direction parallel to the axis of the elongated member **174**, the blocks **208**, **209** are retained against any movement by being disposed between a pair of guide blocks **219**, **220** secured by screws **221**, and suitably pinned as at **222** to the slide block **176**. The blocks **208**, **209** are thus supported to be moved only toward and from the elongated member **174**, and otherwise to be moved jointly with the gage bar assembly **175**.

When the blocks **208**, **209** are placed in a fully engaged and tightened position, it is apparent that the elongated member **174** will be prevented from rotating and that the gage bar assembly **175** will not be able to slide along the side rail bars **172**, **173**. When the manually operated means is actuated by the knob **216** so that the block **209** is released but so that the threads of the block **208** still engage the threads of the elongated member **174**, sliding movement along the side rail bars is still precluded. However, a rotation of the elongated means **174** will effect limited movement of the gage bar assembly **175** as a unit. Stated otherwise, under this relationship of the blocks, the gage bar assembly may be moved by rotation of the elongated member **174**. When the blocks are further retracted so as to fully disengage the threads of the block **208**, then unrestricted movement of the gage bar assembly in a fore and aft direction will be permitted.

As a primary means of indicating the fore and aft location of the gage bar assembly **175**, the counter mech-

anism indicated at **178** in FIGURE 1 and shown in greater detail in FIGURE 24 is provided. A mounting plate **223** is secured to the slide block **176**, and a supporting block **224** is welded to the plate **223**. A rotary counter **225** having indicia wheels is supported thereon and has an input pinion **226** which is driven through an idler **227** by a gear **228** supported on a shaft **229** journaled in the mounting block **224**. A gear **230**, corotatable with the gear **228** engages the teeth or threads of the rack-like or elongated member **174**. The internal details of the counter mechanism **225** are known in the art. The idler gear **227** is supported on a pin shaft **231** carried by the mounting plate **223**.

The ratio of the gear train is so selected that movement of the gage bar assembly **175** for a distance will indicate that distance on the counter **225**. This is accomplished in a typical example as follows. Ten teeth or threads are provided per lineal inch on the elongated member **174**, and forty peripheral teeth are provided on the gear **230**. A relative displacement then of four inches is required to obtain one revolution of the shaft **229**. One revolution of the shaft **229** produces one revolution of the gear **228**, and the gear ratio is so selected that this effects four revolutions of the counter input pinion **226**. The right-hand indicia wheel on the counter **225** moves with the pinion **226** at the same rate so that four revolutions are thereby effected, thereby effecting a change of forty units for a four inch displacement. Thus tenths of inches may be read directly on the counter **225**. The mechanism is so assembled that when the reference surface on the base member **182** coincides with the center line of the punch and support means, the counter **225** will indicate zero. It is thus apparent that the counter mechanism **178** is fixed to the slide block **176** at one end of the gage bar assembly **175** and that it is geared to the threaded portion of the rack-like member **174** for directly indicating the distance between the reference surface on the base member **182** and the center line of the punch and die means. It is also apparent that as the gage bar assembly is moved back and forth, a continuous indication of the distance referred to will be provided.

In order to position the reference surface on the base member **182** more accurately, the elongated member **174** is made rotatable, is provided with threads, and is provided with the knob assembly **179** shown also in FIGURE 23. A rotation of the elongated member **174** while lightly engaged with the threads of the block **208** effects a corresponding change in fore and aft position of the gage bar assembly **175**. Likewise, it changes the position of both the mounting plate **223** and the pinion **230** of the counter mechanism by the same amount so that the indication thereon is not affected. The knob assembly **179** includes a knob **232** having peripheral calibrations, and being corotatably secured to an end of the elongated member **174**. To this end, the member **174** is provided with a Woodruff key **233** received in a slot **234** in the knob **232**. This keying arrangement permits relative axial movement, but precludes relative angular movement therebetween. The periphery of the knob **232** is divided into one hundred equal calibrations, in a typical embodiment, so that thousandths of an inch may be read directly thereon. The elongated member **174** is provided with a bearing portion **174***a* at each end which is rotatably supported in flange portions **33***a* of the workpiece-supporting table **33**. Preferably, a suitable bearing insert **235** and bearing sleeve **236** is also employed as shown. The bearing insert **235** is secured fixedly by a screw **237** to the table flange **33***a*. A locking member or nut **238** is carried on the outer end of the elongated member **174** and coacts with a shoulder **239** on the elongated member **174** to clamp the calibrated knob **232**, and hence also the elongated member **174** to the table **33** in a selected angular position. When the nut **238** is fully tightened, and the knob **232** is set to a zero position, the counter **225** should also indicate a zero position, or precisely a certain tenth of an inch. Any discrepancy in the indication of the counter mechanism **225** may be alleviated by adding to or subtracting from a number of shims **240**. Thus the shims **240** comprise means for adjusting the position of the elongated member or rack-like member **174** in a direction parallel to the axis of the side rail bars **172**, **173**, to a zero counter position.

Since the indication on the calibrated knob **232** and on the counter **225** is thus synchronized, these elements jointly indicate the magnitude of the distance from the reference surface on the base member **182** to the center line of the punch and die support. The indication on the knob, if any, indicates the magnitude of change from the reading appearing on the counter mechanism. In order to keep all changes positive, so that the knob reading will not be subtracted from the counter reading, there is provided a pair of interengaging pins **241**, **242**, the pin **241** being carried by the table flange **33***a*, and the pin **242** being carried by the calibrated knob **232**. These pins engage with each other when the knob is in a zero position, and permit movement of the knob only in an increasing direction. They reengage immediately before the knob can be advanced a full revolution to the zero position. Thus a reading typically on the knob is limited to the range between zero and .098 inch. It is apparent that when the locking nut **238** is fully tightened, both axial and angular movement by both the knob and the elongated member **174** is precluded.

In an actual embodiment, the physical extent of the gage bar assembly **175** is several feet. Therefore, it is advantageous also to have the gage bar assembly clamped near its mid-position, namely at a point approximately rearwardly of the punch and die means, since it is at this point that the operator's pushing force on a workpiece will tend to cause slight yielding. In view of the high degree of accuracy to which the instant gaging is adapted to perform, it is therefore preferable that such clamping be employed to maintain such accuracy. An example of such a clamping structure is shown in FIGURE 25. At a point near the middle of the back rail bar **183**, there is provided a horizontal element **243** which extends transversely to the axis thereof. The table **33** is provided with a locking mechanism which acts on the horizontal element **243** to thereby lock the position of the gage bar assembly **175** with respect to the table **33**. This locking mechanism includes a manually rockable shaft **244** disposed beneath the table **33**, and having on its rearward end, a cam **245** which is corotatable with the shaft **244**. The cam **245** acts on a vertical slide pin **246** to engage and to raise a friction element **247** into clamping relation with respect to the horizontal element **243**. The friction element **247** extends perpendicularly to the drawing and is attached by conventional means remotely from the pin **246** to a guide block **248** in which the pin **246** is slidable and which is apertured to receive the elongated member **243**. At the forward end of the shaft **244**, there is provided a bearing block **249** which is secured to the table **33** and which supports a lock screw **250** the point of which is received in a recess **251** in the shaft **244** to prevent axial movement thereof. A handle **252** is carried on the forward end of the shaft **244** at the front of the table **33**. As illustrated, the structure of FIGURE 25 is shown in a released position. Movement of the handle **252** in either direction raises the slide pin **246** to clamp the friction element **247** against the horizontal element **243**, thereby precluding any horizontal movement of the gage bar assembly **175**.

It is apparent that in certain installations, the indication on the counter mechanism **225** will be sufficiently accurate, and that no rotation of the elongated member **174** will be required. Under such circumstances, the member **174** may comprise a rack.

The back rail bar **183** also slidably supports a template follower mechanism **253**, and selective reciprocation of

the follower mechanism 253 effects a fore and aft movement of the reference surface on the rigid base 182. The follower mechanism 253 is adapted to overlie a template 254 shown fragmentarily in FIGURE 1 and in enlarged cross-section in FIGURE 26, and to engage the workpiece in a manner to effect joint movement therebetween. The workpiece-supporting table 33 is slightly undercut adjacent to the punch and die means for receiving such a template in substantially coplanar relation with the rest of the workpiece-supporting table 33 so that the workpiece can also for certain positions overlie the template 254. The template 254 is located by means of guide buttons 255 and is held securely against the table 33 by a sheet of pressure sensitive tape 256 having a first pressure sensitive coating 257 in engagement with the upper surface of the table 33, and a second pressure sensitive coating 258 in engagement with the lower surface of the template 254. We have found that this type of template attachment is particularly advantageous since there is thus no obstruction provided to free movement of the template follower mechanism 253 or workpiece driven thereby, as has been true in the past with various types of overlapping clamping means employed. We have also found that this mode of attaching the template 254 is extremely reliable and rigidly locates the template in a truly fixed position.

Referring now to FIGURE 27, the operation of the punching machine 30 will be described. A three phase line 259 leads through a master switch 260 and fuses 261 through certain contacts of a motor starter 262 and a thermal overload means 263 to a motor 264 which continuously drives the flywheel-pulley 45. A transformer 265 provides lower voltage for the control circuits.

By manual operation of a start switch 266, the circuit is completed to the coil of the motor starter 262, said circuit including thermal overload contacts 267 and a manual stop switch 268. Completion of the circuit to the coil of the motor starter 262 closes the various contacts thereof which includes a holding contact connected across the starting switch 266. Therefore, any subsequent actuation of the stop switch 268 breaks the circuit to the motor starter 262 to stop the motor 264. For convenience, a power outlet 269 is connected across the secondary of the transformer 265 to energize other accessories, not shown.

Power from the transformer 265 is also directed to a first selector switch 270 which has two positions. In the illustrated position, the selector switch 270 directs power toward a foot switch 271, and in its other position, the selector switch 270 directs power to a switch 272 which forms a part of the template follower mechanism 253. The other side of the switches 271 and 272 are directed to a second selector switch 273. In the illustrated position of the switch 273, it connects the switches 271 and 272 in series with a circuit branch employing two relays and two switches by which single strokes of the ram are effected. In its other position, the selector switch 273 is connected to another circuit branch by which continuous reciprocation of the ram is effected. As mentioned previously, the ram is connected by an electrically actuated clutch to the reciprocating mechanism, the electrically actuated clutch including a solenoid or coil 274. The switches 171, 171 which are responsive to the position of the clamping mechanisms 42, 43, and which are closed as shown when the clamping mechanisms are in a clamped position, are connected in series with the solenoid 274 so that if either clamping mechanism be even partially loosened, the solenoid 274 cannot be energized. Thus it is apparent that if the selector switch 273 be positioned in its other position, and the actuating switch 271 be closed, power will flow continuously through the solenoid 274, so long as the actuating switch 271 is held in a closed position. This is a condition which is particularly advantageous for nibbling operations. It is to be noted that the power for the solenoid passes through the holding contact of the motor starter 262 so that any time that the stop switch 268 is actuated, not only does the motor 264 become deenergized, but also the solenoid 274 is rendered inoperative. Of course, changing the position of any one of switches 270, 271, 273, or 171 also instantly deenergizes the solenoid 274 of the clutch 48.

When the selector switch 273 is in the illustrated position, the solenoid 274 may also be energized through contacts of a control relay 275 which are connected between the holding contact of the motor starter 262 and the solenoid 274. To energize the coil of the control relay 275, the actuator switch, such as 271, is closed, thereby bringing potential to opposite sides of a limit switch 276, also shown in FIGURE 2, which is disposed to be momentarily operated once for each revolution of the flywheel 45. The limit switch 276 is normally open, and when it is momentarily actuated, it completes the circuit to the coil of the control relay 275, thus also closing a holding circuit 277 which bypasses the selector and actuating switches as well as the limit switch 276. Thus the circuit to the solenoid 274 is also closed.

It will be noted that the circuit to the coil of the control relay 275 includes normally closed contacts of a second control relay 278, and the opening of these contacts is utilized to deenergize the holding circuit of the control relay 275, to thereby deenergize the solenoid 274. The control relay 278 includes a coil connected in series with a second limit switch 279. Further rotation of the flywheel closes the limit switch 279 to bring power through the then closed holding contacts of the control relay 275 to the coil of the control relay 278, thereby opening the normally closed contacts in the coil circuit of the control relay 275 and also closing holding contacts of the control relay 278 which are energized through the actuator switches, such as 271. Release of the foot switch 271 thus breaks the holding circuit to the control relay 278 to place it in position for initiation of a second single stroke of the ram.

It is thus apparent that the control circuit provided will regulate the operation of the clutch solenoid 274, and that by proper manipulation thereof, continuous reciprocation of the ram will be provided for a selected period of time, and also single strokes of the ram will be provided even though the actuator switch 271 or 272 is held continuously in a closed position.

Although various minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. A punching machine comprising in combination: a frame having means adapted to support and to reciprocate punch and die means relatively to each other; a horizontally directed table disposed to support a workpiece adjacent to one of the punch and die means; side rail bar means fixedly secured to said table; a gage bar assembly slidably supported at its ends on said bar means and extending transversely thereto along the upper surface of said table, said gage bar assembly having a reference surface perpendicular to said side rail bar means for being engaged by an edge of the workpiece, said gage bar assembly including at least one stop slidably adjustable for a distance along the length of said gage bar assembly and having a reference surface parallel to said side rail bar means for being engaged by another edge of the workpiece.

2. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to directly support a workpiece intermediate the punch and

die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; a mechanism carried at one end of said gage bar assembly for selectively holding and releasing said gage bar assembly for free movement with respect to said table; said gage bar assembly including a horizontal element intermediate its ends and extending transversely thereto, and a locking mechanism secured to said table and selectively operative on said horizontal element to lock said gage bar assembly in a selected position and to release said element for free sliding movement with respect to said table.

3. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; a mechanism carried at one end of said gage bar assembly for selectively holding and releasing said gage bar assembly for free movement with respect to said table; said gage bar assembly including a horizontal element intermediate its ends and extending transversely thereto; a manually rockable shaft disposed beneath and secured to said table; a cam corotatably carried by said shaft; and a friction element actuated by said cam and engageable with said horizontal element to lock said gage bar assembly in position.

4. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member rotatably secured to said table and having a threaded portion adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly and operative on said threaded portion to lock and to release said gage bar assembly for free movement with respect to said elongated member, and to enable driven change in the position thereof; and a knob corotatable with said elongated member by which the position of said gage bar assembly may be changed, said knob being calibrated to indicate directly the magnitude of said change.

5. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member rotatably secured to said table and having a threaded portion adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly and operative on said threaded portion to lock and to release the position of said gage bar assembly, and to enable driven change in said position; a knob corotatable with said elongated member by which said position of said gage bar assembly may be changed; a rotatably driven mechanical digital counter fixedly supported on said one end of said gage bar assembly and geared to said threaded portion; said knob being calibrated to indicate directly and jointly with said counter the distance between said reference surface and the center line of the punch and die support means.

6. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; a rack-like member secured to said table in a position adjacent to and parallel to one of said side rail bars; a rotatably driven mechanical digital counter fixedly secured to one end of said gage bar assembly and geared to said rack-like member; and means for adjusting the position of said rack-like member in a direction parallel to the axes of said side rail bars for effecting precise zeroing of said counter; said counter being operative to directly indicate the distance between said reference surface and the center line of the punch and die support means as said gage bar assembly is moved on said side rail bars.

7. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly and having threaded engagement with said threaded portion for effecting movement of said gage bar assembly thereby; a calibrated knob corotatable with said elongated member for effecting rotation thereof; and a locking member operative on both said knob and said elongated member to clamp said knob and said elongated member to said table, thereby precluding any axial or angular movement of both said knob and said elongated member.

8. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides therof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a refrence surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; manually operable means engaging said blocks

for jointly moving said blocks toward and away from each other; only one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

9. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; a U-shaped member having a pair of arms secured to one of said blocks, said U-shaped member having a bight extending in surrounding relation to said threaded portion; a manually axially movable element extending through said bight and drivingly engaging the other of said blocks for jointly moving said blocks toward and away from each other; one of said blocks having threads engageable with said threaded portion; said manually movable element being selectively positionable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

10. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; spring means continuously urging said blocks apart; manually operable means engaging said blocks for jointly moving said blocks toward each other and for storing energy in said spring means, and for jointly moving said blocks away from each other assisted by said spring means; a stop pin for each of said blocks operative to limit the distance which each block can be retracted from the threaded portion; one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

11. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side bar rails; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; first spring means continuously urging said blocks apart; manually operable means engaging said blocks for jointly moving said blocks toward each other and for storing energy in said spring means, and for jointly moving said blocks away from each other assisted by said spring means; only one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assemby, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars; and second spring means acting between said gage bar assembly and said manually operable means to urge said one threaded block toward said threaded portion, whereby the other block is the first to be released and the last to be clamped.

12. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; a mechanism carried at one end of said gage bar assembly for selectively holding and releasing said gage bar assembly for free movement with respect to said table; said gage bar assembly including a horizontal element intermediate its ends and extending transversely thereto; and a locking mechanism secured to said table and selectively operative on said horizontal element to lock said gage bar assembly in a selected position and to release said element for free sliding movment with respect to said table.

13. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being angaged by an edge of the workpiece; a mechanism carried at one end of said gage bar assembly for selectively holding and releasing said gage bar assembly for free movement with respect to said table; said gage bar assembly including a horizontal element intermediate its ends and extending transversely thereto; a manually rockable shaft disposed beneath and secured

to said table; a cam corotatably carried by said shaft; and a friction element actuated by said cam and engageable with said horizontal element to lock said gage bar assembly in a preselected position.

14. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; a rack-like member secured to said table in a position adjacent to and parallel to one of said side rail bars; a rotatably driven mechanical digital counter fixedly secured to one end of said gage bar assembly and geared to said rack-like manner; and means for adjusting the position of said rack-like member in a direction parallel to the axes of said side rail bars for effecting precise zeroing of said counter; said counter being operative to directly indicate the distance between said reference surface and said predetermined reference point as said gage bar assembly is moved on said side rail bars.

15. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly and having threaded engagement with said threaded portion for effecting movement of said gage bar assembly thereby; a calibrated knob corotatable with said elongated member for effecting rotation thereof; and a locking member operative on both said knob and said elongated member to clamp said knob and said elongated member to said table, thereby precluding an axial or angular movement of both said knob and said elongated member.

16. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; manually operable means engaging said blocks for jointly moving said blocks toward and away from each other; only one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

17. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; a U-shaped member having a pair of arms secured to one of said blocks, said U-shaped member having a bight extending in surrounding relation to said threaded portion; a manually axially movable element extending through said bight and drivingly engaging the other of said blocks for jointly moving said blocks toward and away from each other; one of said blocks having threads engageable with said threaded portion; said manually movable element being selectively positionable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

18. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on opposite sides of said elongated member; spring means continually urging said blocks apart, manually operable means engaging said blocks for jointly moving said blocks toward each other and for storing energy in said spring means, and for jointly moving said blocks away from each other assisted by said spring means; a stop pin for each of said blocks operative to limit the distance which each block can be retracted from the threaded portion; one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars.

19. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination; a table adapted to support the workpiece; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; a gage bar assembly slidably supported at its ends on said side rail bars and having a reference surface for being engaged by an edge of the workpiece; an elongated member having a bearing portion rotatably mounted on said table, and having a threaded portion disposed adjacent to and parallel to one of said side rail bars; a mechanism carried at one end of said gage bar assembly, said mechanism including a pair of movable clamping blocks disposed adjacent to each other on op-

posite sides of said elongated member; first spring means continuously urging said blocks apart; manually operable means engaging said blocks for jointly moving said blocks toward each other and for storing energy in said spring means, and for jointly moving said blocks away from each other assisted by said spring means; only one of said blocks having threads engageable with said threaded portion; said manually operable means being selectively operable to clamp both of said blocks against said threaded portion to preclude movement of said gage bar assembly, to lightly engage the threads of said one block with said threaded portion to enable rotation of said elongated member to reposition said gage bar assembly, and to release both of said blocks from said threaded portion to enable free sliding movement of said gage bar assembly on said side rail bars; and second spring means acting between said gage bar assembly and said manually operable means to urge said one threaded block toward said threaded portion, whereby the other block is the first to be released and the last to be clamped.

20. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; an elongated rigid means slidably supported at its ends on said side rail bars and having means defining a first reference surface extending perpendicularly to said side rail bars for being engaged by an edge of the workpiece; said elongated means having a series of uniformly spaced gaging holes and a rigid back rail bar extending parallel to said first reference surface; a finger stop slidable on said back rail bar and having a second reference surface extending parallel to said side rail bars for being engaged by an other edge of the workpiece, said finger stop being adapted to be clamped to said back rail bar at any selected position therealong; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said back rail bar; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a third and a fourth reference surface spaced from each other and disposed parallel to said side rail bars, said third reference surface being adapted to engage and to locate said finger stop, and said fourth reference surface being adapted to engage said other edge of the workpiece.

21. In a punching machine having a frame, and suppor means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; an elongated rigid means slidably supported at its ends on said side rail bars and having means defining a first reference surface extending perpendicularly to said side rail bars for being engaged by an edge of the workpiece; said elongated means having a series of uniformly spaced gaging holes and a rigid back rail bar extending parallel to said first reference surface; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said back rail bar, said bracket having a C-shaped section with a radial opening smaller than the size of said back rail bar to prevent removal therefrom; said back rail bar having a portion of reduced size smaller than said radial opening with which said bracket may be selectively aligned to permit removal of said bracket therefrom; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second reference surface parallel to said side rail bars for engaging another edge of the workpiece.

22. In a punching machine having a frame, and support means rigidly secured to the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be secured to the frame independently of said support means, and disposed to support a workpiece intermediate the punch and die means; a pair of spaced side rail bars fixedly secured to said table at opposite sides thereof in parallel relation to each other; an elongated rigid means slidably supported at its ends on said side rail bars and having means defining a first reference surface extending perpendicularly to said side rail bars for being engaged by an edge of the workpiece; said elongated means having a series of spaced gaging holes and a series of uniformly spaced threaded holes; a rigid back rail bar extending parallel to said first reference surface; a plate disposed above one of said gaging and one of said threaded holes, said plate having a gage plug rigidly secured thereto and received in said gaging hole, and said plate having a thumbscrew received in said one threaded hole to lock said plate in position; said gage plug having a gaging surface disposed outwardly thereof; a bracket slidably supported on said back rail bar; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second reference surface parallel to said side rail bars for engaging another edge of the workpiece.

23. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; an elongated rigid means supported on said table and having a series of uniformly spaced gaging holes, said rigid means including a rigid rail bar extending therealong; a finger stop slidable on said rigid rail bar and having a first reference surface extending perpendicularly to said rail bar for being engaged by an edge of the workpiece, said finger stop being adapted to be clamped to said rail bar at any selected position therealong; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rigid means; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second reference surface perpendicular to said rail bar for engaging and locating said finger stop.

24. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; an elongated rigid means supported on said table and having a series of uniformly spaced gaging holes; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rigid means; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a reference surface perpendicular to said rigid means for engaging an edge of the workpiece, said bracket being adapted to be clamped to said rigid means at any selected position therealong.

25. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; an elongated rigid means supported on said table and having a series of uniformly spaced gaging holes, said rigid means including a rigid rail bar extending there-

along; a finger stop slidable on said rigid rail bar and having a first reference surface extending perpendicularly to said rail bar for being engaged by an edge of the workpiece, said finger stop being adapted to be clamped to said rail bar at any selected position therealong; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rigid means; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second and a third reference surface spaced from each other and disposed perpendicular to said rail bar, said second reference surface being adapted to engage and to locate said finger stop, and said third reference surface being adapted to engage said edge of the workpiece.

26. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; an elongated rigid means supported on said table and having a series of uniformly spaced gaging holes, said rigid means including a rigid rail bar extending therealong; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rail bar, said bracket having a C-shaped section with a radial opening smaller than the size of said rail bar to prevent removal therefrom; said rail bar having a portion of reduced size smaller than said radial opening with which said bracket may be selectively aligned to enable removal of said bracket therefrom; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second reference surface perpendicular to said rail bar for engaging an edge of the workpiece.

27. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to support the workpiece; an elongated rigid means supported on said table and having a series of uniformly spaced gaging holes and a series of spaced threaded holes; a plate disposed above one of said gaging and one of said threaded holes, said plate having a gage plug rigidly secured thereto and received in said gaging hole, and said plate having a thumbscrew received in said one threaded hole to lock said plate in position; said gage plug having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rigid means; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a reference surface perpendicular to said rigid means for engaging an edge of the workpiece.

28. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination: a table adapted to directly support the workpiece; an elongated gage bar assembly slidably supported for movement along a surface of said table in a direction perpendicular to its length, and having a reference surface for being engaged by an edge of the workpiece; an elongated member rotatably secured to said table and having a threaded portion whose axis is perpendicular to the length of said gage bar assembly and parallel to its direction of movement; a mechanism carried by said gage bar assembly, and including a movable clamping block having a threaded face adapted to be selectively moved against or entirely away from said threaded portion to preclude or to free movement of said gage bar assembly with respect to said elongated member; said mechanism including a mechanical digital counter supported for translation with said gage bar assembly and geared to said threaded portion, and operative to directly indicate the distance between said reference surface and said point as said gage bar assembly is moved back and forth; and a calibrated knob corotatable with said elongated member by rotation of which said position of said gage bar assembly may be changed by a force acting through said clamping block when said clamping block is slightly loose, said knob being calibrated to indicate the magnitude of said change; the threads of said clamping block being operative as a cam in response to movement of said block perpendicularly to said axis against said threaded portion to shift said gage bar assembly and said counter with respect to said threaded portion by an amount needed to synchronize the indication on said counter with the indication on said knob for any angular knob position.

29. In a punching machine having a frame, and support means supported by the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be supported by the frame and disposed to support a workpiece intermediate the punch and die means; side rail bar means fixedly secured to said table; an elongated rigid means slidably supported above said table on said side rail bar means and having means defining a first reference surface extending perpendicularly to said side rail bar means for being engaged by an edge of the workpiece; said elongated means having a series of uniformly spaced gaging holes and a rigid rail bar extending perpendicularly to said side rail bar means and parallel to said first reference surface; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rail bar; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a second reference surface parallel to said side rail bar means for engaging another edge of the workpiece, said bracket being adapted to be clamped to said rail bar at any selected position therealong.

30. In a punching machine having a frame, and support means supported by the frame and adapted to support punch and die means in alignment with each other, the improvement comprising in combination: a horizontally directed table adapted to be supported by the frame and disposed to support a workpiece intermediate the punch and die means; side rail bar means fixedly secured to said table; an elongated rigid means slidably supported above said table on said side rail bar means and having means defining a first reference surface extending perpendicularly to said side rail bar means for being engaged by an edge of the workpiece; said elongated means having a series of uniformly spaced gaging holes and a rigid rail bar extending perpendicularly to said side rail bar means and parallel to said first reference surface; a finger stop slidable on said rail bar and having a second reference surface extending parallel to said side rail bar means for being engaged by another edge of the workpiece, said finger stop being adapted to be clamped to said rail bar at any selected position therealong; a gage plug receivable selectively in any one of said gaging holes and having a gaging surface disposed outwardly thereof; a bracket slidably supported on said rail bar; and a direct reading gage secured to said bracket and having a spindle engageable with said gaging surface of said gage plug; said bracket having a third reference surface parallel to said side rail bar means for engaging and locating said finger stop.

31. A punching machine comprising in combination:

(a) a frame having means adapted to support and to reciprocate punch and die means relatively to each other;

(b) a horizontally directed table disposed to directly support a workpiece adjacent to one of the punch and die means;

(c) manually adjustable means connecting said table to said frame and operative to position said table at a selected height in relation to said punch and die means in response to actuation of said adjustable means; and

(d) adjustable gaging means secured to said table and movable with said table to said selected height and having a vertical reference surface for abutting engagement by an edge of the workpiece, said gaging means being movable horizontally with respect to said table and having structure coactive with said table defining and directly numerically indicating in digits representing units of length the total horizontal distance between said vertical reference surface and the vertical centerline of said punch and die supporting means.

32. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination:

(a) a table adapted to directly engage and support the workpiece;

(b) a rail bar fixedly secured to said table;

(c) a gage bar assembly slidably supported on said rail bar and having a vertical reference surface for being engaged by an edge of the workpiece;

(d) a rack-like member having sloping tooth-like surfaces lying in intersecting planes, said member being secured to said table in a position adjacent to and parallel to said rail bar;

(e) a mechanism carried at one end of said gage bar assembly and operative on said sloping surfaces of said rack-like member to hold and to release said gage bar assembly for free movement with respect to said rack-like member; and

(f) a rotatably driven mechanical digital counter fixedly secured to said one end of said gage bar assembly and geared to said sloping surfaces of said rack-like member, and operative to directly indicate the horizontal distance between said vertical reference surface and said predetermined reference point as said gage bar assembly is so moved on said rail bar.

33. A structure for accurately positioning a workpiece in relation to a predetermined reference point, comprising in combination:

(a) a table adapted to support a workpiece;

(b) a rail bar fixedly secured to said table;

(c) a gage bar assembly slidably supported on said rail bar and having a vertical reference surface for being engaged by an edge of the workpiece;

(d) an elongated member rotatably secured to said table and having a threaded portion adjacent to and parallel to said rail bar;

(e) a mechanism carried at one end of said gage bar assembly and operative on said threaded portion to lock and to release said gage bar assembly for free movement with respect to said elongated member, and to enable driven change in said position;

(f) a calibrated knob corotatable with said elongated member by which said position of said gage bar assembly may be changed; and

(g) a rotatably driven mechanical digital counter fixedly supported on said one end of said gage bar assembly and geared to said threaded portion of said elongated member, said counter being operative to indicate directly in numerals and jointly with said knob the horizontal distance between said vertical reference surface and said predetermined reference point.

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