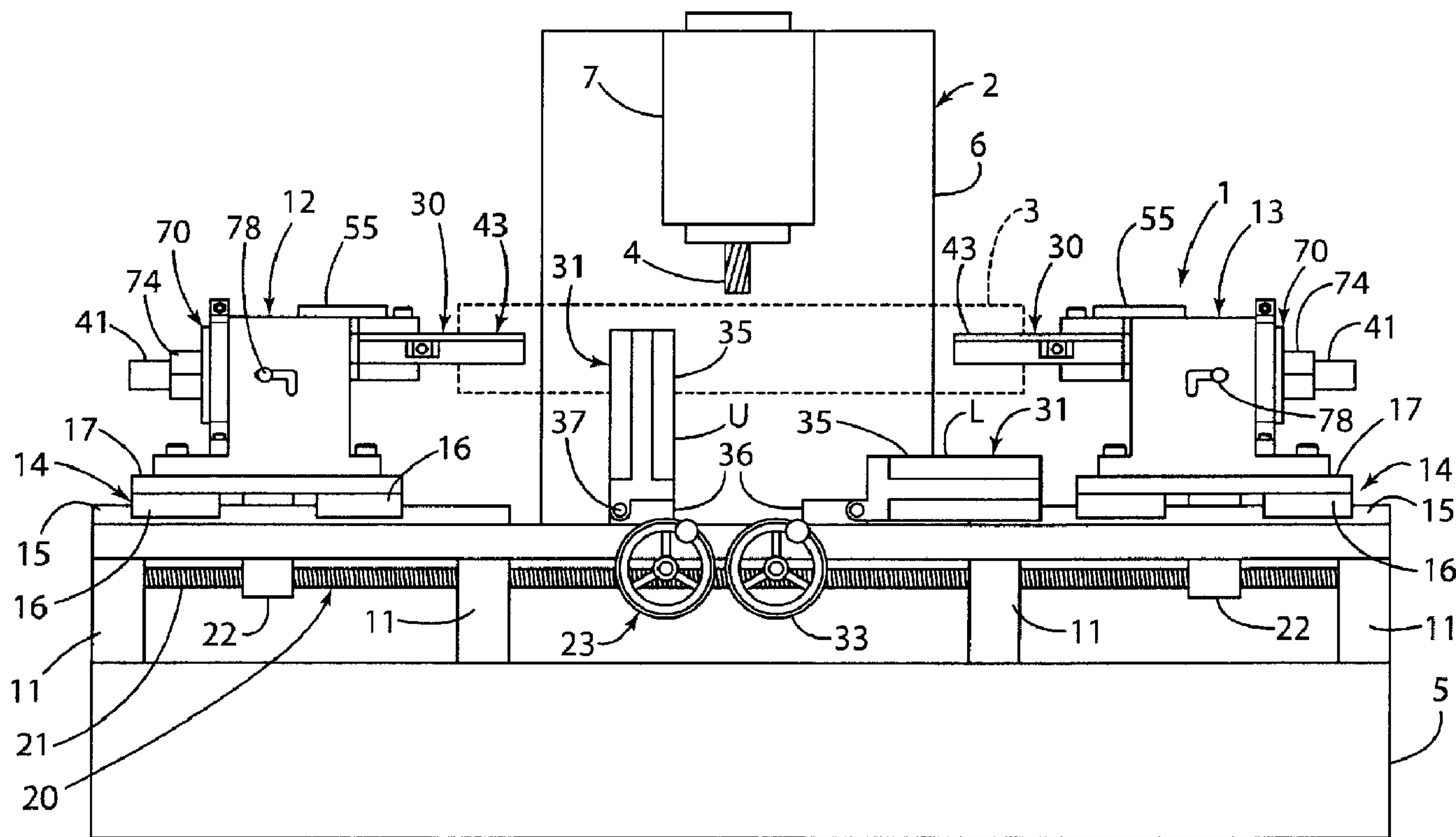




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(54) Titre : MONTAGE DE FIXATION POUR MACHINES-OUTILS
 (54) Title: METHOD AND FIXTURE FOR HANDLING AND PROCESSING DIE COMPONENTS



(57) Abrégé/Abstract:

A fixture for machine tools and the like includes a base member and first and second workpiece support units that are movably connected to the base member and define a space therebetween. The fixture includes a drive assembly that is operably connected to the workpiece support units to move the first and second workpiece support units towards and away from one another. The workpiece support units each include a wedge member extending toward the space between the workpiece support units. The wedge members include opposed engagement surfaces that taper towards one another for engaging slots in opposite ends of a workpiece. Each of the workpiece support units also includes a clamp for clamping a workpiece as it engages the wedge members.

ABSTRACT OF THE DISCLOSURE

A fixture for machine tools and the like includes a base member and first and second workpiece support units that are movably connected to the base member and define a space therebetween. The fixture includes a drive assembly that is operably connected to the workpiece support units to move the first and second workpiece support units towards and away from one another. The workpiece support units each include a wedge member extending toward the space between the workpiece support units. The wedge members include opposed engagement surfaces that taper towards one another for engaging slots in opposite ends of a workpiece. Each of the workpiece support units also includes a clamp for clamping a workpiece as it engages the wedge members.

METHOD AND FIXTURE FOR HANDLING AND PROCESSING DIE COMPONENTS

BACKGROUND OF THE INVENTION

5 Dies utilized for fabricating sheet metal parts and the like typically include a die set having a pair of die shoes (e.g., flat metal plates) that are movably interconnected by posts and bushings that provide for movement of the die shoes towards and away from one another, and align and position the die shoes relative to one another. A variety of punches, die steels and the like are mounted to the die shoes for forming parts from sheet metal as it
10 is fed into the die. A number of openings are typically machined into the die shoe for mounting of the die steel and other such components, and also to provide clearance for slugs that are punched from the sheet metal and pass through openings in the lower die shoe during the forming process.

Dies are often provided with parallels for mounting the die shoes to a press. In
15 general, parallels are elongated heavy steel members with opposite edge surfaces that are machined to parallel so the parallel can position and provide support for the die in the press. The parallels typically include a plurality of threaded openings that receive threaded fasteners for securing the parallels to the die shoes. The die shoes may also include slots or openings at end portions of the parallels to provide for securing the
20 parallel to the press. Depending upon the requirements of a particular die design, parallels may be positioned adjacent or across a slug clearance opening in the die shoe, such that clearance must be machined in the parallel to provide for proper exit of the slugs. Due to the wide variation in the size and configuration of dies, parallels are typically custom made for a particular die. Parallels are commonly rough cut from large plates of hot roll
25 steel using a flame cutter. The rough cut parallels were then individually machined utilizing conventional manual workpiece setup and positioning methods. As a result of the time consuming manual setup and positioning, such machining methods can be costly due to the amount of labor and machine time used.

Accordingly, a way to reduce the setup and machining time would be desirable.

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SUMMARY OF THE INVENTION

The present invention comprises a method and fixture for handling and processing die components. One aspect of the present invention comprises use of a fixture for

machine tools including a base member and first and second workpiece support units that are movably connected to the base member, the first and second workpiece units defining a space therebetween. The fixture further includes a drive assembly that is operably connected to the first and second workpiece support units. The drive assembly is operable to move the first and second workpiece support units towards one another and away from one another. The first and second workpiece support units each include a wedge member extending toward the space between the first and second workpiece support units. The wedge members include opposed engagement surfaces that taper towards one another for engagement of slots in a workpiece, i.e. a die component. The first and second workpiece support units further include a clamp having a pair of movable jaw members positioned adjacent the wedge member for clamping a workpiece as it engages the wedge members.

In another aspect of the invention, die component steel plates are provided with flame cut die processing features such as the aforesaid processing slots, notches and apertures, preferably at the time the component is flame cut from large plates of hot roll steel, which have nothing to do with the ultimate functionality of the die, but rather are made to facilitate handling, locating and/or holding the plate or items to be mounted on the plate during the process of die manufacture. By flame cutting such processing features into the hot roll steel plate when it is flame cut, the expense of tedious positioning, clamping and possibly even subsequent machining for processing purposes only is eliminated.

Another aspect of the present invention comprises use of a fixture for machine tools including a base member and first and second workpiece support units that are movably connected to the base member for movement towards and away from each other. Each workpiece support unit includes a unit base structure and a wedge member that is rotatably mounted to the unit base structure for rotating a workpiece supported on the wedge members between the first and second workpiece support units. The fixture further includes a drive assembly operably connected to the first and second workpiece support units and simultaneously moving the first and second workpiece support units towards and away from each other.

Another aspect of the present invention comprises use of a fixture for machine tools including a base member and first and second workpiece support units mounted to

the base member. Each workpiece support unit includes a unit base structure and an attachment structure rotatably mounted to the base structure. Each attachment structure is configured to hold a workpiece for rotation in the fixture. Each workpiece support unit also includes an indexing device that selectively retains the attachment structure at a selected one of a plurality of predetermined angular positions relative to the unit base structure. The fixture further includes a mechanical drive assembly operably interconnecting the attachment structures. The mechanical drive assembly simultaneously moves the attachment structures towards and away from one another.

These and other features, advantages, and objects of the present invention will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially schematic elevational view of a machine tool and fixture according to one aspect of the present invention;

Fig. 2 is a partially schematic perspective view of the machine tool and fixture of Fig. 1;

Fig. 3 is a perspective view of a workpiece support unit of the fixture of Fig. 1; and Fig. 4 is a perspective view of a workpiece support unit of the fixture of Fig. 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

For purposes of description herein, the terms "upper," "lower," "right," "left," "rear," "front," "vertical," "horizontal," and derivatives thereof shall relate to the invention as oriented in Fig. 1. However, it is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

With reference to Figs. 1 and 2, a fixture 1 according to one aspect of the present invention may be mounted to a machine tool 2 to support a workpiece such as a parallel

during machining operations. In the illustrated example, the machine tool 2 comprises a milling machine of a known type including a bed 5, vertical structure 6, and a head 7 to which a variety of cutters 4, drill bits, reamers, or the like may be attached for machining operations. In the illustrated example, the machine tool 2 is a CNC machine having a computer control system to control the machining operations.

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Fixture 1 includes first and second workpiece support units 12 and 13, respectively, that securely hold and position a workpiece such as a parallel 3 during machining operations. As discussed in more detail below, workpiece support units 12 and 13 include wedge members 42 that engage slots or notches 90 that are pre-formed in the opposite ends 91, 92 of a rough-cut parallel 3. Workpiece support units 12, 13 also include clamps 43 with jaws 44 that clamp onto opposite side surfaces 34 of parallel 3. The workpiece support units 12 and 13 provide for rotation of the parallel 3 about a horizontal axis without disengaging wedge members 42 and clamps 43, such that the position of parallel 3 relative to milling machine 2 remains known, and time-consuming manual setup and repositioning of parallel 3 is not required.

The fixture 1 includes a base 10 that is secured to the bed 5 utilizing a plurality of support blocks 11 and conventional "strap" clamps (not shown) or the like. In general, the fixture 1 may be secured to a machine tool in any suitable manner, depending upon the particular application. Also, it will be understood that the fixture 1 may be utilized with a wide variety of known machine tools. The CNC milling machine 2 is illustrated in a partially schematic manner to facilitate understanding of the use of fixture 1, but the CNC milling machine 2 is not, per se, a novel part of the present invention. The fixture 1 includes a first workpiece support unit 12 and a second workpiece support unit 13. The first and second workpiece support units 12 and 13, respectively, are slidably mounted to the base 10 via linear guides 14 comprising a plurality of rails 15 that are secured to the base, and pillow or slide blocks 16. A drive assembly 20 includes an elongated threaded member 21 extending between the first and second workpiece support units 12 and 13, respectively. The workpiece support units 12 and 13 each include a threaded member 22 threadably engaging the elongated threaded member 21. The threads on the elongated thread member 21 and threaded members 22 is configured such that rotation of elongated threaded member 21 in a given direction simultaneously moves the first and second

support units 12 and 13, respectively, towards and away from each other. A handle 23 is rotatably mounted to the fixture, and includes a gear mechanism (not shown) or the like of a known type that causes the elongated threaded member 21 to rotate upon rotation of handle 23. Due to the simultaneous movement of workpiece support units 12 and 13, a parallel 3 or other workpiece is automatically centered in fixture 1 when wedge members 42 are shifted into engagement with slots 90 upon rotation of handle 23 when parallel 3 is loaded into fixture 1.

In addition to wedge members 42 and clamps 43, fixture 1 also includes a plurality of brackets 31 that may be utilized to further support a parallel 3 in fixture 1. Brackets 31 are movably mounted to the base 10 via guides such as transverse rails 32. A handle 33 is rotatably mounted to the base 10, and is operably connected to the brackets 31 by a drive assembly (not shown) of a known type that is similar to the drive assembly 20 described in more detail above. Rotation of handle 33 causes the brackets 31 to simultaneously move towards and away from each other. The brackets 31 can be clamped to the sides 34 of a workpiece 3 to provide additional support if necessary to prevent vibration or the like during the machining process. Each bracket 31 includes an upwardly extending bracket member 35 that is pivotably mounted to a base bracket member 36 via a pin 37. The upper bracket member 35 can be pivoted to a lowered position L as shown in Figs. 1 and 2 to facilitate loading of a workpiece 3 in the fixture 1. Also, the upper bracket members 35 may be positioned in the lower position L if extra support is not required during the machining of a particular workpiece. Alternately, the upper bracket members 31 may be pivoted to the upper position U and utilized to clamp a workpiece 3 as described above.

With further reference to Figs. 3 and 4, the workpiece support units 12, 13 each include a unit base structure 40, and a workpiece support accessory 30 including a wedge member 42 and clamp 43. Workpiece support accessory 30 is rotatably mounted to the unit base structure 40 via a shaft 41 or the like. The workpiece support units 12 and 13 include a block 77 that is secured to a plate 17, and pillow blocks 16 are, in turn, secured to the plate 17.

Wedge members 42 include opposed tapered surfaces 45 and 46 that extend towards one another adjacent the end 47 of wedge members 42. The jaws 44 of clamp 43 include outer ends 48 and clamping surfaces 49 adjacent the outer ends 48 that extend

inwardly, forming a smooth radius. The radiused surface portions 49 ensure that the jaws 44 securely clamp a workpiece positioned in the workpiece support accessory, despite variations in the thicknesses of different workpieces. Inner ends 50 of jaws 44 are pivotably connected to plates 51 and 52 via carriage bolts 54, pins or the like. A threaded rod 60 extends through clearance openings 61 in jaws 43, and threadably engages pins 62. Threaded rod 60 passes through a clearance opening or bushing 63 in wedge member 42. In the illustrated example, the jaws 44 include a main jaw member 64 and a plate member 65 that closes off clearance openings 61 in main jaw members 64. Threaded rod 60 includes an end 66 having flat surfaces or the like to thereby enable a user to rotate the threaded rod 60 to draw the jaws 44 towards and away from one another utilizing a wrench or the like. The plates 51 and 52 are secured to the shaft 41, and the wedge member 42 is also secured to the shaft 41, such that the clamp 43 and wedge member 42 can be simultaneously rotated together relative to the unit base structure 40 to rotate a parallel 3. A retainer plate 55 includes a pair of elongated slots 56 that receive threaded fasteners 57. The end portion 58 of retainer plate 55 can be positioned to overlap the plate 51. The threaded fastener 57 can then be tightened, thereby locking the plate 51 in a horizontal position, with wedge member 42 in the position illustrated in Figs. 3 and 4. The retainer plate 55 also retains the jaws 44 of clamp 43 in the position illustrated in Figs. 3 and 4.

The first and second workpiece support units 12 and 13 also include an indexing mechanism 70 (Figs. 3, 4). The indexing mechanism 70 is utilized to selectively lock the workpiece support accessory 30 at a preselected one of a plurality of predetermined angular positions for machining angled clearance notches 98 (Fig. 1) or the like in parallel 3. Indexing mechanism 70 includes an index wheel 71 that is fixed to the shaft 41 via a key or the like (not shown) that engages key way 72 in shaft 41, and a corresponding key way (not shown) in indexing wheel 71. The end portion 73 of shaft 41 is threaded, and a threaded fastener 74 is threadably received on the shaft 41 to thereby retain the index wheel 71. The indexing wheel 71 includes a plurality of openings 75 that extend around the indexing wheel 71 in a circular pattern. A pair of pins 76 are slidably mounted in a block 77 of unit base structure 40 adjacent opposite sides 88, 89 of block 77. Pins 76 are operably connected to handles 78 that are received within L-shaped openings 79 on the

opposite sides 88 and 89 of block 77. Handles 78 can be shifted in the direction of the arrow "A" (Fig. 3) to retract pins 76 from an opening 75 in index wheel 71. Handles 78 and pins 76 are biased by a spring or the like (not shown) into the engaged position (i.e., the direction opposite arrow "A"). Handles 78 can be shifted in the direction of the arrow "B" into the end 80 of L-shaped slots 79 to thereby retain the pins 76 in the retracted position for rotation of index wheel 71 and the workpiece support accessory 30. The openings 75 in index wheel 71 are preferably spaced at equal angular intervals to thereby position the workpiece support accessory 30 and the workpiece 3 at a known angular position. In the illustrated example, the openings 75 are positioned at 22.5° intervals relative to one another. As discussed above, retainer plate 55 may be utilized to retain the wedge member 42 and clamp 43 in the horizontal position. If the workpiece 3 is to be rotated in fixture 1, the fasteners 57 are loosened, and the retainer plate 55 is shifted in the direction of the arrow "C" (Fig. 3) such that the end portion 58 of plate 55 does not overlap plate 51, thereby permitting rotation of wedge member 42 and clamp 43. The indexing device 70 also includes a retaining clamp 81 having a base portion 82 and a pair of C-shaped arms 83 that extend upwardly around the outer peripheral surface 84 of index wheel 71. A threaded fastener 85 extends through the end portions 86 of C-shaped arms 83. The threaded fastener 85 can be loosened to permit rotation of index wheel 71 to the desired position. The pin 76 can then be engaged with the selected opening 75 utilizing handles 78. The threaded fastener 85 can then be tightened to thereby clamp onto the indexing wheel 71. The retaining clamp 81 is secured to the block 77 via threaded fasteners 87 or the like, such that the retaining clamp 81 prevents rotation of index wheel 71 relative to the block 77 when threaded fastener 85 is tightened.

With reference back to Fig. 2, in use a workpiece such as a parallel 3 is loaded into the fixture 1 prior to machining. The parallel 3 includes notches 90 at the opposite ends 91 and 92 of parallel 3. The parallel 3 may be made from hot roll steel or the like, and the parallel 3 is initially rough cut with a flame cutter or the like from a large plate of steel. The notches 90 are cut into the parallel 3 at the time the parallel 3 is cut from a plate of steel, so the rough-cut parallel can be secured in fixture 1 without additional machining. The flame cutting process produces relatively rough and imprecise end surfaces 93, and

upper and lower surfaces 94 and 95. Also, the surfaces forming notches 90 are also relatively rough and imprecise as a result of the flame cutting process.

The parallel 3 is initially positioned between the first and second workpiece support units 12 and 13, respectively. The handle 23 is then rotated to draw the workpiece support units 12 and 13 towards one another. The parallel 3 is positioned with notches 90 in alignment with wedge members 42, and wedge members 42 enter the notches 90 as the workpiece support units 12 and 13 are drawn together. The tapered surfaces 45 and 46 of wedge members 42 engage notches 90, typically at corners 96, to thereby support and center the parallel 3. The clamps 30 are then tightened utilizing a wrench or the like to rotate the threaded members 60. In this way, the parallel 3 is rigidly secured in the fixture 1. Because workpiece support units 12 and 13 simultaneously move towards one another at the same rate, the parallel 3 is automatically centered relative to opposite ends 91 and 92 of parallel 3 in fixture 1 as wedge members 42 engage notches 90. Also, jaws 44 contact opposite sides 34 of parallel 3 and thereby center parallel 3 in fixture 1 relative to sides 34.

If required, the upper bracket members 35 may be positioned in the upright position "U", and handle 33 may then be rotated to clamp onto the opposite sides 34 of parallel 3 to further support the parallel 3 in fixture 1. The surface 94 of parallel 3 may then be machined flat, and a number of features such as threaded openings 97 may also be machined. The retainer plates 55 and clamp 81 may then be loosened, and handles 78 are also shifted to retract the retainer pins 76 from index wheels 71 to rotate the parallel 3 about axis "H" to a desired angular position. One or more clearance notches or ramps 98 may then be machined at an angle in the parallel 3 to provide for exit of slugs and the like, or to provide clearance for other components or the like.

As discussed above, the wedge members 42 and clamps 43 center the parallel 3 on the fixture 1, such that the position and orientation of the various openings 97, clearance notches 98, and/or other machined features are precisely located relative to one another. After machining the upper surface 94, the parallel 3 can be rotated 180° in fixture 1, and the surface 95 may then be machined parallel to the surface 94. If additional features need to be machined into surface 95, such features can be accurately positioned relative to each other, and relative to the surface 94 and other machined features associated with surface 94.

The fixture 1 does not require the time-consuming manual setup procedures associated with conventional machining operations. The wedges 42 and clamps 43 quickly center a workpiece in the fixture 1, and securely hold the workpiece for machining. Because the workpiece does not move relative to the wedges 42 and clamps 5 43, the workpiece can be rotated to provide for accurate machining on opposite sides of the workpiece without manually measuring and locating the workpiece.

In the foregoing description, it will be readily appreciated by those skilled in the art that modifications may be made to the invention without departing from the concepts disclosed herein. Such modifications are to be considered as included in the following 10 claims, unless these claims by their language expressly state otherwise.

CLAIMS:

1. A method for handling and processing steel tool components, comprising:
flame-cutting at least one locating feature into a piece of steel to be made into a tool component, which locating feature has nothing to do with the ultimate functionality of the tool component, but rather is made to facilitate handling, locating and/or holding the piece of steel during the process of tool manufacture; and wherein:
engaging said flame-cut locating feature with a holding member without first precision machining said flame-cut locating feature, for holding said rough-cut tool component during the process of die manufacture.
2. The method of claim 1 which includes forming said piece of steel by flame-cutting a plate of hot roll steel of the type having parallel hot-rolled opposite side faces to form a rough-cut tool component having a rough flame-cut perimeter surface extending transversely between the opposite side faces, the rough-cut part having opposite ends and a central portion that is generally midway between the opposite ends, the central portion having a quadrilateral cross-sectional shape, and flame-cutting said locating feature into said rough flame-cut perimeter surface.
3. The method of claim 2, wherein:
the tool component comprises a parallel, and including:
securing the parallel to a die shoe.
4. The method of claim 2, wherein:
said rough-cut tool component has an elongated shape defining opposite ends, the flame-cutting process including cutting at least one of a slot, notch, and aperture in each opposite end.
5. The method of claim 4, including:
bringing tapered holding members into engagement with the at least one of a slot, notch, and aperture.

6. The method of claim 2, wherein:
 - the step of flame-cutting at least one locating feature comprises flame-cutting at least a pair of substantially identical notches in each opposite end of the rough-cut tool component.

7. The method of claim 2, wherein:
 - the piece of steel comprises a section of hot-rolled steel material; and including:
 - flame-cutting a second locating feature into the hot-rolled steel material;
 - providing at least two holding members;
 - engaging the first and second flame-cut locating features with the holding members, without first precision machining said flame-cut locating features;
 - securing the holding members to a powered machine tool to thereby rigidly secure the piece of steel to the machine tool; and
 - machining the piece of steel to remove some of the steel material and thereby form functional features to be utilized for die assembly and/or operation.

8. The method of claim 7, wherein:
 - the step of flame-cutting includes cutting the piece of steel into an elongated shape having opposite ends, and wherein the notches are cut into the opposite ends;
 - the step of engaging the notches with holding members includes simultaneously moving the holding members relative to the machine tool.

9. The method of claim 2, including:
 - forming said piece of steel by flame-cutting a plate of hot roll steel material to form a piece of steel having a perimeter that is at least somewhat similar in shape to a predefined desired final shape of the tool component being fabricated, and wherein the perimeter include at least two of said flame-cut locating features, said flame-cut locating features comprising at least a first notch that is flame-cut into a first side portion of the piece of steel, and a second notch that is flame-cut into a second side portion of the piece of steel that is generally opposite the first side portion;
 - positioning holding members in the first and second notches to retain the piece of steel for further machining operations, without first precision machining said flame-cut notches; and

machining features in the piece of steel while it is retained by the holding members.

10. The method of claim 9, further including the step of:
rotating the holding members and the piece of steel.

11. The method of claim 10, wherein:

at least a first feature is machined in the piece of steel while it is retained in a first orientation relative to a machine tool prior to the step of rotating the holding members and the piece of steel, and at least a second feature is machined in the piece of steel after the step of rotating the holding members and the piece of steel.

12. The method of claim 10, wherein:

the holding members and the piece of steel are rotated simultaneously without repositioning the holding members relative to the first and second flame-cut notches.

13. The method of claim 1 which includes:

providing a fixture having a base member, and first and second workpiece support units, each of which includes a movable wedge member;

forming said piece of steel by flame-cutting a plate of hot roll steel to form a rough-cut tool component having hot-rolled opposite side faces and a perimeter surface extending between the opposite side faces, at least a portion of the perimeter surface comprising a flame-cut surface;

and wherein flame-cutting at least one locating feature includes flame-cutting at least two notches having flame-cut surface portions extending between the opposite side faces;

positioning the rough-cut tool component in the fixture;

bringing the wedge members into contact with the flame-cut surface portions of the notches to rigidly secure the rough-cut tool component, without first precision machining said flame-cut notches;

machining features into the rough-cut component utilizing a powered machine tool.

14. The method of claim 13, further including the step of:
moving the wedge members relative to the notches.

15. The method of claim 13, wherein:
the step of machining locating features into the rough-cut component includes removing material utilizing a rotating cutter.
16. The method of claim 13, wherein:
the wedge members include opposed surfaces that taper towards each other; and including the step of:
moving the wedge members towards another to bring the opposed surfaces into tight contact with the flame-cut surface portions of the notches.
17. The method of claim 13, further including the step of:
flame-cutting a notch base surface extending between the opposed notch surfaces, such that the notches are formed by three generally orthogonal flame-cut surfaces.
18. The method of claim 13, further including the step of:
flame-cutting perimeter surface portions that are generally orthogonal to the opposite side faces.
19. The method of claim 13, further including the step of:
flame-cutting hot-rolled steel to form generally parallel opposite end surfaces, and wherein the notches are flame-cut into the parallel end surfaces.
20. The method of claim 13, wherein:
the machine tool comprises a mill having a bed and a rotating cutter; the method further including the steps of:
fixing the wedge members to the bed;
moving the bed to bring the rotating cutter into contact with the rough-cut component.

21. The method of claim 1 including:

providing a fixture having a base member and first and second workpiece support units movably mounted to the base member, wherein the first and second workpiece support units include holding surfaces;

forming said piece of steel by flame-cutting a plate of hot roll steel to form a rough-cut component having opposite faces comprising hot-rolled surface material and flame-cut surface portions extending between the opposite faces;

and wherein flame-cutting at least one locating feature includes flame-cutting at least two locating features extending between the opposite faces, wherein the locating features comprises surfaces having a predefined shape configured to engage the holding surfaces of the workpiece support units;

securing the rough-cut component to the fixture by moving the holding surfaces into engagement with the locating features, without first precision machining said flame-cut locating features.

22. The method of claim 21, further including the step of:

forming parallel edge surfaces on the rough-cut component to form a parallel for a die.

23. The method of claim 21, wherein:

each workpiece support unit includes a unit base structure, wherein the holding surfaces are rotatably mounted to the unit base structures, and wherein each workpiece support unit includes an indexing device selectively retaining the holding surfaces at a selected one of a plurality of predetermined angular positions relative to the unit base structure, and including the steps of:

rotating the holding surfaces and rough-cut component to selected angular positions relative to the unit base structures;

retaining the holding surfaces at a selected angular position utilizing the indexing device.

24. The method of claim 23, wherein the step of rotating the holding surfaces and rough-cut component includes rotating the holding surfaces one hundred and eighty degrees relative to the base member.

25. The method of claim 23, wherein the step of providing a fixture includes providing clamps associated with the first and second workpiece support units, the method further including the step of clamping the rough-cut component.

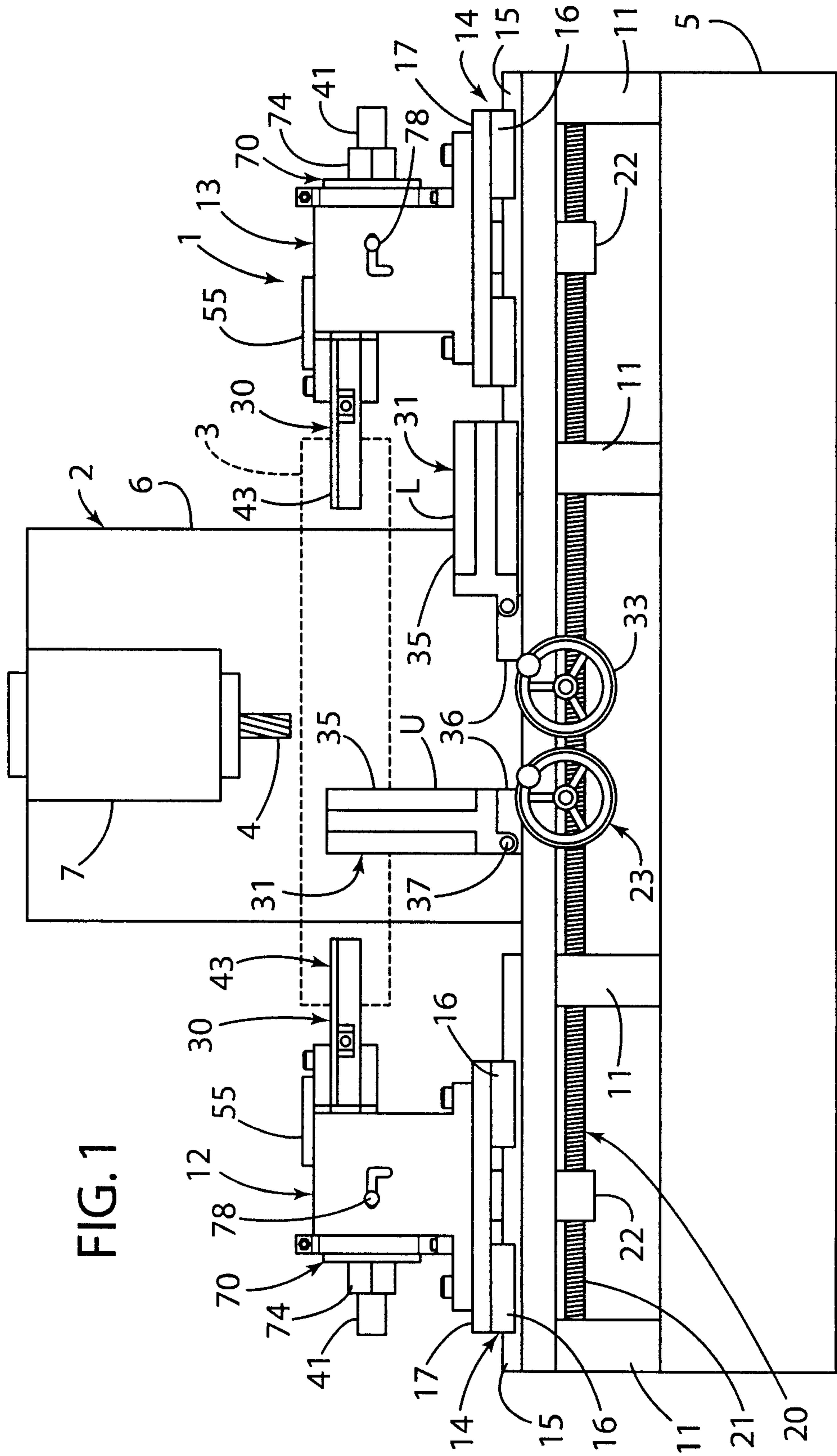


FIG.1

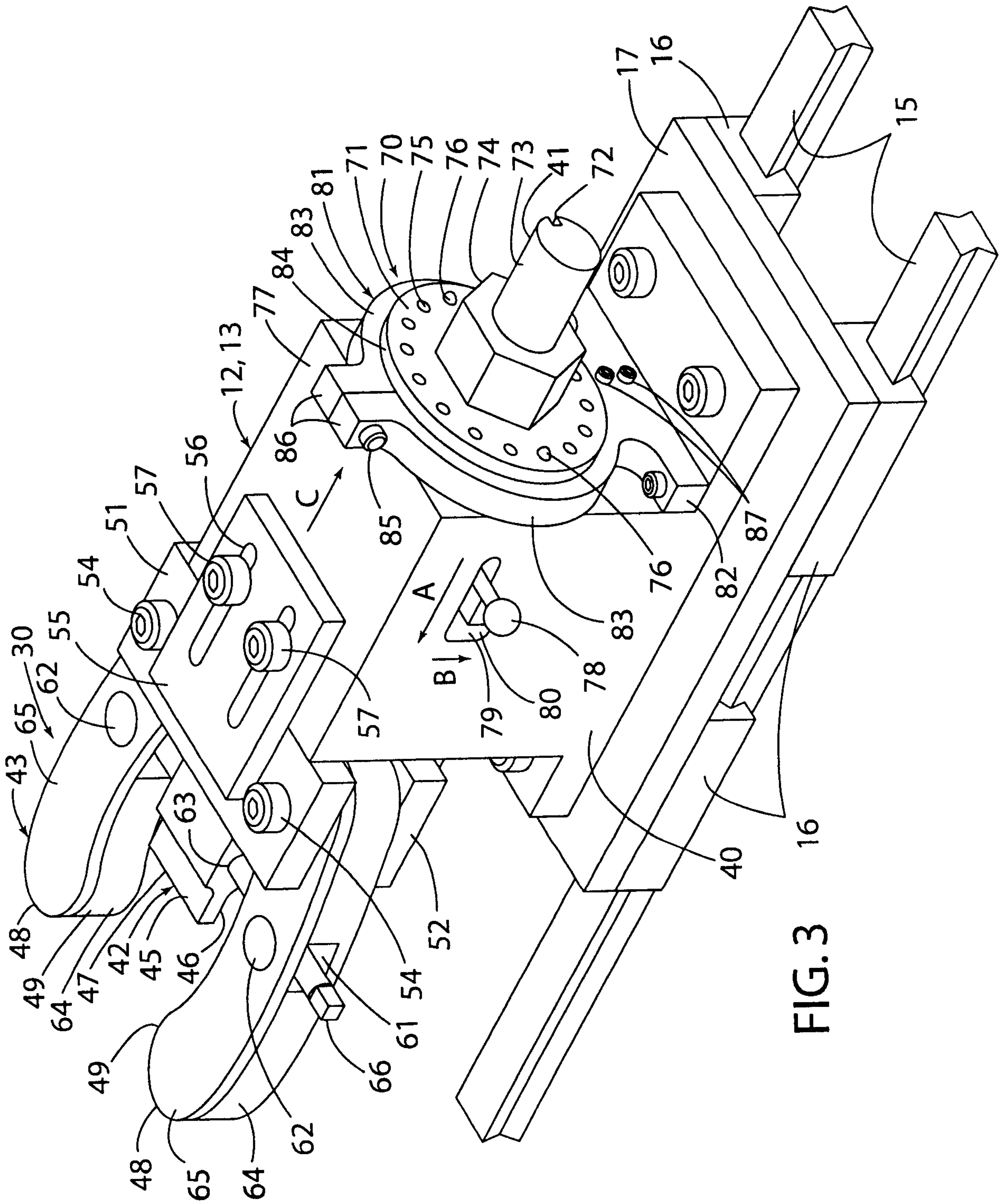


FIG. 3

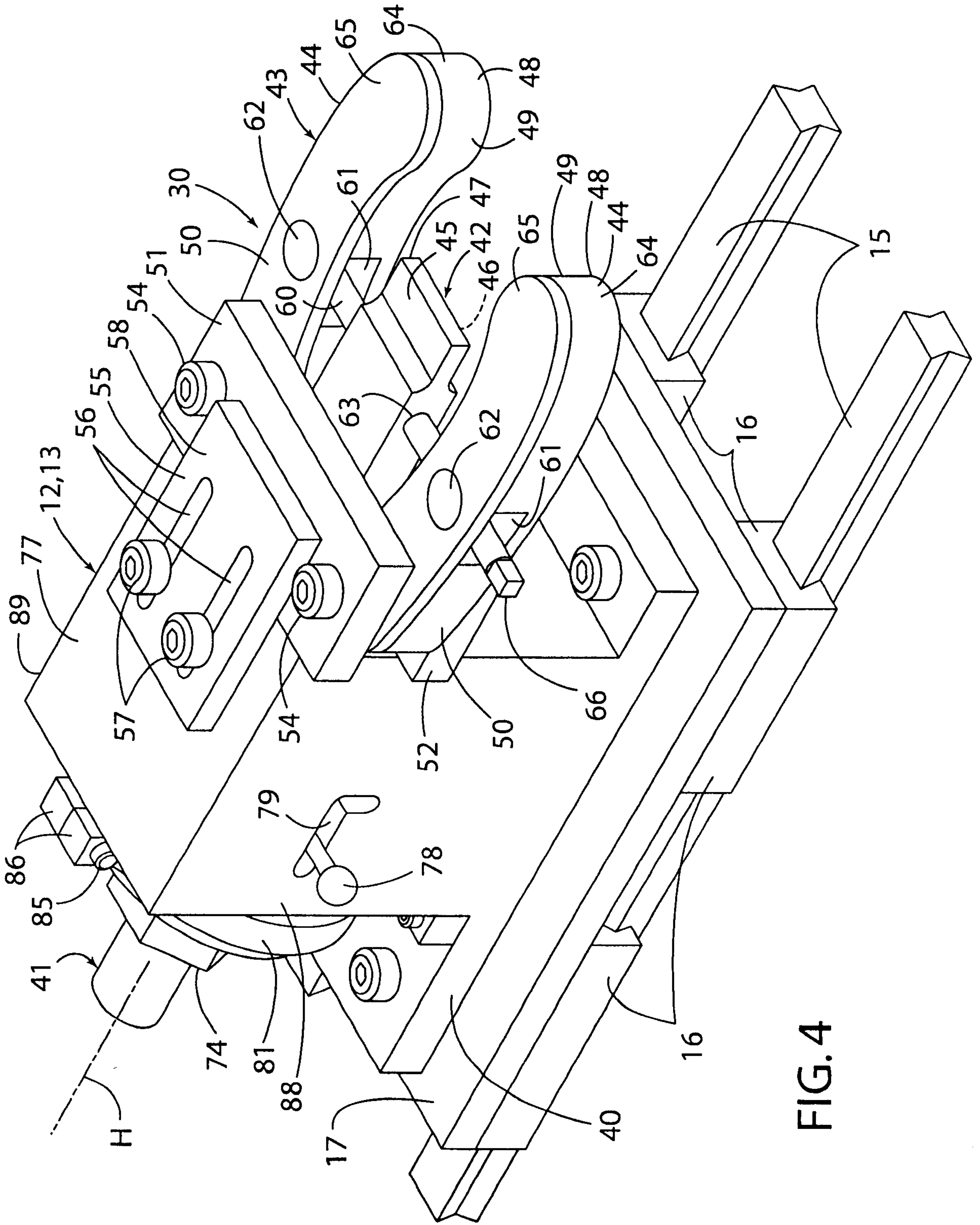


FIG. 4

