

SPECIFICATION
Improvements In or Relating to a Device for
Holding a Workpiece

This invention relates to a device for holding a
5 workpiece and more particularly to a device which
may be mounted to a machine tool for holding a
workpiece in position for machining.

Various methods are well known for fabricating
an article from raw material. Broadly, commercial
10 and industrial fabricating processes can be
classified under the headings of machining,
forming and assembling. Of immediate concern, is
the procedure of machining.

In general, machining can be defined as the act
15 of or the processes involved in shaping a solid
piece of raw material into a finished product,
usually in accordance with a predetermined plan
as may be given by a blueprint. The material being
worked upon is usually referred to as the
20 workpiece. During machining, various cutting
operations are performed upon the work piece by
a machine tool. Common machining operations
include drilling, turning, boring, grinding, shaping
planing and other well known material removing
25 procedures. The actual removal of material is
done by a cutting tool which is held and driven by
a machine tool, such as drill press, lathe, vertical
and horizontal milling machines, surface grinder
internal and external grinders, shaper and planer.
30 Other machine tools and cutting processes will
readily occur to those skilled in the art.

The prior art is replete with clamping and
holding devices for supporting a work piece
during machining. Face plates, chucks and cullers
35 are used to hold the workpiece for latches and
other machine tools in which the work piece is
rotated against a stationary cutting tool. Angle
plates, vises and various hold-down and clamping
arrangements are commonly used to secure work
40 in machine tools of the types having a rotating
cutter. Milling machines and similar machining
tools have integral work supporting tables, while
in machines of the type represented by latches,
the work supporting device is attached to a
45 spindle.

Each type of work supporting fixture has
unique, inherent characteristics which are
especially suited for particular machining
operations. Vises and chucks grip a portion of the
50 workpiece which is then unavailable for
machining. Face plates and angle plates can be
made to support work in such a manner that
substantial portions of the work piece are
exposed. Numerous means are commonly
55 employed within the art for securing the work
piece to a plate-type holding fixture. For example,
clamps may embrace the work piece and in turn
be secured to the plate by bolts received directly
in tapped holes within the plate, or engaged with
60 T-nuts carried in especially machined slots which
extend along the surface of the plate.

Another arrangement includes the use of C-
clamps or parallel clamps straddling both the
work piece and the plate for abutting the work

65 piece against the surface of the plate.

For production machining it is common
practice to provide a face plate having a plurality
of apertures, either slots or cylindrical bores,
extending therethrough. The work piece, usually a
70 rough case or moulded item, is preliminarily
prepared by machining a flat surface which then
becomes the base or reference surface. Threaded
holes, normally made by drilling and tapping, are
formed into the work piece from the machined
75 surface. To provide adequate support, two or
more threaded holes may be created. The
machined surface of the work piece is then placed
against the work supporting surface of the plate.
Subsequently, bolts are passed through the
80 apertures in the plate and threadedly engaged
within the preformed holes in the work piece.
Locating fixtures of various types are commonly
used to maintain relative positioning between
subsequent work pieces to enable machining
85 operations to be accomplished without resetting
the machine.

The latter method of attaching a work piece to
a face plate has obvious advantages over
clamping type methods. A substantially greater
90 portion of the work piece is available for
machining. However, it is physically impossible to
provide a plate having an infinite array of
apertures. Therefore, the holes drilled and tapped
into the work piece must be accurately located to
95 align with pre-existing apertures within the plate
apertures especially created for the immediate
purpose. When considering a large production
run, for example, it will be appreciated that the
accurate location of several threaded holes, which
100 only serve as an intermediate expediency, within
the work piece is an undesirably time consuming
and laborious task.

This latter means of attaching a work piece
may, however, provide only a partial solution to
105 the short-comings of the prior art clamps and the
like and may be inadequate in use with certain
machine tools and under certain machining
operations. Sufficient clearance must be provided
on the backside of the face plate for manipulation
110 of the bolts which extend through the fixture into
the work piece. The space requirement is
generally of minor concern when the fixture is
positioned perpendicularly to the work support
surface of the machine tool. When positioned
115 parallel to the work supporting surface, as is
frequently required during machine tool practice,
the fixture must be elevated. This represents a
serious limitation. For example, machine tools
have a characteristic maximum distance between
120 the cutting tool and the work support surface.
Height which is occupied by the work holding
fixture subtracts from the working height of the
machine and places a dimensional limit upon the
work piece. The fixture is inoperative in
125 combination with machine tools of limited
capacity. Also, the ability of a machine tool to
remove stock at a rapid rate is determined at least
partially, by the rigidity of the work piece. As a
general rule, rigidity is decreased in proportion to

the distance of the work piece from the normal work support surface of the machine tool. Further, it is an annoyance and a hindrance for the machinist to perform simultaneous manipulative functions on either side of the work holding fixture.

It would be highly advantageous, therefore, to provide improved work holding means and it is an object of the present invention to provide a device for holding a work piece in which the disadvantages of the prior art are at least partially obviated.

According to this invention there is provided a device for holding a work piece to facilitate machining by a machine tool, said device comprising a substantially rigid work piece support member having first and second spaced opposed surfaces, there being one or more apertures through said member between said first and second surfaces thereof, a spindle mounted for rotation within said aperture or each of said apertures, said spindle having first and second ends and said first end of said spindle being positioned proximate the first surface of said member and first retention means for limiting the movement of said spindle in a direction toward the first surface of said member, said spindle being provided with receiving means for receiving holding means for securing a work piece to said device, located so that, on rotation of the spindle, the position of the receiving means is adjusted.

In one preferred further embodiment, the holding means is in the form of a pin which may be detachably engaged with the work piece. An aperture within the spindle receives the pin and connection means are provided for detachably securing the pin to the spindle. The connection means may be in the form of a thrust member which engages a shoulder of the pin and bears against an opposing portion of the spindle.

The actuator means may conveniently comprise a locking ring which cammingly urges forward or retracts the spindle in the direction of its axis of rotation in response to rotation of the ring. A passage is provided through the side of the support member for a tool which detachably engages and rotates the locking ring. The thrust member of the connection means is also receivable through the passage. A rotatable spindle having a slotted aperture therethrough, provides for alignment of the pin in a desired position.

Preferably the receiving means of each spindle is in the form of a radial slot extending axially through the spindle. An attachment means such as a bolt is receivable through the slot for engagement with a threaded hole performed in a work piece and for securing the work piece to the work supporting surface of the support member.

The relative position of the slot, with reference to the surface of the support member, is movable in response to rotation of the spindle. The spindle may also carry other receiving means such as a T-slot extending diametrically across the end of the spindle. Preferably, the end of the spindle is

recessed from the work supporting surface of the plate to insure that the work piece abuts the work supporting surface.

The support member may comprise a plate which may be positioned horizontally upon the normal work supporting surface of table of a machine tool. In an alternative embodiment, a second plate resting upon the normal work supporting surface of the machine tool holds the work supporting surface in vertical alignment.

In yet another embodiment, means are provided on the second surface of the support member for detachable securement to spindle type machines such as latches.

In order that the invention may be more readily understood and so that further features may be appreciated, the invention will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a device in accordance with the present invention for holding a work-piece, the device being positioned upon the normal work supporting table of a machine tool, such as a milling machine;

Figure 2 is a perspective view generally corresponding to the view of Figure 1 and further illustrating the device of the present invention having a work piece mounted in position for machining;

Figure 3 is an enlarged offset vertical sectional view taken along the line 3—3 of Figure 1;

Figure 4 is an enlarged fragmentary view of the work piece mounting surface of the device of Figure 1;

Figure 5 is an enlarged fragmentary perspective view of the device of Figure 1 and shown partly in section as generated along the line 5—5 of Figure 4;

Figure 6 is a fragmentary perspective view of an alternative embodiment of a device for holding a work piece, in accordance with the present invention, the device being adapted for use with spindle type machines, specifically herein shown as a lathe.

Figure 7 is a part cut away perspective view of another embodiment of a device for holding a work piece in accordance with the present invention, the device being secured to the normal work support surface of a machine tool and holding a work piece, the work piece being shown in broken outline;

Figure 8 is an enlarged exploded part cut away perspective view of the device of Figure 7;

Figure 9A is an enlarged fragmentary vertical sectional view taken along the line 9—9 of Figure 7 and showing the device thereof as it would appear in a work piece receiving position;

Figure 9B is a view generally corresponding to the view of Figure 9A and showing the device thereof in the subsequent work piece holding position; and

Figure 10 is a part cut away perspective view of the underside of the device of Figure 7.

Turning now to the drawings in which the same reference numerals represent corresponding

elements throughout the several views, attention is first directed to Figure 1 which shows a preferred embodiment of a device in accordance with the present invention and generally designated by the reference character 10. The device 10, (see also Figure 3) includes a substantially rigid plate 11 having first and second spaced opposed surfaces 12 and 13. The plate 11 is generally rectangular and has first and second longitudinal edges 16 and 17 respectively and first and second lateral edges 18 and 19 respectively. The first surface 12 is the surface on which work pieces are mounted, as will be described presently.

A rigid base plate 20 having a top surface 21 and a bottom surface 22 is secured to the second surface 13 of plate 11 for example by mechanical fasteners or by welding or by any other suitable means. The bottom surface 22 of the base plate 20 is perpendicular to the first surface 12 of the plate 11.

Table 23 is representative of a typical work supporting table common to various machine tools, such as milling machines for example. Table 23 includes a work supporting surface 26 having a plurality of parallel longitudinally extending T-slots 27. The use of T-slots 27 in conjunction with various clamping devices for affixing a work piece directly to the work supporting surface 26, or alternatively for securing an auxiliary work holding device, such as a vise or conventional angle plate, to the surface 26 will be readily understood by those skilled in the art.

Surface 26 is a precision surface which is flat and generally lies in a plane either perpendicular or parallel to a cutting tool 28 rotated and held by a chuck 29 of the machine tool as seen in Figure 2. The bottom surface 22 of the base plate 20 rests upon the work supporting surface 26 and holds first surface 12 of plate 11 perpendicular to surface 26. Rigidity is provided by gusset 30 affixed to base 20 and plate 11 proximate the second lateral edge 19. Further rigidity is provided by an end plate 31 similarly affixed to base 20 and plate 11 proximate the first lateral edge 18. The end plate 31 has an outside surface (not shown) which is perpendicular to first surface 12 and to bottom surface 22. This end plate 31 can be employed if desired, instead of base plate 20, to support the first surface 12 in a substantially vertical position on supporting surface 26. Various means for rigidly attaching base plate 20 or end plate 31 to table 23 will readily occur to those skilled in the art. For this purpose base plate 20 and end plate 31 may have apertures, in the form of either cylindrical bores or slots, formed therethrough, to accommodate bolts which may be engaged with T-nuts adapted to locate within T-slots 27.

It will be appreciated by those skilled in the art that the plate 11 need not necessarily be provided with a base 20, a gusset 30 and an end plate 31. In such an embodiment the plate 11 could be placed horizontally upon the work supporting surface 26. If it was desired to elevate the plate

11 from work supporting surface 26, various types of well known spacers, such as those commonly referred to as parallels, could be placed between work supporting surface 26 and second surface 13 of plate 11. Plate 11 could be secured to table 23 by clamps or other well known means which may conveniently be adapted to engage the T-slots 27. Securing means which would be suitable for fixing plate 11 to the table 23 are provided in the embodiment shown in Figures 7—10, the securing means including recesses 70 extending downwardly from the work bearing surface 12. Slots 71 extend inwardly from end surfaces 18 and 19 between surfaces 13 and 12, and base surface 13 rests upon work support surface 26. Conventional T-nuts 72 locate in appropriate T-slots 27 in alignment with slots 71. Cap screws 73 extend through slots 71 into the respective T-nuts 72. Each cap screw 73 has a head 74 which is received in the appropriate recess 70 below the level of work bearing surface 12 to provide an unobstructed surface.

The plate 11 is provided with a plurality of spindles 32 which as may be seen from Figure 5, each have an outer cylindrical surface 33 which is rotatably journaled within a bore 34. Each bore 34 extends through plate 11 between first surface 12 and second surface 13 and is cylindrical about a longitudinal axis shown for example in Figure 3 by the broken line A, which is perpendicular to face 12. Each spindle 32 is rotatable about the longitudinal axis of the bore in which it locates. Each spindle 32 is adapted to receive holding means which engage a work piece to hold the work piece in position for machining.

Each bore 34 includes a forward portion extending inwardly from first surface 12 and a counterbore 37 extending inwardly from second surface 13 and terminating with annular shoulder 38 extending radially inwardly relative to counterbore 37. The outer surface 33 of spindle 32 comprises a first cylindrical section 39 and an enlarged second cylindrical section 40 with an annular shoulder 41 extending radially therebetween. The first cylindrical section 39 and second cylindrical section 40 are rotatable within the forward portion of the bore 34 and within the counterbore 37 respectively. The contact between annular shoulder 41 provides retention means for limiting axial movement of the spindle 32 in a direction towards the first surface 12, of the plate 11 as indicated by arrow B (see Figure 3). Furthermore the first section 39 in addition to being sized to be rotatably and slidably journaled within bore 34, may be provided with an O-ring seal to prevent the passage into the bore 34 of machining fluids, machining particles and other contaminants from the surface 12 of the plate 11. As reference to the drawings will show the embodiment of Figure 9A includes an O-ring seal 76 of this type which locates in an annular groove 77 formed in the first section 39 of the spindle 32.

Each spindle 32 has a first end 42 and a second end 43 each of which are generally

perpendicular to axis A and which are positioned proximate first surface 12 and second surface 13 respectively of plate 11. Preferably, the first end 42 is recessed slightly, 5/1,000 of an inch for example, from first surface 12, the purpose of which will be explained presently. Annular grooves 44 are formed in plate 11 extending radially outwardly from each counterbore 37. A locking ring 47 in the form of an annular member which is split radially, is seated within each groove 44 and serves to engage the second end 43 of a respective one of the spindles 32 to prevent the disengagement of the spindle 32 from plate 11.

Referring now specifically to Figures 4 and 5, it may be seen that each spindle 32 is provided with various receiving means adapted to receive securing means to facilitate the securing of a work piece against surface 12 of plate 11. A first receiving means is in the form of a slot 48. Slot 48 extends through spindle 32, being open at both the first end 42 and the second end 43 of the spindle 32. Slot 48 also extends in a radial direction, the radially inner end 49 of the slot 48 being semi-cylindrical about the longitudinal axis of the bore 34 and the radially outer end which lies within the second section 40 of the spindle 32 also being of semi-cylindrical configuration. The portion of the slot 48 which lies within the first section 39 of the spindle extends radially to the periphery of the spindle, the spindle 32 thus having a rectangular opening at one side. Accordingly, means for securing a work piece against the first surface 12 can be received through slot 48 at the centre of spindle 32. If the securing means is a bolt, for example, the longitudinal axis of the bolt can align with axis A. The relative position of the bolt with respect to the work supporting surface 12 is readily alterable by displacing the bolt along slot 48 and/or by rotation of the spindle 32. It will be appreciated, therefore that the securing means is capable of assuming any position within bore 34.

A second receiving means with which the spindle 32 is provided is in the form of a T-slot 50. The T-slot 50 extends radially across spindle 32 and is open at the first end 42 of the spindle. Access to T-slot 50, for the insertion of a T-nut or T-headed bolt therein, is provided by an opening 51 having substantially the same width as the enlarged portion of the T-slot and located substantially about the axial centre of the first end 42 of the spindle 32. It will be readily recognized that by rotation of the spindle 32 the T-slot 50, is movable to provide receiving means over substantially the entire area defined by bore 34. A plurality of spaced threaded bores 52, such as may be formed by the operation of drilling and tapping, are also provided in the spindle 32 and form third receiving means. Each threaded bore 52 extends substantially perpendicularly through the spindle from the first end 42.

The device 10 further includes fourth receiving means which are provided in the plate 11. The fourth receiving means comprises longitudinal T-

slots 53 and lateral T-slots 54. T-slots 53 and 54 are accessible from the first surface 12 and are arranged to lie between the spindles 32.

A typical work piece, such as work piece 57 shown in Figure 2, can be readily attached to the device 10 by various means consistent with the immediate desires of the machine tool operator. As previously stated, it is conventional practice to prepare the work piece by machining a base surface and forming two or more threaded holes. With conventional work holding fixtures, it is required that the threaded holes be accurately formed to align with pre-existing bolt receiving holes within the holding fixtures. Alternatively, the fixtures could be drilled to accommodate a work piece having a given threaded hole arrangement. It is also necessary that several fixtures be available for use with pieces of various sizes and having various threaded hole arrangements, since only a limited number of holes can be drilled through a given fixture.

With the device of the present invention, accurate positioning of the threaded bores in the base of the work piece is rendered unnecessary. The appropriate spindles are simply rotated until the slots 48 align with respective bores in a particular work piece. Such an arrangement is particularly advantageous in production run machining operations where locating means are used in combination with a holding device of the type described. The locating means enables each successive work piece to be positioned at approximately the same location on face 12. Rotation of the appropriate spindles 32 readily compensates for inaccuracies in the placement of threaded bores of subsequent work pieces.

Other obvious advantages of the described embodiment of workpiece holding device will also be apparent. The use of various straps and clamps in combination with T-slots or threaded holes is conventional practice and well known to those skilled in the art. Heretofore, the engagement of the clamps or straps with the work piece has been restricted in accordance with the availability of T-slots or threaded apertures in a given work piece holding fixture. Frequently, it was necessary to clamp the work piece at available locations and machine that portion of the piece that was exposed for machining. Subsequently, the work piece was reorientated and reclamped to expose the remaining portions of the work piece to the cutter of the machine tool. With the above described device it is readily apparent that a large number of possible clamping positions are provided by combination of the T-slots 53 and 54 carried by plate 11, and the T-slots 50 and threaded holes 52 which are movable by rotation of the spindles 32.

As the bolt or other securing means is tightened, shoulder 38 of the spindle 32 is drawn firmly against shoulder 41 of the bore 34 and the base of the work piece is drawn firmly against the surface 12. This is assured since the first end 42 of each spindle 32 is recessed from the surface 12. During the securement of the work piece to

face 12, no stress is applied to locking ring 43.

Figure 6 illustrates an alternative embodiment of a device 60 for holding a work piece. The device 60 is particularly adapted for use in combination with the type of machine tool which rotates the work piece and in Figure 6 is illustrated in use with a lathe 61. Briefly, the lathe 61 includes a bed 62 and a head stock 63 which drivingly rotates spindle 64. Further description of the lathe 61 will not be made, since such machine tools are well known to those skilled in the art.

The device 60 includes a generally cylindrical rigid plate 67 having first surface 68 against which a workpiece may be mounted and a spaced opposed second surface 69. Plate 67 is generally analogous to the plate 11 of the previously described embodiment. A plurality of spindles 32, as described in connection with the previous embodiment are rotatably mounted in the plate 67 but in the present embodiment the plate 67 is of circular configuration and the spindles 32 are arranged in an annular formation.

Attachment means (not shown) extend axially from second surface 69 for coupling fixture 60 with spindle 64. Manufacturers of lathes and other rotating type machine tools generally provide a variety of holding fixtures, such as face plates, chucks and cullets, which are detachably securable to the spindle of the machine in accordance with the immediate needs of the machine operator. The exact means of attaching the holding fixtures to the spindle is variable with the specific manufacturer, but generally includes some type of threaded connection or pin and cam lock arrangement. However, separate attachment means, as an independent accessory item, is often supplied by the manufacturer for use by machine tool operators desirous of fabricating a specialized holding fixture. Plate 67 is adapted to receive the types of attachment means commonly supplied, to enable the device 60 to be attached to the spindle 64 of the lathe 61 but as an alternative plate 67 can be secured directly to a face plate as supplied by the manufacturer.

As illustrated in Figure 6 a work piece 57 is attached to fixture 60 for turning, boring and facing operations as are usually performed on lathes. The work piece 57 is initially preferred by machining the base surface, if necessary, and forming threaded holes therein as appropriate. Subsequently, the base surface of the work piece 57 is placed against the first surface 68 of plate 67. A centre or other locating device may be used for ensuring correct positioning of the work piece 57 and the appropriate spindles 32 are then rotated to bring the respective slots 48 to alignment with the threaded holes in the work piece. Finally, bolts 71 are located within the slots 48 and are engaged with the threaded holes in the work piece 57.

Yet another embodiment of a device for holding a work piece is illustrated in Figures 7 to 10. In this embodiment which is in many respects similar to the embodiment of Figures 1 to 5 an actuator means is provided for each spindle 32.

The actuator means comprises a thrust ring 78 and a locking ring 79, which locate in counterbore 37 of the plate 11. The thrust ring 78 is an annular member having outer surface 80, inner surface 81, first end 82 and second end 83. A counterbore 84 extends radially inwardly from second end 83 and terminates with annular shoulder 85 which extends to the inner surface 81. The spindle 32 and thrust ring 78 are interlocked for relative movement in one direction by the abutment of a shoulder 86 of the spindle 32 against shoulder 85. Accordingly, as thrust ring 78 moves in a direction away from surface 12 of plate 11, the spindle 32 is forced in the same direction. A guide pin 86 is press fitted into an aperture 87, formed in the thrust ring 78 and extends from first end 82 of the thrust ring 78 substantially parallel to the axis of rotation of the spindle 32. The projecting portion of the guide pin 86 is slidably received in a guide socket 88 formed in the plate 11. Pin 86 and socket 88 serve to provide means for preventing rotation of the thrust ring 78 relative to plate 11.

The annular locking ring 79 includes an outer cylindrical surface 89, an inner cylindrical surface 90 and first and second ends 91 and 92, respectively. The outer cylindrical surface 89 is rotatably journaled within counterbore 37. The first end 91 is a thrust surface which bears against the annular shoulder 38 provided in the bore 34 of plate 11. A split ring 47, located in an annular groove 44, extending radially outwardly from counterbore 37, engages the second end 92 of the locking ring 79 and provides retention means for retaining the locking ring 79 within counterbore 37. Thrust ring 78 and locking ring 79 therefore, in this embodiment, act as an extension of second cylindrical section 40 of spindle 32 described in connection with the first embodiment.

Thrust ring 78 and locking ring 79 having a camming relationship such that longitudinal movement is a direction along the axis of rotation of the spindle 32 is imparted to thrust ring 78 in response to rotation of locking ring 79. The camming relationship may be provided by various camming means carried by thrust ring 78 and complementary cam means carried by locking ring 79. In the present embodiment, the cam means comprises an external screw thread 95 provided on the outer surface 80 of thrust ring 78, and a matingly engagable internal screw thread 96 provided on the inner surface 90 of locking ring 79.

A plurality of angularly spaced bores 97 extend radially inwardly from the outer surface 89 of the locking ring 79. An elongate tool element 98, having an engaging end 99 and a hand grip end 100, is used for rotating locking ring 79, the several bores 97 functioning as sockets for sequentially receiving the engaging end 99 of the tool element 98. A passage 101 which is of sufficient width to expose at least two bores 97 is provided in the side of the plate 11 adjacent each spindle 32, the passage allowing insertion of the

tool element 98 and movement thereof to rotate the locking ring 79.

An annular groove 101 is carried in counterbore 84 of thrust ring 78. A bore 102, is provided which extends radially inwardly from second section 40 of spindle 32 and is aligned with the annular groove 101. A threaded aperture 103 extends inwardly from the second end 43 of spindle 32 and intercepts radial bore 102. Two ball bearings 104 are located in bore 102 and the movement of the ball bearings 104 along the bore 102 is controlled by a grub screw 105 which is threadedly engaged within aperture 103. As specifically illustrated in Figure 9A, grub screw 105 is in the advanced position, abutting the inner ball bearing 104 which urge the outer ball bearing 104 partially into annular groove 101. The groove 101 provides a race for outer ball bearing 104 during rotary motion of spindle 32 relative to the thrust ring 78. The foregoing arrangement functions as a detent for preventing axial movement of the spindle 32 relative to thrust ring 78. Upon retraction of grub screw 105, both ball bearings 104 are free to move radially inwardly and the outer ball bearing can thus move to a position within bore 102, whereby spindle 32 may be removed from thrust ring 78 in a direction away from the surface of plate 11.

An attachment means 75 for a work piece includes a pin 106, having first and second ends 107 and 108, respectively, which is received through aperture 48 in the spindle 32. The first end 107 of the pin 106 extends beyond the first end 42 of spindle 32 and the second end 108 of the pin 106 projects beyond the second end 43 of spindle 32. Pin 106 is movable within elongated apertures 48 between an initial position in alignment with the axis of rotation of the spindle 32 and selected positions spaced from that axis. The pin 106 comprises at its first end 107 a work piece engaging means in the form of a threaded stud 109. The main portion of the pin 106 is of greater diameter than the stud 109 and thus defines an annular shoulder 110 about the base of the stud 109. Opposed parallel flats 111, sized to receive a conventional wrench for rotation of pin 106 are provided intermediate the ends 107 and 108.

An annular peripheral groove 112, defining a radial shoulder 113, is formed in pin 106 proximate the second end 108. A thrust member 114, is provided having opposed sides 115 and 116 and including an elongate slot 117 which is receivable by annular groove 112. An elongate stem 119 extends from the thrust member 114 and has a hand grip section 120 at the free end thereof. The thrust member 114 may be introduced through the passage 101 described above and the stem 119 is of sufficient length for hand grip section 120 to project beyond edge surface 16 of plate 11 when thrust member 114 is engaged with pin 106.

The function of the foregoing described embodiment of the invention and the procedure for holding a work piece in position will now be

described. Initially, plate 11 is placed upon table 23 with base surface 13 against the work support surface 26 of the table 23. Utilizing T-nuts 72 and cap screws 73 the plate 11 is secured to table 23 in accordance with the standard procedure for securing other well known ancillary work holding devices to a machine tool table in accordance with conventional practice in the art. Also in accordance with well known procedure, the work piece to be machined is provided with a base surface having tapped holes extending inwardly therefrom. Generally, two or more tapped holes are required to facilitate the firm fixing in position of the work piece to resist the forces of machining operations.

Threaded stud 109 of pin 106 is engaged with a selected threaded hole within the work piece. A wrench is engaged with flats 111 and the pin 106 is rotated until shoulder 110 firmly abuts the base surface of the work piece in a manner analogous to tightening a conventional bolt. The number of pins 106 engaged with the work piece is determined by the machine tool operator in order to obtain the desired holding strength. It will be appreciated that although the tapped holes need not be accurately positioned, they should be located within predetermined zones. A zone is described as the circle defined by the aperture 48 in a spindle 32 in response to rotation of the spindle.

For purposes of description, each spindle 32 is assumed to be at an initial position as illustrated in Figure 9A. The first end 82 of thrust ring 78 abuts annular shoulder 38 of counterbore 37, and the first end 42 of spindle 32 lies in the plane of the work bearing surface 12 of plate 11. The work piece is lowered onto the surface 12, the pins 106 entering respective pre-aligned apertures 48. To pre-align the apertures 48, the appropriate spindles 32 are rotated as necessary to bring apertures 48 into alignment with the respective pins 106. Subsequently, the machine tool operator, holding hand grip section 120 of stem 119, passes thrust member 114 through passage 101 and engages thrust member 114 with the annular groove 112 of pin 106. This action is repeated until a thrust member 114 is engaged with each pin 106.

Thereafter, each locking ring 79, associated with a spindle 32 having a pin 106 therethrough, is rotated. To accomplish rotation of locking ring 79, the machine tool operator grasps tool element 98 by hand grip end 100 and, passing tool element 98 through passage 101, inserts engaging end 99 into a bore 97. The tool element 98 is moved in a normal tightening direction, usually clockwise, until either no further movement of locking ring 79 is felt or until tool element 98 strikes the side of passage 101. In the latter case, tool element 98 is withdrawn from the immediate bore 97, repositioned in a subsequent bore 97, and the action repeated. During the rotation of lock ring 79, thrust ring 78 is cammingly moved in a direction away from annular shoulder 38. Annular shoulder 85 of

thrust ring 78 bearing against annular shoulder 86 of spindle 32, moves spindle 32 in a direction away from the work bearing surface 12 of plate 11. The pin 106 is also caused to move in a direction away from work bearing surface 12, since the second end 43 of the spindle 32 bears against thrust member 114 which, in turn bears against the radial shoulder 113 of pin 106. Due to the movement of pin 106 and spindle 32 in response to rotation of locking ring 79, the base surface of work piece 57 is drawn firmly against work bearing surface 12.

Figure 9B illustrates the device as it would appear in the work piece holding position. The use of tool element 98 and stem 119 is best illustrated in Figure 10. The distance spindle 32 must be retracted in order to urge the work piece 57 firmly against the work bearing surface 12 depends on the distance between shoulders 110 and 113 of pin 106 and thickness of thrust member 114, as measured between opposed sides 115 and 116. In the initial, or work receiving position, shoulder 113 must reside at a sufficient distance from the second end 43 of spindle 32 to enable the thrust member 114 to be correctly positioned. When the thrust member 114 is in position spindle 32 is moved in a direction away from work piece bearing surface 12 until contact is made between the second end 43 of spindle 32 and side 115 of the thrust member 114. As previously noted, the force of the contact of the workpiece with surface 12 must be sufficient to immobilize the work piece. The device of this can be manufactured such that movement of spindle 32 away from surface 12 need only be a few thousands of an inch.

The degrees through which locking ring 79 need be rotated between the work piece receiving position and the work piece holding position is generally a function of the helical angle, or lead, of the complementary camming means between thrust ring 78 and locking ring 79. In the immediate embodiment, the cam means are in the form of external and internal screw threads 95 and 96, respectively. As will be readily recognized by those skilled in the art, the use of a sixteen pitch single thread will yield a lead distance of .0625 inches. Accordingly, rotating locking ring 79 through 45 degrees will move spindle 32 approximately .008 inches.

For removal of the work piece, locking ring 79 is rotated in a counter direction, utilizing tool element 98. Stem 119, with thrust member 114, is withdrawn from pin 106 and the work piece is lifted from plate 11. Subsequently, pins 106 are withdrawn from the work piece. Alternatively, another work piece, having corresponding pins 106 previously attached thereto, is affixed to plate 11 as previously described.

Work piece 57 may be affixed to plate 11 by means other than the means previously described, utilizing a T-slot 50 or threaded apertures 52, of the type described above in connection with the first described embodiment. Alternatively, pin 106 can be provided with a

threaded aperture, or T-slot, extending inwardly from shoulder 110 in lieu of threaded stud 109. Pins 106 may also have an extended length to accommodate a work piece which is supported in a spaced relationship from work bearing surface 12 by various stand-off devices, such as those commonly referred to as parallels. Such modifications do not alter the function of the device as previously described.

Other modifications and variations to the embodiment herein chosen for purposes of illustration will readily occur to those skilled in the art. Grub screw 103 selectively urges a ball bearing 104 partially into groove 101 and provides for disassembly of spindle 32 from thrust ring 78. A spring residing in bore 102 and bearing against ball 104 will provide an equivalent structure. Similarly, end 83 of thrust ring 78 may project beyond end 43 of spindle 32 and carry an internal snap ring for retention purposes, as previously described in connection with ring 47 for retaining locking ring 79.

Where the advantages offered by aperture 48 is provided in rotatable spindle 32 are not desired, spindle 32 need not rotate. In the last described embodiment, locking ring 79 could if desired be adapted to interact directly with spindle 32. Spindle 32 could be stabilized against rotation by a pin, similar to pin 86, or by other well known means, such as a key and key-way means and the external screw thread 95 could be provided directly by second section 40 of spindle 32. It will be appreciated that either second section 40 would have to be enlarged, or inner surface 90 of locking ring 79 reduced in size for mating of the complementary camming means.

Plate 11 is readily securable to various ancillary devices to facilitate particular machining operations. For angular machining, plate 11 is secured to an angular holding device, such as a sign plate. It is also envisioned, for frequent and repetitive angle machining, that the work piece bearing surface 12 could be disposed at a predetermined angle from base surface 13. Holding a work piece at a predetermined angle is particularly advantageous in connection with certain long range production runs.

Various changes and modifications to the embodiments herein chosen for purposes of illustration will readily occur to those skilled in the art. It will be appreciated for example, that the size, configuration, number and placement of spindles within a given plate is at the discretion of the manufacturer. The number and placement of engagement and receiving means associated with each spindle is similarly readily alterable. Also, alternate shapes of the plate and the receiving means carried directly thereby are readily subject to modification.

125 Claims

1. A device for holding a work piece to facilitate machining by a machine tool, said device comprising a substantially rigid work piece support member having first and second spaced



thrust ring 78 bearing against annular shoulder 86 of spindle 32, moves spindle 32 in a direction away from the work bearing surface 12 of plate 11. The pin 106 is also caused to move in a direction away from work bearing surface 12, since the second end 43 of the spindle 32 bears against thrust member 114 which, in turn bears against the radial shoulder 113 of pin 106. Due to the movement of pin 106 and spindle 32 in response to rotation of locking ring 79, the base surface of work piece 57 is drawn firmly against work bearing surface 12.

Figure 9B illustrates the device as it would appear in the work piece holding position. The use of tool element 98 and stem 119 is best illustrated in Figure 10. The distance spindle 32 must be retracted in order to urge the work piece 57 firmly against the work bearing surface 12 depends on the distance between shoulders 110 and 113 of pin 106 and thickness of thrust member 114, as measured between opposed sides 115 and 116. In the initial, or work receiving position, shoulder 113 must reside at a sufficient distance from the second end 43 of spindle 32 to enable the thrust member 114 to be correctly positioned. When the thrust member 114 is in position spindle 32 is moved in a direction away from work piece bearing surface 12 until contact is made between the second end 43 of spindle 32 and side 115 of the thrust member 114. As previously noted, the force of the contact of the workpiece with surface 12 must be sufficient to immobilize the work piece. The device of this can be manufactured such that movement of spindle 32 away from surface 12 need only be a few thousands of an inch.

The degrees through which locking ring 79 need be rotated between the work piece receiving position and the work piece holding position is generally a function of the helical angle, or lead, of the complemental camming means between thrust ring 78 and locking ring 79. In the immediate embodiment, the cam means are in the form of external and internal screw threads 95 and 96, respectively. As will be readily recognized by those skilled in the art, the use of a sixteen pitch single thread will yield a lead distance of .0625 inches. Accordingly, rotating locking ring 79 through 45 degrees will move spindle 32 approximately .008 inches.

For removal of the work piece, locking ring 79 is rotated in a counter direction, utilizing tool element 98. Stem 119, with thrust member 114, is withdrawn from pin 106 and the work piece is lifted from plate 11. Subsequently, pins 106 are withdrawn from the work piece. Alternatively, another work piece, having corresponding pins 106 previously attached thereto, is affixed to plate 11 as previously described.

Work piece 57 may be affixed to plate 11 by means other than the means previously described, utilizing a T-slot 50 or threaded apertures 52, of the type described above in connection with the first described embodiment. Alternatively, pin 106 can be provided with a

threaded aperture, or T-slot, extending inwardly from shoulder 110 in lieu of threaded stud 109. Pins 106 may also have an extended length to accommodate a work piece which is supported in a spaced relationship from work bearing surface 12 by various stand-off devices, such as those commonly referred to as parallels. Such modifications do not alter the function of the device as previously described.

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Plate 11 is readily securable to various ancillary devices to facilitate particular machining operations. For angular machining, plate 11 is secured to an angular holding device, such as a sign plate. It is also envisioned, for frequent and repetitive angle machining, that the work piece bearing surface 12 could be disposed at a predetermined angle from base surface 13. Holding a work piece at a predetermined angle is particularly advantageous in connection with certain long range production runs.

Various changes and modifications to the embodiments herein chosen for purposes of illustration will readily occur to those skilled in the art. It will be appreciated for example, that the size, configuration, number and placement of spindles within a given plate is at the discretion of the manufacturer. The number and placement of engagement and receiving means associated with each spindle is similarly readily alterable. Also, alternate shapes of the plate and the receiving means carried directly thereby are readily subject to modification.

125 Claims

1. A device for holding a work piece to facilitate machining by a machine tool, said device comprising a substantially rigid work piece support member having first and second spaced



opposed surfaces, therein being one or more apertures through said member between said first and second surfaces thereof, a spindle mounted for rotation within said aperture or each of said apertures, said spindle having first and second ends and said first end of said spindle being positioned proximate the first surface of said member, and first retention means for limiting the movement of said spindle in a direction toward the first surface of said member, said spindle being provided with receiving means for receiving holding means for securing a work piece to said device, located so that, on rotation of the spindle, the position of the receiving means is adjusted.

2. A device according to claim 1 wherein said aperture or each said aperture is in the form of a generally cylindrical bore and wherein said spindle has an outer generally cylindrical side surface which cooperates with said bore to facilitate rotation of said spindle within said bore.

3. A device according to claim 2 wherein said first retention means includes a first annular shoulder extending inwardly within said bore and a second annular shoulder extending radially outwardly from said spindle and received against said first shoulder.

4. A device according to claim 2, or claim 3 further including second retention means cooperating with said first retention means for retaining said spindle within said bore.

5. A device according to claim 4 wherein said second retention means includes an annular groove extending radially outwardly from said bore and an annular ring member carried in said groove and extending radially inwardly to receive the second end of said spindle there-against.

6. A device according to any one of claims 1 to 5 wherein said receiving means comprises a radial slot extending through said spindle between the first and second ends thereof.

7. A device according to claim 6, wherein said slot extends radially from proximate the axis of rotation of said spindle to proximate the outer surface of said spindle.

8. A device according to claim 7, wherein said slot defines an opening along the outer side surface of said spindle.

9. A device according to any one of claims 1 to 8 wherein said receiving means includes a T-slot extending diametrically along the first end of said spindle.

10. A device according to any one of claims 1 to 9 wherein said receiving means includes an internally threaded bore extending inwardly from the first end of said spindle and having a longitudinal axis substantially parallel to the axis of rotation of said spindle.

11. A device according to any one of claims 1 to 9 wherein said receiving means include a plurality of spaced, annularly arranged, internally threaded bores extending inwardly from the first end of said spindle, each said bore having a longitudinal axis substantially parallel to the axis of rotation of said spindle.

12. A device according to any one of claims 1

to 11 wherein the first end of said spindle is recessed from the first surface of said work piece support member.

13. A device according to any one of claims 1 to 12 wherein receiving means are also provided on said work piece support member.

14. A device according to any one of the preceding claims further including means for detachably securing said work piece support member to a machining tool.

15. A device according to any one of the preceding claims wherein said work piece support member comprises a generally rectangular plate, having first and second longitudinal edges and first and second lateral edges.

16. A device according to claim 15, further including a first base plate carried by said rigid plate proximate a longitudinal edge thereof and having a bottom surface substantially perpendicular to the first surface of said rigid plate.

17. A device according to claim 16 further including a second base plate carried by said rigid plate proximate a lateral edge thereof and having an outer surface substantially perpendicular to the first surface of said rigid plate.

18. A device according to any one of claims 1 to 4 wherein said work piece support member comprises a generally cylindrical plate.

19. A device according to claim 1 or claim 2 wherein said spindle disposed within said aperture or each said aperture is arranged for movement within said aperture or each of said apertures in the direction of the axis of rotation of the spindle and wherein holding means is provided extending from the first end of said spindle, and actuator means are provided for retracting said spindle relative to the first surface of said work piece support member thereby to enable a work piece to be urged into contact with said first surface.

20. A device according to claim 19, wherein said receiving means includes a receiving aperture extending through said spindle between the first and second ends thereof and wherein said holding means comprises a pin having first and second ends and receivable within the aperture in said spindle; there being work piece engaging means carried proximate the first end of said pin, and wherein connection means are provided for detachably securing said pin in position relative to said spindle.

21. A device according to claim 20, wherein said receiving aperture is in the form of an elongate slot extending from proximate the axis of rotation of said spindle to proximate the peripheral edge of said spindle.

22. A device according to claim 21, wherein since said spindle is rotatably journaled said slot is adjustable to receive said pin at any location within a circle defined by the rotation of said slot.

23. A device according to claim 20, claim 21 or claim 22 wherein said connection means includes a radial shoulder carried proximate the second end of said pin, said radial shoulder being



spaced from and opposed to an abutment surface provided by a portion of the second surface of said spindle which lies about the periphery of said slot when said pin is received within the receiving aperture in said spindle and a thrust member having spaced opposed sides and being positionable between said abutment surface and said radial shoulder, one of said sides being received against said abutment surface and the outer of said sides receiving said radial shoulder thereagainst for limiting the movement of said pin in a direction toward the first end of said spindle.

24. A device according to claim 23, further including a passage extending inwardly from the edge surface of said work piece support member for receiving said thrust member therethrough for positioning said thrust member relative said abutment surface and said radial shoulder.

25. A device according to claim 24, wherein said thrust member is provided with an elongate stem having a free end with a grip section and having a length such that the hand grip section projects beyond the edge surface of said work piece support member when said thrust member is positioned between said abutment surface and said radial shoulder.

26. A device according to any one of claims 19 to 25 wherein said actuator means comprises a cylindrical element engaging the spindle proximate the second end thereof said cylindrical element being provided with cam means, a locking ring having an outer cylindrical surface and being rotatably mounted within said work piece support member at a position spaced from said first surface said locking ring being provided with complimentary cam means engaging said cam means and means for rotating said locking ring whereby said spindle may be moved relative to said first surface.

27. A device according to claim 26, wherein a counterbore is formed extending inwardly from the second surface of said work piece support member said counterbore being concentric with the axis of rotation of said spindle and terminating with an annular shoulder spaced from said first surface, said locking ring being rotatably journaled within said counter bore and including a thrust surface in juxtaposition with said annular shoulder of said counterbore.

28. A device according to claim 27, wherein said means for rotating said locking ring includes, a socket formed in said locking ring, passage means communicating between the counterbore and the edge surface of said work piece support member and exposing said socket, and a tool element having an engaging end receivable in said socket and having a hand grip end, said tool element being receivable through said passage means for rotation of said locking ring.

29. A device according to claim 28, wherein said means for rotating said locking ring comprises a plurality of angularly spaced sockets extending radially inwardly from the outer surface of said locking ring and wherein said passage means has sufficient width to expose at least two

of said sockets.

30. A device according to claim 29, further including retention means for retaining said locking ring within said counterbore.

31. A device according to claim 30, wherein said locking ring includes a second surface spaced from said thrust surface and spaced from the base surface of said plate, and said retention means includes, an annular groove in said counterbore intermediate the second surface of said locking ring and the second surface of said support member, and a snap ring held in said groove and projecting inwardly therefrom for receiving the second surface of said locking ring thereagainst.

32. A device according to any one of claims 26 to 31 wherein said cylindrical element comprises an outer surface provided with said cam means, a bore therethrough for rotatably receiving said spindle, and interlocking means for engaging said spindle for moving said spindle in a direction away from the first surface of said support member and means for preventing rotary motion of said cylindrical element relative to said support member.

33. A device according to claim 32, wherein said interlocking means comprises an annular flange extending inwardly from the bore of said cylindrical element and a complimentary annular flange extending outwardly from said spindle for bearing against the annular flange of said cylindrical element.

34. A device according to claim 32 or claim 33, wherein said means for preventing rotary motion of said cylindrical element comprises a guide pin projecting from said cylindrical element toward the first surface of said support member and substantially parallel to the axis of rotation of the spindle, and a guide socket formed in said support member and extending from the annular shoulder of said counterbore and slidably receiving said guide pin.

35. A device according to any one of claims 26 to 34 and further including detent means carried by said spindle and engaging said cylindrical element for preventing axial movement of said spindle relative to said cylindrical element.

36. A device according to claim 35, wherein said detent means includes an annular groove in the bore of said cylindrical element, an aperture in said spindle and having an end thereof communicating with the annular groove in said thrust ring, a detent element movably carried in said aperture, and means for projecting said detent element from said aperture into said annular groove.

37. A device for holding a work piece substantially as herein described with reference to and as illustrated in Figures 1 to 5 of the accompanying drawings.

38. A device for holding a workpiece substantially as herein described with reference to and as illustrated in Figures 1 to 5 as modified by Figure 6 of the accompanying drawings.

39. A device for holding a workpiece

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substantially as herein described with reference to
and as illustrated in Figures 7 to 10 of the
accompanying drawings.

40. A device for holding a workpiece according
5 to any one of the preceding claims mounted to a
machine tool.

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