A clamping tool (10) for removing the gap between and temporarily clamping workpieces (12, 14) together for subsequent fastening and having a cable actuated toggle member (46) for engagement with one side (70) of the workpieces (12, 14) and a nut member (40) engageable with the opposite side (68) of the workpieces (12, 14).
(54) Title: BLIND ALIGNMENT AND CLAMP UP TOOL

(57) Abstract

A clamping tool (10) for removing the gap between and temporarily clamping workpieces (12, 14) together for subsequent fastening and having a cable actuated toggle member (46) for engagement with one side (70) of the workpieces (12, 14) and a nut member (40) engageable with the opposite side (68) of the workpieces (12, 14).
SUMMARY BACKGROUND OF THE INVENTION

The present invention relates to apparatus for temporarily clamping workpieces together to facilitate the subsequent, permanent securement of the workpieces together.

In many structural applications it is desirable to secure workpieces such as structural members together by use of blind fasteners. However, frequently the workpieces in their pre-fastened condition are spaced apart at the desired fastening location whereby fastening can be inhibited or require the use of fasteners having a large grip capability. The present invention provides a unique clamping tool or device for temporarily clamping the workpieces together, thereby removing the space or gap therebetween and thus facilitating the application of permanent fasteners of a minimal or routine size for such workpieces. After the permanent fasteners have been installed the unique clamping device can be removed and used in other applications.

In this regard the clamping tool functions somewhat as a blind fastener since it can be applied and removed from one side of the workpieces being secured without the need for access to the other side. While it is believed that the device of the present invention will be most advantageously used in applications where blind fasteners are to be installed it can be used to temporarily clamp workpieces together for other purposes including, by way of example, fastening by non-blind fasteners and welding. The clamping tool can also be utilized to clamp the workpieces together to facilitate drilling of aligned holes through the workpieces for fasteners to be installed or for other processing.

Thus it is an object of the present invention to provide a unique device for temporarily clamping workpieces together to facilitate subsequent fastening.
It is another object to provide such a clamping device which can be applied and removed with access only to one side of the workpieces.

It is a general object of the present invention to provide a unique device for temporarily clamping workpieces together.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, in which:

DESCRIPTION OF THE VIEWS OF THE DRAWINGS

Figure 1 is a longitudinal, partial sectional view depicting the clamping tool of the present invention being initially applied to a pair of spaced workpieces to be clamped together;

Figure 2 is a view similar to Figure 1 depicting the clamping tool being placed in a condition preparatory to clamping the workpieces together;

Figure 3 is a view similar to Figures 1 and 2 depicting the clamping tool in its actuated condition clamping the workpieces together;

Figure 4 is a top elevational fragmentary, sectional view to enlarged scale of the clamping tool and a workpiece of Figure 3 shown in the actuated condition and taken generally along the lines of the Arrows 4-4 in Figure 3;

Figure 5 is a fragmentary, sectional view to enlarged scale of the clamping tool and a workpiece generally taken generally in the area of the Circle 5 in Figure 4;

Figure 6 is a front elevational view to enlarged scale of the toggle member and spherical ball assembly of the clamping tool;

Figure 7 is an end elevational view of the toggle member of Figure 6 taken in the direction of the Arrow 7;

Figure 8 is a longitudinal, partial sectional view similar to Figure 3 depicting a modified form of clamping tool in its actuated condition clamping a pair of workpieces together;
Figure 9 is a fragmentary elevational view similar to Figure 4 but depicting the modified form of the clamping tool of Figure 8 taken generally along the lines of the Arrows 9-9 in Figure 8;

Figure 10 is a sectional view of the clamping tool of Figures 8 and 9 taken generally along the lines of the Arrows 10-10 in Figure 9; and

Figure 11 is a fragmentary view similar to that of Figure 10 but depicting another embodiment of clamping tool.

DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

Looking now to Figures 1-3 of the drawings, a clamping tool 10 is shown in assembly relationship with a pair of workpieces 12 and 14 having generally aligned bores 13 and 15, respectively. The clamping tool 10 includes an elongated pin member or support shaft 16 having an axially extending through bore 18. A slotted, inner end portion 20 of the support shaft 16 has a pair of diametrically opposite slots 22, 22' which are in communication with the confronting portion of the through bore 18. The slots 22, 22' have a width W1 (see Figure 4) for a purpose to be seen. A threaded portion 24 is spaced from the slotted portion 20 by a thread relief groove 27. The diameter of the threaded portion 24 across the crest of the threads is generally the same as the diameter of the generally smooth slotted portion 20. An opposite, outer end portion 26 is of a reduced diameter and has a section 28 provided with a relatively light, straight knurl which serves a purpose to be described. The knurled section 28 provides a roughened surface to facilitate gripping by hand and/or a plier type device.

The clamping tool 10 further includes an actuator rod 30 having a generally uniform diameter and of a size to be slidingly received in the through bore 18 of support shaft 16 with a slight clearance fit. The actuator rod 30 terminates at its outer end in a reduced diameter, threaded portion 32. An enlarged knob member 34 is adapted to be threadably secured to the threaded portion 32 of the
actuator rod 30. The knob member 34 can be fixed from rotation by the application a suitable plastic adhesive material such as the adhesive sold under the tradename LOCTITE "Red".

An axially extending anti-rotation groove 36 is provided at the outer end of the actuator rod 30. The groove 36 is adapted to receive a radially extending set screw 38 at the outer end portion 26 of the support shaft 16. In this way relative rotation between the support shaft 16 and actuator rod 30 is prevented while permitting relative axial movement therebetween.

An enlarged nut member 40 has a through bore with its forward or inner end portion 42 having an internal thread form adapted to threadably engage the threaded portion 24 of support shaft 16. The nut member 40 has a counterbored portion 44 at its rearward or outer end adapted to be received over the threaded portion 24 with a slight clearance. The outer surface of the nut member 40 is of a hexagonal or other well known irregular configuration (not shown) adapted to be gripped by a standard wrench or tool. The counterbored portion 44 permits the clamping tool 10 to be used with workpieces having a substantially reduced overall thickness from that as shown for the workpieces 12 and 14. In these applications the nut member 40 can be threaded onto the threaded portion 24 from the opposite end thereby permitting the adjacent section of the smooth inner end portion 20 of the support shaft 16 to be received in the counterbored portion 44 in a clearance relationship. At the same time the overall length of the nut member 40 can be optimized to facilitate gripping and turning by hand or by a suitable tool. In one form of the invention, a nut member 40 can be provided having its threaded end portion 42 with a minor or crest diameter of around .865 inches and a pitch diameter of around .895 inches. The counterbored portion 44 can be provided with a diameter of around 1.0 inches which provides clearance with the threaded portion 24 having a major or crest diameter of around .924 inches. The axial
length of the nut member 40 can be around 3.0 inches with the axial length of the threaded portion 42 being around 1.0 inches and the axial length of the counterbored portion 44 being around 2.0 inches. The outer surface of the nut member 40 can be provided with a hexagonal shape with diametrically opposed flats being spaced around 1.75 inches apart. Thus the nut member 40 would have an overall length providing a significant engagement surface area for a wrench. At the same time the nut member 40 with the extended counterbored portion 44 permits the nut member 40 and hence the clamping tool 10 to be utilized with workpieces, such as workpieces 12 and 14, varying in total thickness over a significant range.

The clamping tool 10 includes a toggle member 46 which is of a generally flat, plate like construction having a generally rectangular shape. The toggle member 46 is of a thickness T1 (see Figure 7) and is adapted to be slidably received in the slots 22, 22' with a slight clearance fit relative to the slot width W1. In this regard the width W1 of slots 22, 22' is substantially less than the diameter D1 (see Figure 4) of the through bore 18 and in one form of the invention was around 30% less. The toggle member 46 has a through bore 48 having its axis X1 at a point midway along its length L (see Figure 6). At the same time, however, the axis X1 is located slightly off center along the width W2 of the toggle member 46. Each of the four end surfaces of the toggle member 46 is curved having a diameter generally equal to the thickness T1. The curved surfaces facilitate sliding relative to surfaces engaged thereby during operation of the clamping tool 10. A hardened, spherical ball member 50 is adapted to be located in the through bore 48 in toggle member 46 with a slight clearance fit to permit rolling therein. At the same time, the ball member 50 and the associated bore 48 are of a diameter generally equal to the diameter D1 of the shaft bore 18 in support shaft 16 to provide rolling engagement with the bore surface. The slot 22' is provided with a radial bore 52 near its rearward end.
The radial bore 52 is of a diameter to receive the ball member 50 in clearance relationship whereby the toggle member 46 with the ball member 50 in the ball retaining bore 48 can be moved through the slot 22' with the ball member 50 moving through the radial bore 52 until it is seated in the axial shaft bore 18.

The toggle member 46 is operably connected to the actuator rod 30 by a cable 54. Looking now to Figures 1-4, it can be seen that the cable 54 has one end connected to the longitudinal end 49 of the toggle member 46 by way of a longitudinal bore 56 (see Figures 6 and 7). A set screw 58 extends through a transverse bore 60 intersecting the longitudinal bore 56 whereby the end of the cable 54 in the longitudinal bore 56 can be clamped in place.

The longitudinal bore 56 and hence the location of the connection of the end of the cable 54 is rearwardly offset from the longitudinal center line X2 of the toggle member 46 and is even farther offset from the longitudinal center line X3 of the transverse ball retaining bore 48 and associated spherical ball member 50. Since the toggle member 46 is mounted on the ball member 50 for pivotal movement about the axis X1 of the bore 48, and hence of the ball member 50, this offset provides a moment arm M between the connecting point of the cable 54 to the toggle member 46 and its axis X1 of rotation to thereby facilitate the pivotal actuation of the toggle member 46 by the actuator rod 30 through the cable 54.

In this regard the opposite end of the cable 54 is connected to the inner end of the actuator rod 30. That end of the cable 54 is located in an axial bore 62 in the inner end of the actuator rod 30 and is fixed there by one or more set screws 64 located in a radially intersecting through bore.

The cable 54 while flexible has sufficient stiffness to permit manipulation of the toggle member 46 by the axial movement of the actuator rod 30 pulling and pushing on the cable 54. In one form of the invention the cable 54 was of
a 11 x 19 stranded stainless steel cable having a diameter of around .0625 inches.

The opposite radially outer sides of the slot 22' are chamfered to provide chamfered surfaces 66. The chamfered surfaces 66 along with the radius of curvature provided on the surface of the toggle member 46 adapted to engage the inside surface 70 of workpiece 12 provides clearance for the cable 54. This clearance inhibits the cable 54 from being caught between the engagement surface of the toggle member 46 and the inside surface 70 of the workpiece 12. This can be seen in Figure 5 which illustrates the clearance provided. The chamfered surfaces 66 also act as a guide for the cable 54. In addition the angulation of the chamfer avoids sharp corners and thereby provides a smoother surface for engagement with the cable 54. It should also be noted that the point of connection of the cable 54 to the toggle member 46 is offset relative to the center line T2 midway along its thickness T1 (see Figure 7). This tends to locate the cable 54 somewhat off center from the thickness midpoint and thus further assists in locating the cable 54 to one side thereby positioning the cable 54 away from the engaging surfaces and into the clearance provided by the toggle member 46 and slot 22'.

Looking now to Figure 1, the clamping device 10 is initially placed in its pre-actuated condition by simply pulling, in the direction of the Arrow P1, on the actuator rod 30 and cable 54 to pivot the toggle member 46 to its reclined position in which it is generally completely within the confines of the support shaft 16. In this regard the width W2 of the toggle member 46 is generally around the outside diameter D2 of the inner end portion 20 of the support shaft 16. The inner end portion 20 of the support shaft 16 is then extended through the aligned bores 13 and 15 in workpieces 12 and 14 in a clearance relationship. In this condition the clamping device 10 and workpieces 12 and 14 are in the positions generally as shown in Figure 1. Next the actuator rod 30 is pushed, in the direction of
Arrow P2, into the through bore 18 of support shaft 16 acting on the cable 54 to pivot the toggle member 46 at least partially to an upright position as shown in Figure 2. Now the nut member 40 is threaded further onto the threaded portion 24 of the support shaft 16 into engagement with the outer surface 68 of workpiece 14 while moving the toggle member 46 into engagement with the inner surface 70 of the workpiece 12. Further threading of the nut member 40 with the toggle member 46 now in its fully upright position will draw the workpieces 12 and 14 together to remove the gap therebetween as shown in Figure 3. The nut member 40 can be torqued onto the threaded portion 24 by a wrench (not shown) having a standard, configuration matably engageable with the outer surface of the nut member 40.

In the fully clamped position of Figures 3 and 4, the innermost end 41 of the toggle member 46 is in full engagement with the similarily contoured inner end surface 43 of the slots 22, 22'. This provides not only substantial bearing surfaces to react the applied loads but also provides engaged components having a high shear and compressive strength at these locations.

Now with the workpieces 12 and 14 firmly clamped together they can be permanently secured together by standard fasteners or some other means such as welding. With the workpieces 12 and 14 secured together the clamping device 10 can be actuated in the reverse order and returned to its condition of Figure 1 for removal and use in other similar applications.

Thus a clamping device 10 of a relatively simple construction and operation has been provided for clamping workpieces together to facilitate their subsequent permanent connection.

A modified form of the invention is shown in Figures 8-10 where components similar to like components of the embodiment of Figures 1-7 have been given the same numeral designation with the addition of the letter postscript "a". Unless described otherwise the like numbered components can
be considered to be of substantially the same construction and to function similarly. Thus, for purposes of brevity, the details of all components will not be repeated.

Looking now to Figures 8-10 of the drawings, the clamping tool 10a is shown in assembly relationship with workpieces 12a and 14a having generally aligned bores 13a and 15a, respectively. The clamping tool 10a includes an elongated, generally solid support rod 16a having a generally uniform maximum outer diameter. An inner end portion 20a of the support rod 16a has a diametrically extending through slot 22a. A threaded outer end portion 24a is spaced from the slotted portion 20a by a thread relief groove 27a. The free or outer end of the threaded portion 24a is provided with a plurality of flats 29a to facilitate gripping by a tool and/or by hand.

An enlarged nut member 40a has a through bore with its forward or inner end 42a having an internal thread form adapted to threadably engage the threaded portion 24a of support rod 16a. The nut member 40a has a counterbored portion 44a at its rearward or outer end adapted to be received over the threaded portion 24a with a slight clearance. The nut member 40a is of substantially the same construction and function as nut member 40 of Figures 1-7 and hence those details will not be repeated here.

The clamping tool 10a includes a toggle member 46a which is of a generally flat, plate like construction having a generally rectangular shape. The toggle member 46a is of a thickness adapted to be slidable received in the slot 22a with a slight clearance fit relative to the slot width. The toggle member 46a has a through bore 48a having its axis X1a at a point midway along its length. At the same time, however, the axis X1a is located off center along the width of the toggle member 46a. The toggle member 46a has one corner 47 with a curved surface having a relatively large radius which in one embodiment was around .60 of the width of toggle member 46a. The curved or arcuate corner 47 facilitates sliding engagement relative to end surface 43a.
of the slot 22a engaged thereby during operation of the clamping tool 10a. An elongated, split spring type pin 51 is adapted to be located with resilient gripping, engagement in the through bore 48a in toggle member 46a. The support rod 16a has a pair of axially extending diametrically opposed guide slots 53 in quadrature with and which communicate with the slot 22a. At the same time, the pin 51 when resiliently installed in the bore 48a is of a diameter generally equal to the width of the guide slots 53 to provide sliding engagement therein with a reasonably close clearance fit.

The toggle member 46a is operably connected to an actuator cable 54a. The cable 54a has one end connected by a pivot pin 55 located at and pivotally connected to one side of the toggle member 46a near the end 45 which is adapted to engage the end surface 43a of the slot 22a.

The location of the connection of the end of the cable 54a is offset both widthwise and lengthwise from the center line of the pin 51. The pin 51 being on the axis X1a is itself offset along the width of the toggle member 46a while being located generally centrally along its length. The noted offset provides a moment arm between the connecting point of the cable 54a and pivot pin 55 to the toggle member 46a and the pivot axis X1a of rotation of the pin 51 to thereby facilitate the pivotal actuation of the toggle member 46a by the cable 54a. A groove 57 extends axially across the length of the threaded portion 24a of the support rod 16a into communication with the through slot 22a. The location of the pivot pin 55 and cable 54a place them at a level in line with and generally within the groove 57.

Thus the actuator cable 54a and pivot pin 55 will be located in alignment with and within the groove 57 generally at all times. This arrangement literally precludes the cable 54a from being caught between the toggle member 46a and the inner surface 70a of the workpiece 12a during actuation and engagement. A snap ring 59 in a groove in the outer end of the end portion 20a further helps to retain the
cable 54a within the groove 57. A second snap ring 61 is located within a groove at the outer end of the threaded portion 24a to maintain the cable 54a within the groove 57 generally throughout the associated length of the support rod 16a (see Figure 8). A cap 63 can be applied to the free end of the cable 54a to facilitate hand actuation. With this structure chamfered surfaces, such as surfaces 66 in slot 22' of the embodiment of Figures 1-7, are not required or provided in slot 22a and in addition the associated end surfaces of the toggle member 46a need not be extensively arcuately formed for clearance purposes as in the embodiment of Figures 1-7. The cable 54a while flexible has sufficient stiffness to permit manipulation of the toggle member 46a by axially pulling and pushing on the cable 54a. The cable 54a can be of the same construction as cable 54 of Figures 1-7.

The operation of the clamping device 10a is substantially the same as that of the device 10 and can be operated in the same sequence as shown and described in conjunction with Figures 1-3 by simply pulling and pushing on the actuator cable 54a to pivot the toggle member 46a to its desired positions. Similarly the nut member 40a is applied in the manner of nut member 40 to clamp the workpieces 12a and 14a firmly together as shown in Figures 8-10.

With the workpieces 12a and 14a firmly clamped together they can be permanently secured together by standard fasteners or some other means such as welding or subject to other operations as desired. Upon the completion of the desired operation, the clamping device 10a can be actuated in the reverse order and returned to its deactivated condition for removal and use in other similar applications.

Another modified form of the invention is shown in Figure 11 which is substantially identical to the embodiment of Figures 8-10 except here the toggle member is in a fixed pivotal position in a slot through the support rod. Thus in the description of the embodiment of Figure 11 components
similar to like components of the embodiment of Figures 8-10 have been given the same numeral designation with the addition of the letter postscript "b". Unless described otherwise the like numbered components can be considered to function similarly and thus generally only the details of the differences in construction and operation of the clamping tool of Figure 11 relative to that of Figures 8-10 will be described for purposes of simplicity.

Looking now to Figure 11 of the drawings, the clamping tool 10b is shown in assembly relationship with workpieces 12b and 14b having generally aligned bores 13b and 15b, respectively. The clamping tool 10b includes an elongated support rod 16b having an inner, end portion 20b with a diametrically extending through slot 22b. The support rod 16b is of essentially the same construction as support rod 16a except as shown and described. Thus the support rod 16b has a threaded outer end portion (not shown), such as end portion 24a, which is spaced from the slotted portion 20b by a thread relief groove (not shown) such as groove 27b.

The clamping tool 10b includes a toggle member 46b which is generally identical to toggle member 46a. The through bore 48b and its axis X1b are substantially the same as the similarly numbered counterparts of Figures 8-10. In this construction, however, the support pin 51b, which is located in the through bore 48b, is pivotally supported in an axially fixed position in the slot 22b.

The toggle member 46b is operably connected to actuator cable 54b by a pivot pin 55b pivotally supported at one side of the toggle member 46b near the end 45b.

An offset similar to that of Figures 8-10 provides a moment arm between the connecting point of the cable 54b and pivot pin 55b to the toggle member 46b and the pivot axis of the support pin 51b to facilitate the pivotal actuation of the toggle member 46b by the cable 54b. As with the embodiment of Figures 8-19 a groove 57b extends axially across the length of the threaded portion 24b of the support rod 16a into communication with the through slot 22b with
the pivot pin 55b and cable 54b located generally within the groove 57b.

Snap rings such as 59b at the outer end of the end portion 20b help to retain the cable 54b within the groove 57b across its length.

The cable 54b, similarly to cables 54 and 54a, while flexible has sufficient stiffness to permit manipulation of the toggle member 46b by axially pulling and pushing on the cable 54b.

The operation of the clamping device 10b is similar to that of the devices 10 and 10a and can be operated in the same manner as shown and described in conjunction with Figures 1-3 and thus its operation is accomplished simply by pulling and pushing on the actuator cable 54b to pivot the toggle member 46b to its desired positions. The associated nut member (not shown), such as 40, 40a, is threaded further onto the threaded portion (not shown) such as threaded portion 24b of the support rod 16b, into engagement with the outer surface of workpiece 14b while moving the toggle member 46b into engagement with the inner surface 70b of the workpiece 12b. Further threading of the nut member with the toggle member 46b now in its fully upright position will draw the workpieces 12b and 14b together to remove the gap as shown in Figure 11.

With the workpieces 12b and 14b firmly clamped together they can be permanently secured together or operated upon as previously described after which the clamping device 10a can be actuated in the reverse order and returned to its deactivated condition for removal and use in other similar applications.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects stated above, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the invention.
WHAT IS CLAIMED IS:

1. A clamping tool for pulling together and clamping spaced apart workpieces with the workpieces having generally aligned openings and with a forward workpiece having a forward surface and a rearward workpiece having a rearward surface, said clamping tool comprising:
   an elongated shaft member having a leading end and a trailing end and having an axial shaft bore extending from said trailing end to said leading end,
   at least a portion of said shaft member at said leading end being of a size to extend through the aligned openings in a clearance relationship,
   an actuating rod slidably supported in said shaft bore and being actuable from the trailing end of said shaft member,
   said shaft bore having a slotted area including an axially extending slot in radial communication with said shaft bore at the leading end of said shaft member,
   a toggle member slidably supported in said shaft bore at said slotted area and being pivotally supported for selective movement from a reclining position generally within the confines of said shaft member at said shaft bore and said slot for passage through the aligned workpiece openings from the forward surface and an upright position extending radially outwardly from said slot for engagement with the rearward surface of the rearward workpiece,
   a flexible cable having one end secured to said toggle member and an opposite end secured to said actuating rod whereby sliding reciprocating motion of said actuating rod will selectively pivot said toggle member between its reclining position and its upright position,
   said shaft member having an actuating portion intermediate its leading and trailing ends,
   an actuating member movably mounted on said actuating portion and adapted to engage the forward surface of the forward workpiece and to be axially moved on said actuating
portion to clamp the workpieces together when said toggle member is in its upright position in engagement with the rearward surface of the rearward workpiece with said actuating member in engagement with the forward surface of the forward workpiece.

2. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position.

3. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,

said toggle member having a retaining bore at said pivot axis, a ball member located in said retaining bore and being of a diameter for location within and rolling engagement with said shaft bore, said ball member supporting said toggle member for translational and pivotal movement within said shaft bore.

4. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,
said shaft member having an axially extending guide slot located in said slotted area transversely to said first slot,
said toggle member having a retaining bore at said pivot axis, a ball member located in said retaining bore and being of a diameter for location within and rolling engagement with said shaft bore, said ball member supporting said toggle member for translational and pivotal movement within said shaft bore.

5. The clamping tool of claim 1 including anti-rotation means for preventing relative rotation between said shaft member and said actuating rod while permitting relative reciprocating movement of said actuating rod within said shaft bore.

6. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,
said cable connected to said toggle member at one end along its width and at a position laterally offset from the longitudinal line extending through said pivot axis whereby pivotal movement is facilitated.

7. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,
said pivot axis being offset in one direction from the longitudinally extending center line along the width of said toggle member,
said cable connected to said toggle member at one end along its width and at a position offset from the longitudinal center line in a direction opposite from the offset of said pivot axis whereby pivotal movement is facilitated.

8. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position, said cable extending from said toggle member through said shaft bore to said actuating rod.

9. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position, said cable connected to said toggle member at one end along its width and at a position laterally offset from the longitudinal line extending through said pivot axis whereby pivotal movement is facilitated, said toggle member having an engaging surface for engaging the rearward workpiece surface with said engaging surface providing a clearance for said cable between said engaging surface and the rearward workpiece surface.

10. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and
generally transverse to the axis of said shaft bore when placed in the upright position,

said cable connected to said toggle member at one end along its width and at a position laterally offset from the longitudinal line extending through said pivot axis whereby pivotal movement is facilitated,

said toggle member having an engaging surface along its width for engaging the rearward workpiece surface and an offset position at one side of its width for providing clearance for said cable when said engaging surface is in engagement with the rearward workpiece surface.

11. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,

said cable connected to said toggle member at one end along its width and at a position laterally offset from the longitudinal line extending through said pivot axis whereby pivotal movement is facilitated,

said toggle member having an engaging surface along its width for engaging the rearward workpiece surface and an offset portion at one side of its width for providing clearance for said cable when said engaging surface is in engagement with the rearward workpiece surface,

said slot being chamfered to provide a generally smooth engagement surface for said cable and to provide clearance with said cable.

12. The clamping tool of claim 1 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and
generally transverse to the axis of said shaft bore when placed in the upright position,
said toggle member having a through bore at said pivot axis, a ball member located in said through bore and being of a diameter for location within and rolling engagement with said shaft bore, said ball member supporting said toggle member for translational and pivotal movement within said shaft bore,
a radially extending bore extending through said slot into communication with said shaft bore and being of a diameter to permit movement of said ball member therethrough for location within said shaft bore.

13. The clamping tool of claim 1 with said cable being of a flexible structure having a preselected stiffness to facilitate pivotal movement of said toggle member when actuated to apply a pushing force on said toggle member.

14. The clamping tool of claim 1 with said actuating portion being a threaded portion and with said actuating member being a nut member threadably engaged with said threaded portion for selective axial movement along said threaded portion.

15. A clamping tool for pulling together and clamping spaced apart workpieces with the workpieces having generally aligned openings and with a forward workpiece having a forward surface and a rearward workpiece having a rearward surface, said clamping tool comprising:
an elongated shaft member having a leading end and a trailing end and having an axial shaft bore extending from said trailing end to said leading end,
said leading end of said shaft member having an outer surface of a size to permit said leading end to be inserted through the aligned openings with a radial clearance,
an actuating rod slidably supported in said shaft bore and being actuable from the trailing end of said shaft member,
said shaft bore having a pair of diametrically opposed slots in radial communication with said shaft bore at the leading end of said shaft member,

a toggle member slidably supported in said shaft bore at said slotted area and being pivotally supported for selective movement from a reclining position generally within the confines of said shaft member at said shaft bore and said slots for passage through the aligned workpiece openings from the forward surface and an upright position extending radially outwardly from said slots for engagement with the rearward surface of the rearward workpiece and with the leading end of said slots whereby the clamp load is reacted through said toggle member and against the leading end of said slots,

a flexible cable having one end secured to said toggle member and an opposite end secured to said actuating rod whereby sliding reciprocating motion of said actuating rod will selectively pivot said toggle member between its reclining position and its upright position,

said shaft member having a threaded actuating portion intermediate its leading and trailing ends,

a nut member threadably mounted on said threaded portion and adapted to engage the forward surface of the forward workpiece and to be threaded on said threaded portion to clamp the workpieces together when said toggle member is in its upright position in engagement with the rearward surface of the rearward workpiece with said nut member in engagement with the forward surface of the forward workpiece,

said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse to the axis of said shaft bore when placed in the upright position,
said toggle member having a retaining bore at said pivot axis, a ball member located in said retaining bore and being of a diameter for location within and rolling engagement with said shaft bore, said ball member supporting said toggle member for translational and pivotal movement within said shaft bore.

16. A clamping tool for pulling together and clamping spaced apart workpieces with the workpieces having generally aligned openings and with a forward workpiece having a forward surface and a rearward workpiece having a rearward surface, said clamping tool comprising:

an elongated shaft member having a leading end and a trailing end,

said leading end of said shaft member having an outer surface of a size to permit said leading end to be inserted through the aligned openings with a radial clearance,

a slotted area including an axially extending through slot at the leading end of said shaft member,

a toggle member pivotally supported within said slot for selective movement from a reclining position generally within the confines of said shaft member at said slot for passage through the aligned workpiece openings from the forward surface of the forward workpiece and an upright position extending radially outwardly from said slot for engagement with the rearward surface of the rearward workpiece,

a flexible cable having a leading end secured to said toggle member and an opposite trailing end operatively connected to said shaft member and actuable from the trailing end of said shaft member whereby reciprocating motion of said flexible cable will selectively pivot said toggle member between its reclining position and its upright position.

17. The clamping tool of claim 16 with said shaft member having an axially extending retaining groove extending from said through slot generally to the trailing end of said shaft member,
said flexible cable being generally located within the confines of said retaining groove.

18. The clamping tool of claim 16 with said toggle member being pivotally secured in said through slot by an axially fixed support pin.

19. The clamping tool of claim 16 with said shaft member having an axial shaft bore extending into said leading end, said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse the axis of said shaft bore when placed in the upright position,

said toggle member having a retaining bore at said pivot axis, a support pin located in said retaining bore and being of a diameter for location within and sliding engagement with said guide slot, said support pin supporting said toggle member for translational and pivotal movement within said shaft bore and said through slot.

20. The clamping tool of claim 16 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite ends of its length and width and with said toggle member having its length generally parallel with the axis of said shaft bore when placed in the reclining position and generally transverse the axis of said shaft bore when placed in the upright position,

said toggle member having a retaining bore at said pivot axis, a ball member located in said retaining bore and being of a diameter for location within and rolling engagement with said shaft bore, said ball member supporting said toggle member for translational and pivotal movement within said shaft bore.

21. The clamping tool of claim 16 with said toggle member being of an elongated structure having a preselected length and width and a pivot axis located between opposite
ends of its length and width and with said toggle member having its length generally parallel with said through slot when placed in the reclining position and generally transverse to said through slot when placed in the upright position,

said shaft member having an axially extending guide slot located in said slotted area transversely to said through slot,

said toggle member having a retaining bore at said pivot axis, a support pin located in said retaining bore and being of a diameter for location within and sliding engagement with said guide slot, said support pin supporting said toggle member for translational and pivotal movement within said through slot.

22. The clamping tool of claim 16 with said shaft member having an actuating portion,

an actuating member movably mounted on said actuating portion and adapted to engage the forward surface of the forward workpiece and to be axially moved on said actuating portion to clamp the workpieces together when said toggle member is in its upright position in engagement with the rearward surface of the rearward workpiece with said actuating member in engagement with the forward surface of the forward workpiece.

23. The clamping tool of claim 16 with said shaft member having a threaded section,

a nut member threadably mounted on said threaded section and adapted to engage the forward surface of the forward workpiece and to be axially advanced on said threaded section to clamp the workpieces together when said toggle member is in its upright position in engagement with the rearward surface of the rearward workpiece with said actuating member in engagement with the forward surface of the forward workpiece,

said nut member having a through bore with a threaded portion at one end of said through bore for threadably engaging said threaded section and an enlarged counterbore.
at the opposite end of said through bore providing clearance with said threaded section whereby said nut member can be threadably applied to said threaded section from either said threaded section or said opposite end to accommodate use of said clamping tool with workpieces having a total thickness varying over a significant range.