

A Clamping Device

Background and Field of the Invention

5 The invention relates to a clamping device.

It is common to use a support structure for supporting or holding objects for display or storage. An example of a support structure is an extendable pipe assembly having an inner pipe slidably movable within an outer pipe to adjust
10 the effective length of the pipe assembly. With an end of the outer pipe rested on the ground, the inner pipe may be extended to contact a ceiling and the relative movement of the pipe assembly locked in place. Clamping devices may then be attached to the pipe assembly (i.e. along the inner or outer pipes) and the clamping devices further include attachment members for attaching to the
15 objects for displaying or holding to the objects etc.

Existing clamping devices do not clamp well to the pipe assembly, especially when used with a pipe assembly having a varying diameter or thickness.

20 It is an object of this invention to provide a clamping device which addresses at least one of the prior art disadvantages and/or to provide the public with a useful choice.

Summary of the Invention

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In a first aspect of the present invention, there is provided a clamping device for clamping to a support structure, comprising first and second clamping jaws movable linearly relative to each other for clamping or unclamping from the support structure; a rotatable handle for controlling the relative linear movement
30 of the first and second clamping jaws; and a translation mechanism configured to translate the rotation of the handle into the respective linear movements of the first and second clamping jaws.

The described embodiment has an advantage of achieving a more effective clamping action.

Preferably, the handle is removable, and this may be done after the clamping
5 device is clamped to the support structure for safety reasons. The clamping device may comprise a first interface connector arranged to replace the handle and configured to be coupled to the translation mechanism for supporting an article.

10 The term "article" is used in a broad sense to mean any item and this may include books, furniture, items for display, and even support plates for such items or objects to be placed thereon.

Preferably, the first interface connector may include a cross channel or an
15 elongate channel for coupling to matching connectors.

The clamping device may further comprise second and third interface connectors coupled to respective outward portions of the clamping jaws, the second and third interface connectors being arranged to support an article. The
20 second and third interface connectors may include a cross channel or an elongate channel for coupling to matching connectors.

Each of the first and second clamping jaws may include an engagement slot for engaging connectors to enable at least one article to be coupled to the clamping
25 device.

Preferably, the translation mechanism may include a threaded screw arranged to be detachably coupled to the handle; a connecting block arranged to be slidably coupled to the first and second clamping jaws; a translation block
30 arranged between the first and second clamping jaws and threadedly coupled to the threaded screw, the translation block including sliding channels to enable the clamping jaws to move linearly with respect to the connecting block.

The translation block may be arranged to move along a linear axis of movement which is orthogonal to the linear movement axis of the first and second clamping jaws. Preferably, the translation block may have an arcuate abutment surface for engaging the support structure.

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The clamping device may further comprise an engagement block threadedly coupled to the threaded screw, the engagement block being arranged to cooperate with the first and second clamping jaws for clamping to the support structure. The engagement block may be arranged to move along a linear axis
10 of movement which is orthogonal to the linear movement axis of the first and second clamping jaws. The engagement block may have an arcuate abutment surface for engaging the support structure.

Advantageously, each of the first and second clamping devices may include a
15 concave clamping surface, and inner and outer planar portions at sides of the concave clamping surface, the outer planar portion including a channel for engaging with a part of the support structure.

The clamping device may include the article, and the article may be a support
20 member for supporting objects for display. Alternatively, the article may include a connector attached to an object in order for the object to be mounted to the support structure.

The clamping device may form part of a support apparatus which forms a
25 second aspect of the invention in which there is provided a support apparatus comprising a plurality of support structures for supporting articles for display; and at least one clamping device according to any preceding claim, the clamping device being clamped to one of the support structures for supporting support members for carrying the articles.

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It should be appreciated that features relevant to one aspect may also be relevant to the other aspects.

Brief Description of the Drawings

Exemplary embodiments of the invention will now be described with reference
5 to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of an apparatus for supporting
objects including three support structures and a number of clamping devices
according to preferred embodiments of the invention;

10 Figure 2 is a close-up view of portion AA of Figure 1 to illustrate one of
the first clamping devices, namely a third clamping device;

Figure 3 is a top perspective view of the third clamping device of Figure
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Figure 4 is a bottom perspective view of the third clamping device of
15 Figure 3;

Figure 5 is an exploded unassembled view of the third clamping device
of Figure 4;

Figure 6 is a cross-sectional view of a handle and a threaded screw of
the third clamping device of Figure 5;

20 Figure 7 is a cross-sectional view of a translation block, an engagement
block, and first and second clamping jaws of the third clamping device of Figure
5;

Figure 8a is a bottom plan view of the third clamping device of Figure 4
showing the third clamping device in an open position, Figure 8b is an end view
25 of the third clamping device of Figure 8a, and Figure 8c is a cross sectional
view of the third clamping device of Figure 8b in the direction B-B;

Figure 9a is a view of the clamping device of Figure 8a but with the
clamping jaws partially closed, and Figure 9b is a corresponding view of the
clamping device of Figure 9a but shown in cross-section similar to Figure 8c;

30 Figure 10a is a view of the clamping device of Figures 8a and 9a but with
the clamping jaws fully closed, Figure 10b is a corresponding view of the
clamping device of Figure 10a but shown in cross-section similar to Figure 8c;

Figure 11 is a perspective view of the clamping device of Figure 4 to illustrate that a handle of the clamping device is removable;

Figure 12 is a perspective view of the clamping device of Figure 11 to illustrate that with the removal of the handle how an interface connector can be
5 mounted in its place:

Figure 13 is a perspective view of the clamping device of Figure 12 to illustrate the clamping device after the interface connector is mounted;

Figures 14 and 15 illustrate variations of the clamping device of Figure 4;

Figure 16 is a duplicate view of the apparatus of Figure 1, but with
10 another portion EE highlighted;

Figure 17 is a close-up view of the portion EE of Figure 16 to illustrate a seventh clamping device more clearly, which is another embodiment of a clamping device;

Figure 18 is an enlarged perspective view of the seventh clamping
15 device of Figure 17 from one direction;

Figure 19 shows the seventh clamping device of Figure 18 from another direction;

Figure 20 is an exploded unassembled view of the seventh clamping device of Figures 18 and 19 to show the various parts;

Figure 21 is a cross sectional view of the seventh clamping device of
20 Figure 20;

Figure 22a is a plan view of the seventh clamping device of Figure 18 showing the seventh clamping device in an open position, Figure 22b is an end view of the seventh clamping device of Figure 22a, and Figure 22c is a cross
25 sectional view of the seventh clamping device of Figure 22b in the direction F-F;

Figure 23a is a view of the seventh clamping device of Figure 22a but with the device clamping jaws partially closed, and Figure 23b is a corresponding view of the clamping device of Figure 23a but shown in cross-section similar to Figure 22c;

Figure 24a is a view of the seventh clamping device of Figures 22a and
30 23a but with the device clamping jaws fully closed, Figure 24b is a corresponding view of the clamping device of Figure 24a but shown in cross-section similar to Figure 22c;

Figure 25 is a perspective view of the seventh clamping device of Figure 18 to illustrate that a handle of the clamping device is removable;

Figure 26 illustrates how variant interface connectors of Figure 14 may be coupled to device interface connectors of the seventh clamping device of Figure 25; and

Figure 27 shows the clamping device of Figure 12 but with a slightly modified interface connector mounted in place of the handle.

Detailed Description of Preferred Embodiments

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Figure 1 is a schematic perspective view of a support apparatus 1000 having first, second and third support structures 1100,1200,1300 and a number of clamping devices including first, second, third, fourth, fifth, sixth and seventh clamping devices 100,200,300,400,500,600,700.

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Each of the first, second and third support structures 1100,1200,1300 includes telescopic support members 1102,1104,1202,1204,1302,1304 and respective locking mechanisms 1106,1206,1306 for locking the respective positions of the telescopic support members 1102,104,1202,1204,1302,1304. The clamping devices 100,200,300,400,500,600 are configured to be clamped to respective parts of the support structures 1100,1200,1300 and to enable objects or articles to be attached to the clamping devices 100,200,300,400,500,600.

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Specifically, in this embodiment, the first, second, third and fourth clamping devices 100,200,300,400 are arranged to support respective rods 1400,1402 in horizontal positions between the first and second support structures 1100,1200, and the third and fourth clamping devices 300,400 are also arranged to support an upright banner 1404 together with the fifth and sixth clamping devices 500,600.

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It should be mentioned that the first to sixth clamping devices 100,200,300,400,500,600 are structurally similar whereas the seventh clamping

device 500 is structurally slightly different from the rest and the structures of these clamping devices will be explained next.

Figure 2 is a close-up view of portion AA of Figure 1 to show the third clamping device 300 more clearly and it should be appreciated that the description below on the third clamping device 300 is also applicable for the first, second, fourth, fifth and sixth clamping devices 100,200,400,500,600.

Figure 3 is an enlarged top perspective view of the third clamping device 300 of Figure 2, and Figure 4 is a bottom perspective view of the third clamping device 300 of Figure 3. The third clamping device 300 includes a rotatable handle 302 for opening or closing first and second clamping jaws 304,306. Figure 5 is an exploded unassembled view of the third clamping device 300 of Figure 4 to show the various components of the third clamping device 300.

The third clamping device 300 includes a translation mechanism 308 having a threaded screw 310, a translation block 312 and an engagement block 314. The threaded screw 310 includes a threaded head section 316 for attaching to the handle 302 and a generally cylindrical shank body 318 attached to the head section 316.

The head section 316 has two opposing flat portions 316a and threaded sides 316b with the flat portions 316a arranged to be received in a slot 302a of the handle 302. The handle 302 includes an elongate rotatable arm 302b which may be grasped by a user's hand for rotating the arm 302b and a neck 302c. Figure 6 shows a cross-sectional view of the threaded screw 310 and the handle 302 and it should be apparent that the handle 302 also includes a screw head engagement channel 302d at the neck 302c arranged to receive the head section 316 in order for the head section 316 to fit snugly in the slot 302a. In this way, when the rotatable arm 302b of handle 302 is rotated, this rotates the threaded screw 316 via the head section 316. It should be appreciated that rotation of the handle 302 would drive the shank body 318 of the threaded screw 316 through the engagement block 314 as will be explained below.

The translation mechanism 308 also includes a connecting member 320 for coupling to the first and second clamping jaws 304,306. The connecting member 320 has a generally flat and planar connecting member body 322 having a central opening 324 and two first jaw engagement lugs 326,328 arranged at one end of the connecting member body 322 and two second jaw engagement lugs 330,332 arranged at another end of the connecting member body 322.

Each of the first and second clamping jaws 304,306 comprises a clamping portion 334,336 having a generally concave or arcuate clamping surface 338,340 and an interface connector 342,344 at the back of the clamping surface 338,340. The interface connectors 342,344 enable objects or articles to be connected thereto and in this embodiment, the interface connectors 342,344 include a cross channel 346,348 (see also Figure 3) for attaching to matching connectors from other objects. The cross channel 346,348 is "sunken in" and defined by four raised quadrants 346a,348a.

It should be appreciated that from a plan view of the interface connectors 342,344, the design of the interface connectors look like a "poppy flower" and thus, the interface connectors 342,344 may also be called "poppy slots". Indeed, in this preferred embodiment, the interface connectors 342,344 may have standard dimensions so that the industry may easily know what type of connectors can fit the interface connectors 342,344. The plan view of one of the interface connectors 342 may be seen from Figure 8b which has the following preferred dimensions:

- $W_{(\text{channel})}$ – width of the cross channels 346,348 = 10.25mm
- $W_{(\text{connector})}$ – edge to edge width of the interface connector 342 = 29mm
- $\text{Arc}_{(\text{connector})}$ – diameter of each of the four arcs along the edges of the interface connector = 5.5mm
- CCir – diameter of the centre aperture of the interface connector = 10mm (but this may vary according to screw size)

- $Cir_{(Connector)}$ – diameter of curved corners of the interface connector as measured from the centre aperture = 35mm
- $T_{(connector)}$ – thickness of the quadrants 346a of the interface connector = 4.5mm

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From Figure 8a, it should also be easily appreciated that the interface connector 342 is raised and spaced from the clamping portion 334 by a stub member 342a (and likewise for the other interface connector 344 which also has a stub member 344a). The stub member 342a has an edge to edge width of 21mm and also with curved corners with a diameter of 27mm from a centre of the stub member 342a and compared with the dimensions of the interface connector 342,344 above, it should be appreciated that the stub member 342a,344a is smaller in size.

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15 With these dimensions, it makes easier for the industry to know what connectors would match with the interface connectors 342a,344a.

Each of the first and second clamping jaws 304,306 also includes a coupling portion 350,352 which joins the clamping portion 334,336. Each of the coupling portions 350,352 includes an inner side 350a,352a, an outer side 350b,352b arranged opposite the inner side 350a,352a, a top side 350c,352c and first and second side portions 350d,350e,352d,352e.

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At the top sides 350c,352c of the coupling portions 350,352 of the first and second clamping jaws 304,306, there are respective first jaw engagement grooves 354,356 and second jaw engagement grooves 358,360 for engaging respective first jaw engagement lugs 326,328 and the second jaw engagement lugs 330,332 of the connecting member 320. In this way, the first and second clamping jaws 304,306 are coupled to the connecting member 320 and slidable between open and close positions, and the engagements may be observed from Figures 3 and 4.

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The third clamping device 300 further includes an engagement receptacle 362,364 disposed at each of the coupling portions 350,352 accessible via the outer sides 350b,352b of the coupling portions 350,352 with the engagement receptacles 362,364 arranged to receive matching connectors for objects to be attached to the third clamping device 300 via the engagement receptacles 362,364. The third clamping device 300 further includes two knurled head screws 365,367 which are inserted via respective knurled head screw channels 365a,367a (see Figure 3) accessible via the corresponding second side portions 350e,352e of the coupling portions 350,352. The two knurled head screws 365,367 are used to abut against matching connectors in order to hold the matching connectors

The third clamping device 300 also includes two locking nut sets 366,368 with each locking nut set 366,368 having a sealing member 366a,368a, a locking nut biasing spring 366b,368b and a locking member 366c,368c. The locking member 366c,368c has a hemispheric base 366d,368d, a hemispheric finger member 366e,368e and an interface member 366f,368f substantially narrower or smaller than the size of the hemispheric base 366d,368d. Part of the locking nut set 366,368 is arranged to be received in respective locking nut channels 366g,368g with the finger member 366e,368e protruding out of the locking nut channels 366g,368g and the sealing member 366a,368a sealing the corresponding locking channel 366g,368g (see Figures 3 and 4). In a resting position, the base member 366d,368d of the locking member 366c,368c blocks a part of the engagement receptacles 362,364 to prevent the matching connectors to be inserted into the engagement receptacles 362,364. To allow the matching connector to be inserted into the engagement receptacle 362,364, the finger member 366e,368e is depressed which biases the base 366d,368d against the locking nut biasing spring 366b,368b so that the interface member 366f,368f (being smaller) is in registration with the engagement receptacle 362,364 which creates a clear passage in the engagement receptacles 362,364 for the matching connector to be inserted therein. The force on the finger member 366e,368e may then be released for the biasing spring 366b,368b to bias the base 366d,368d to engage the matching connector. Further, the

knurled head screw 365,367 is threaded through the respective knurled head screw channel 365a,367a to abut against the matching connectors in order to securely hold the matching connectors in the engagement receptacles 362,364.

5 The translation block 312 of the translation mechanism 308 includes two elongate sliding channels 312a,312b at sides 312c of the translation block 312 with the sliding channels 312a,312b slightly inclined with respect to a horizontal axis of the translation block 312. At a top surface 312d of the translation block 312, there is a threaded through hole 312e which runs through to a bottom
10 surface 312f of the translation block 312, and this may be seen more clearly from Figure 7, which is a cross-sectional view of the translation block 312, the first and second clamping jaws 304,306 and the engagement block 314.

Each inner side 350a,352a of the coupling portions 350,352 includes two
15 identical curved shoulders 350f,350g,352f,352g defining a gap 350h,352h to receive respective ends 312g,312h of the translation block 312. Each of the first side portion 350d,352d of the coupling portions 350,352 includes a sliding pin through hole 350i,352i which extends across both shoulders 350f,350g,352f,352g. The sliding pin through holes 350i,352i are arranged in
20 registration with the respective sliding channels 312a,312b and a sliding pin 350j,352j is arranged to be inserted into each sliding pin through hole 350i,352i and through the corresponding sliding channel 312a,312b so that the sliding pin 350j,352j is slidable along the sliding channel 312a,312b.

25 The third clamping device 300 also includes translation block biasing springs 370,372 arranged between the inner sides 350a,352a of the coupling portions 350,352 and arranged to create a compression force when the clamping jaws 304,306 are caused to move toward each other.

30 When assembled, the shank body 318 of the threaded screw 310 is inserted (and rotated if necessary) through a spacer 374, the central opening 324 of the connecting member 320, the threaded through hole 312e, an engagement block threaded hole 314a of the engagement block 314 and eventually to an end ring

376. The engagement block 314 further includes a curved abutment surface 314b which is arranged to cooperate with the clamping surfaces 338,340 for clamping securely to the second support structure 1200.

5 An operation of the third clamping device will now be described with reference to Figures 8a, 8b, 8c, 9a, 9b, 10a and 10b. Figure 8a is a bottom plan view of the third clamping device 300 of Figure 4 which shows the third clamping device 300 in an open position i.e. with the clamping jaws 304,306 fully open and the sliding pins 350j,352j are at outer positions of the sliding channels 312a,312b.

10 When the handle 302 is rotated in one direction (say clockwise), this rotates the threaded screw 310 and causes the threaded screw 310 to withdraw into the engagement block 314 or the other way of looking at it, is that the engagement block 314 is being urged outwardly. At the same time, the sliding pins 350j,352j travel inwardly along the sliding channels 312a,312b to cause the first and

15 second clamping jaws 304,306 to move closer to each other. In this way, rotation of the handle 302 is translated by the translation mechanism 308 to a linear movement of the clamping jaws 304,306. As it can be appreciated, both clamping jaws move or slide (with respect to the connecting member 320) at the same time or simultaneously.

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It should be explained that the movement of the clamping jaws 304,306 towards or away from each other are in a linear movement i.e. the clamping jaws have a linear axis of movement. To elaborate, Figure 8b is an end view of the third clamping device 300 of Figure 8a, and Figure 8c is a cross sectional view of the

25 third clamping device 300 of Figure 8b along the lines B-B. Figure 8c also illustrates a first longitudinal axis CC of the first clamping jaw 304 and a second longitudinal axis DD of the second clamping jaw 306 and during the linear movement, the first and second longitudinal axes CC,DD are parallel to each other (unlike pivoting clamps in which the clamps move across a circular axis).

30 In other words, the entire first and second clamping jaws 304,306 move the same distance linearly, towards or away from each other, and are symmetrical to each other at a centre axis of the clamping device 300.

Figures 9a and 9b show the third clamping device 300 in a partially closed position with the first and third clamping jaws 304,306 (and similarly the axes CC,DD) closer to each other than that shown in Figures 8a and 8c. It should also be apparent from Figure 9b that the sliding pin 350j,352j has moved along
5 the respective sliding channel 312a,312b to an intermediate position.

Figures 10a and 10b shows what happens when the handle 302 is further rotated in the clockwise direction i.e. when the third clamping device 300 is fully closed. It should be appreciated that the further rotation of the handle 302 is
10 being translated into further linear movements of the clamping jaws 304,306 towards each other until the inner sides 350a,352a almost touch each other, and the movement is limited by the end ring 376 engaging a part of the engagement block threaded hole 314a of the engagement block 314 which prevents further movement inwards of the clamping jaws. The sliding pins
15 350j,352j are at the innermost positions of the sliding channels 312a,312b. It should be apparent also that between the movements of the clamping device 300 illustrated in Figures 8a,9a and 10a, the third clamping device 300 may be adapted to clamp to various sizes of support structures 1200 and when the third clamping device 300 is securely clamped to the support structure 1200, the user
20 may stop the rotation of the handle 302 and due to the threaded screw 310, the clamping jaws 304,306 are positively held at that position.

From Figures 10a and 10b, it should be easily appreciated that the curvature of the first and second clamping jaws 304,306 and the engagement block 314
25 cooperate to define a generally circular shape which is most suitable for clamping to cylindrical support structures such as that shown in Figure 1. It should be appreciated, however, the shape of the first and second clamping jaws 304,306 and the engagement block 314 may be modified to adapt to different size and shape of support structures.

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If the handle 302 is rotated the other way (counter-clockwise), this would open the first and second clamping jaws 304,306 (and the engagement block 314)

from the closed position illustrated in Figure 10a to the intermediate position of Figure 9a and eventually to the open position of Figure 8a.

It should be mentioned that with the clamping jaws 304,306 (or the entire
5 clamping jaws 304,306) moving linearly, this provides a better clamping action or grip to the support structure 1200 and the clamping device 300 is more flexible to be used with support structures of varying diameters/thicknesses. This also allows the third clamping device 300 to support heavier objects or articles. Also, with the engagement block 314 being moved to cooperate with
10 the first and second clamping jaws 304,306 a much more effective clamping action may be achieved. Indeed, it should also be appreciated that the movement of the engagement block 314 is orthogonal to the axis of movement of the clamping jaws and similarly in a linear movement too. This can be seen from Figure 9a which shows a third longitudinal axis EE of the engagement
15 block 314 in relation to the first and second longitudinal axes CC,DD of the first and second clamping jaws 304,306.

When the third clamping device 300 is clamped to a suitable position of the support structure 1200, the interface connector 342,344 may be coupled to
20 matching connectors to mount or support articles or objects and with reference to Figure 1, that's how the (upper) rod 1400 is supported at one end by the third clamping device 300 and at the same time, the clamping device 300 also supports the upright banner 1404 via the two interface connectors 342,344.

25 Another feature of the third clamping device 300 is that the handle 302 is removable from the threaded screw 310 (by disengaging the head section 316a from the slot 302a of the handle 302) and replaced by a further interface connector (for example, the third interface connector 378 and it should also be apparent that other types of connectors may be used) arranged over the head
30 section 316 and which is mounted to the connecting member 320 using screws 380. In this way, further objects or articles may be mounted to the third clamping device 300 which increases the usefulness of the third clamping device 300. The ability to remove the handle 302 is also a safety feature since

this prevents any mischief or accidental turning of the handle 302 which may cause the third clamping device 300 to be unclamped from the support structure 1200 and cause the upper rod 1400 or the upright banner 1404 to drop.

5 The third clamping device 300 may also be equipped with different interface connectors and this is shown in Figure 14 which illustrates a variant clamping device 800 which is similar to the third clamping device 300 of Figures 3 and 4, except that the variant clamping device 800 includes variant interface connectors 802,804 which are generally round and has an elongate channel
10 806 with a number of mounting holes 808. This allows other types of matching connectors to be used with the variant clamping device 800 which makes the clamping device much more flexible. It should also be appreciated that the interface connectors 342,344 of the third clamping device 300 are screwed onto the clamping jaws 304,306 which means that the interface connectors 342,344
15 are easily attached with the variant interface connectors 802,804, and this also means that the third clamping device 300 may be easily adapted to become the variant clamping device 800. Similar to the third clamping device 300, the variant clamping device 800 has a handle 808 which is removable and Figure 15 shows the variant clamping device 800 with its handle 808 replaced by
20 another variant interface connector 810.

Figure 16 is a duplicate view of the apparatus 1000 of Figure 1, and Figure 17 is a close-up view of a portion EE of Figure 16 to show the seventh clamping device 700 more clearly and this relates to a second embodiment of the
25 invention.

From Figure 17, it can be seen that the third support structure 1300 of the apparatus 1000 includes an extension pipe 1406 mounted horizontally with respect to the third support structure 1300 via the fifth clamping device 500 (via
30 one of the interface connectors similar to the ones described for the third clamping device 300). The seventh clamping device 700 is clamped to the extension pipe 1406 and arranged to be attached to two support plates 1408,1410 in order for objects or articles to be placed on the support plates

1408,1401. For example, the support plates 1408,1410 may be used to support products for display, sale or exhibition.

Figure 18 is an enlarged perspective view from one side of the seventh clamping device 700 of Figure 17, and Figure 19 is an enlarged perspective view from another side of the seventh clamping device 700 of Figure 17. Figure 20 is an exploded unassembled view of the seventh clamping device 700 of Figure 18 or 19 to show the various components of the third clamping device 300.

The working principles of the seventh clamping device 700 are similar to the third clamping device 300 described earlier and thus only the differences will be elaborated.

The seventh clamping device 700 includes a device rotatable handle 702 for opening and closing first and second device clamping jaws 704,706. The seventh clamping device 700 also includes a device translation mechanism 708 having a device threaded screw 710 and a device translation block 712 (and it should be appreciated that the seventh clamping device 700 does not have the engagement block 314 of the third clamping device 300). The device threaded screw 710 includes a threaded device head section 716 for attaching to the device rotatable handle 702 and a generally cylindrical device shank body 718 attached to the device head section 716. The working principle of the device threaded screw 710 is very similar to the threaded screw 310 of the third clamping device 300.

Instead of an elongate rotatable arm 302b of the third clamping device 300, the handle 702 of the seventh clamping device 700 includes a knob 702b which may be turned by a user's hand, and a neck 702c. Figure 21 shows a cross-sectional view of the exploded arrangement of Figure 20, and it should be threaded screw 310 and the handle 302 and it should be apparent that the connections between the device threaded screw 710 and the handle 702 are similar to the third clamping device 300.

The device translation mechanism 708 also includes a device connecting member 720 structurally similar, but square shape, to the connecting member 320 of the third clamping device 300 for coupling to the first and second device clamping jaws 704,706. Connection between the device connecting member 720 and the device clamping jaws 704,706 is similar to what is described earlier for the third clamping device 300.

Each of the first and second device clamping jaws 704,706 comprises a device clamping portion 734,736 having a generally concave or arcuate device clamping surface 738,740 and inner and outer flat portions 731,733,735,737 at each side of the curved device clamping surface 738,740. The outer flat portion 733,737 of the device clamping portion 734,736 includes a horizontal channel 741,743 with a slight step which is used for engaging support structures or rods which have a square or rectangular diameter. This is to achieve a better clamping action. In other words, the device clamping portion 734,736 is adapted to be clamped to round or rectangular support structures since the seventh clamping device 700 has the curved device clamping surface 738,740 as well as the flat portions 731,733,735,737.

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At the back of the device clamping portions 734,736, the seventh clamping includes a device interface connector 742,744 and it should be mentioned that the device interface connectors 742,744 are similar to the interface connectors 342,344 of the third clamping device 300.

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Each of the first and second device clamping jaws 704,706 also includes a device coupling portion 750,752 which joins the clamping portions 734,736. The device coupling portions 750,752 includes first jaw device engagement grooves 754,756 (see Figure 18) and second jaw device engagement grooves 758,760 for engaging respective first jaw device engagement lugs 726,728 and the second jaw device engagement lugs 730,732 of the device connecting member 720 in order for the first and second device clamping jaws 704,706 to be slidably coupled to the device connecting member 720. However, unlike the

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third clamping device 300, the device coupling portions 750,752 do not have the engagement receptacles 362,364 nor the knurled head screws 365,367 of the third clamping device.

5 The device translation block 712 of the seventh clamping device 700 functions in a similar way as the translation block 312 of the third clamping device 300 and the device translation block 712 also includes two elongate device sliding channels 712a,712b at sides 712c of the translation block 712. The device coupling portions 750,752 include spaced apart shoulder members
10 750f,750g,752f,752g with each pair defining a device gap 750h,752h to receive respective ends 712g,712h of the translation block 712. Near a centre, the device translation block 712 further includes a curved device abutment surface 712d (see Figure 21) which is arranged to cooperate with the device clamping surface 738,740 for clamping securely to the extension pipe 1406.

15 Assembly of the device translation block 712, the device connecting member 720 and the first and second clamping jaws 704,706 are similar to those of the third clamping device 300, using device sliding pins 750j,752j arranged into device sliding pin through holes 750i,752i and through the respective elongate
20 device sliding channels 712a,712b. Similar to the third clamping device 300, there are device translation block biasing springs 770,772 arranged between the coupling portions 750,752 of the clamping jaws 704,706. The device threaded screw 710 is inserted through the device connecting member 720 and the device translation block 712 and eventually to a device end ring 776 (but
25 there is no engagement block 314 of the third clamping device 300).

An operation of the seventh clamping device is shown in Figures 22a,22b,22c,23a,23b,24a,24b, and Figure 22a shows the seventh clamping device 700 in an open position and the first device clamping jaw 704 includes a
30 first device longitudinal axis GG and the second device clamping jaw 706 includes a second device longitudinal axis HH and in response to the rotation of the handle 702, the first and second clamping jaws 704,706 are arranged to move linearly towards each other. The operation of the seventh clamping device

700 is similar to the operation of the third clamping device and the rotation of the handle 702 retracts the device threaded screw 710 outwardly of the device translation block 712 and this is shown in Figures 23a and 23b, which shows the seventh clamping device 700 in a partially closed position. In this partially closed position, it should be appreciated that the device translation block 712 slightly protrudes outwardly compared to the position of Figure 22c and the movement of the translation block 712 (refer to the horizontal axis JJ) is also linear in a direction which is substantially orthogonal to the direction of the first and second device longitudinal axes GG,HH. It can be appreciated that in the seventh clamping device 700, the translation block 712 performs the function of the translation block 312 and the engagement block 314 of the third clamping device 300. Figures 24a and 24b show the seventh clamping device 700 in a fully closed position and with the device translation block 712 protruded outwards more than that shown in Figure 23b.

Similar to the flexibility of the third clamping device 300, the seventh clamping device 700 may also be adapted to clamp to various sizes of support structures 1300 (including the extension pipe 1406), be it circular to rectangular cross-sections. With the seventh clamping device 700 securely clamped to the extension pipe 1406, the support plates 1408,1410 are arranged to be connected to the seventh clamping device 700 via the respective device interface connectors 742,744. The linear movement of the device clamping jaws 704,706 (and the device translation block 712), this achieves a better clamping action. In addition, further objects or articles may be mounted to the seventh clamping device via the device interface connectors 742,744. Figure 25 shows that the handle 702 of the seventh clamping device 700 is removable and this is a safety feature to reduce mishaps or accidents associated with the performance of this product i.e. without the handle 702, it wouldn't be possible to unclamp the device clamping jaws 704,706 so the seventh clamping device 700 may remain securely clamped to the extension pipe 1406. Also, Figure 26 illustrates how the device interface connectors 742,744 of the seventh clamping device 700 is adapted to fit with other types of connectors such as that used by the variant clamping device 800 of Figure 14. Figure 26 shows the seventh

clamping device of Figure 25 with the variant interface connectors 802,804 of the variant clamping device 800 slotted to the device interface connectors 742,744 to allow objects to be attached to the variant interface connectors 802,804, instead of the device interface connectors 742,744.

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With the described embodiments, the clamping devices 300,700 are configured with the clamping jaws 304,306,704,706 to move in a linear axis of movement which enables the clamping devices 300,700 to be clamped to support structures more effectively. This also allows other objects and articles to be mounted to the clamping devices 300,700 with greater ease.

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The described embodiments should not be construed as limitative. For example, the clamping jaws 304,306 of the third clamping device 300 may have different shape or sizes in order to be clamped to corresponding shapes and sizes of the support structures. Similarly, the interface connectors 342,344 of the third clamping device may be modified accordingly to match with other types of matching connectors. The handle 302 of the third clamping device 300 may be modified accordingly and similarly for the device handle 702 of the seventh clamping device 700.

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Also, the third interface connector 378 may be adapted in a different manner depending on the size of the third clamping device 300. In the embodiment of Figure 12, the screws 380 are arranged adjacent to narrow sides of the connecting member 320 (or the connecting member body 322) and this may require some modification to the third interface connector 378. However, the screws 380 (and corresponding screw holes 381) may be relocated to be at the wider portion of the connecting member 320 such as that shown in Figure 27, which has the three parts labeled as screws 380', screw holes 381' and the third interface connector 378' to differentiate from these components of Figure 12.

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It should be appreciated that the third and seventh clamping devices 300,700 are very flexible since the interface connectors 342,344 (or device interface connectors 742,744) allow objects to be mounted directly (if the objects have

the matching connectors) or may be used to mount support members (such as the support plates 1408,1410 shown in Figure 17) in order for objects to be placed on the support members.

- 5 Having now fully described the invention, it should be apparent to one of ordinary skill in the art that many modifications can be made hereto without departing from the scope as claimed.

CLAIMS

1. A clamping device for clamping to a support structure, comprising
first and second clamping jaws movable linearly relative to each other for
5 clamping or unclamping from the support structure;
a rotatable handle for controlling the relative linear movement of the first
and second clamping jaws; and
a translation mechanism configured to translate the rotation of the handle
into the respective linear movements of the first and second clamping jaws.
- 10 2. A clamping device according to claim 1, wherein the handle is
removable.
3. A clamping device according to claim 2, further comprising a first
15 interface connector arranged to replace the handle and configured to be
coupled to the translation mechanism for supporting an article.
4. A clamping device according to claim 3, wherein the first interface
connector includes a cross channel or an elongate channel for coupling to
20 matching connectors.
5. A clamping device according to any preceding claim, further comprising
second and third interface connectors coupled to respective outward portions of
the clamping jaws, the second and third interface connectors being arranged to
25 support an article.
6. A clamping device according to claim 5, wherein the second and third
interface connectors include a cross channel or an elongate channel for
coupling to matching connectors.
- 30 7. A clamping device according to any preceding claim, wherein each of the
first and second clamping jaws include an engagement slot for engaging
connectors to enable at least one article to be coupled to the clamping device.

8. A clamping device according to any preceding claim, wherein the translation mechanism includes a threaded screw arranged to be detachably coupled to the handle;

5 a connecting block arranged to be slidably coupled to the first and second clamping jaws; and

a translation block arranged between the first and second clamping jaws and threadedly coupled to the threaded screw, the translation block including sliding channels to enable the clamping jaws to move linearly with respect to the
10 connecting block.

9. A clamping device according to claim 8, wherein the translation block is arranged to move along a linear axis of movement which is orthogonal to the linear movement axis of the first and second clamping jaws.

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10. A clamping device according to claim 9, wherein the translation block has an arcuate abutment surface for engaging the support structure.

11. A clamping device according to claim 8, further comprising an
20 engagement block threadedly coupled to the threaded screw, the engagement block being arranged to cooperate with the first and second clamping jaws for clamping to the support structure.

12. A clamping device according to claim 11, wherein the engagement block
25 is arranged to move along a linear axis of movement which is orthogonal to the linear movement axis of the first and second clamping jaws.

13. A clamping device according to claim 11 or 12, wherein the engagement block has an arcuate abutment surface for engaging the support structure.

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14. A clamping device according to any preceding claim, where each of the first and second clamping devices includes a concave clamping surface, and inner and outer planar portions at sides of the concave clamping surface, the

outer planar portion including a channel for engaging with a part of the support structure.

15. A clamping device according to any preceding claim, wherein the article
5 is a support member for supporting objects for display.

16. A clamping device according to any of claims 1 to 14, wherein the article includes a connector attached to an object in order for the object to be mounted to the support structure.

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17. A support apparatus comprising
a plurality of support structures for supporting articles for display; and
at least one clamping device according to any preceding claim, the
clamping device being clamped to one of the support structures for supporting
15 support members for carrying the articles.