

APPARATUS FOR AND A METHOD USED IN COMPRESSING A WORKPIECE**Introduction**

The present invention relates to an apparatus for compressing a workpiece. It is suitable for all sorts of applications, for example to presses for the encapsulation of semi-conductor components and injection moulding.

In most presses, a workpiece is pressed between two platens. It is known that toggles driven by hydraulic cylinders or ballscrews are used to preset the clamping position of the workpiece to be pressed, and the compressive force produced by the hydraulic cylinders or ballscrews is of a fixed magnitude that is dependent on the mechanical strength and limited displacement of the toggle. This restricts the use of each toggle-activated press to a specific workpiece type, as the toggle-activated press must be particularly configured for every workpiece specification in order to achieve the desired compressive forces from the fixed displacement provided by the toggle. However, it is known that toggles allow a fast velocity to be reached with each displacement to compression, thereby shortening each compression cycle, a useful result leading to cost savings during mass production.

Presses have also been suggested that rotate a ballscrew to perform the main movement of bringing the two parts of a mould, on two platens, together. A clamping force is then applied by a pneumatic cylinder to a nut which acts on the ball screw. Such apparatus is described in document WO 97/39873. This machine requires two modes of driver to operate. Further, the lifespan of the ballscrew tends to be short.

To vary settings such as forces significantly, for example upon the change to a different workpiece, requires either a redesign of the whole machine or other major changes. When the relevant components are buried within the apparatus, this is at best inconvenient and at worst impossible.

It is an aim of the present invention to provide some improvements over known

presses or at least useful alternatives to known presses such as both the toggle-activated and the ballscrew-activated presses.

Summary of the Invention

According to one aspect of the present invention, there is provided apparatus for compressing a workpiece, comprising:

- a first element;

- a clamping element connected to said first element and moveable relative thereto;

- connexion means operable between at least two states, a first state in which relative motion between the clamping element and said first element is permitted and a second state in which relative motion of the clamping element toward said first element is substantially prevented;

- displacement cam means for displacing the first element; and

- clamping cam means for transmitting a force to said first element, through said clamping element when said connexion means is in said second state;

- wherein activation of said displacement cam means is operable to effect movement of the first element in a first direction and activation of the clamping cam means is operable to transmit a compressing force to the first element.

Preferably, the displacement cam means and said clamping cam means are activated by a single shared drive shaft.

According to a second aspect of the present invention, there is provided a method used in compressing a workpiece comprising the steps of:

- displacing a first element in a first direction, using a first cam motion, whilst allowing relative movement between a clamping element and the first element;

- transmitting a compressing force to said first element through said clamping element, using a second cam motion, without allowing substantial relative movement of the clamping element toward the first element; wherein

- in said step of displacing a first element, the first cam motion does not act through the clamping element to displace the first element.

Preferably, said transmitting step includes the step of displacing said clamping element. The displacement of the first element in the step of displacing a first element is advantageously at least 10, 20, 30, 50, 100 or more times the displacement of the first element in the transmitting step.

According to a third aspect of the present invention, there is provided a press including apparatus of the first aspect.

The present invention also contemplates workpieces made using the above apparatus or method and products containing such workpieces.

In an embodied aspect the invention relates to an apparatus for compressing a workpiece. The apparatus has a fixed platen and a moving platen to compress a workpiece placed between the fixed platen and the moving platen. The apparatus also has a displacement actuator and a force actuator. The displacement actuator has a displacement cam releasably engaging a displacement cam-follower that is mounted in a fixed connection with the moving platen. The force actuator has a clamping cam moveably connected to a moveable clamping platen. The clamping platen has blocks depending from it which are operable to engage blocks mounted on the moving platen. Synchronised activation of the displacement actuator and the force actuator can effect high velocity of the moving platen as well as transmission of a high compressive force from the clamping platen to the moving platen to compress the workpiece between the moving platen and the fixed platen.

The present invention allows advantageous high speed ratios of displacement to compression, while providing a wide range in the compression load for flexibility of the apparatus, for use with different workpiece types. This can be achieved without the difficulty of resetting the settings that can occur in some known presses.

Description of the Drawings

The present invention will be further described by way of non-limitative example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic front view of an apparatus according to a first embodiment of the present invention;

Figures 2a-2d are schematic sectional views of the apparatus of Figure 1, through line 2-2, when the apparatus is in a first stage, a second stage, a third stage and a fourth stage respectively;

Figures 3a-3d are schematic sectional views of the apparatus of Figure 1, through line 3-3, when the apparatus is in the same first stage, second stage, third stage and fourth stage, respectively;

Figures 4a-4c are schematic sectional views of a second apparatus when the second apparatus is in a first stage, a second stage, and third stage respectively; and

Figure 5 is a schematic view of a third embodiment.

Detailed Description

The invention relates to apparatus for compressing a workpiece, with particular applications to encapsulating semi-conductor components. The apparatus may be in the form of a press module, having a fixed platen and a moving platen to compress a workpiece, for example in a mould placed between them. The press module also has a displacement actuator and a force actuator below the moving platen. Synchronised activation of the displacement actuator and the force actuator can effect high velocity of the moving platen as well as transmission of a high compressive force to the moving platen to compress the workpiece between the moving platen and the fixed platen.

Description of First Preferred Embodiment

Figure 1 shows a first preferred embodiment of the apparatus 6, with the fixed platen 10 and the moving platen 12 between which a workpiece 8 is to be compressed. In use, the fixed platen 10 is immovably positioned on four guide columns 20 (although only two can be seen in Figure 1), while the moving platen 12 is constrained to move only up or down, below the fixed platen 10 on a single axis along the guide columns 20. An upper end of a platen post 22 is fixedly connected to a crossbrace 37 which crosses between two fixed blocks 39. These fixed blocks are mounted on the underside of the moving platen 12. Thus the platen post 22, the fixed blocks 39 and the moving platen 12 move up and down together.

A displacement actuator 14, connected to a motor 24 by a drive shaft 26, drives the main displacement of the moving platen 12. The displacement actuator 14 comprises a displacement cam 114 mounted on the drive shaft 26 and a displacement cam-follower 214. The displacement cam-follower 214 is mounted on the lower end of the platen post 22, and releasably engages the displacement cam 114 in rolling contact when the displacement cam 114 is rotated. The displacement cam 114 is in the form of a disc where the geometric centre of the disc is off-set from the centre of rotation of said disc by a predetermined distance. The displacement cam-follower 214 is a simple roller.

The displacement cam 114 shares the same axis of rotation with the drive shaft 26, which is transverse to the axis of motion of the moving platen 12. Rotation of the displacement cam 114 against the displacement cam-follower 214 results in the displacement of the platen post 22 and hence the moving platen 12. The stroke covered by the moving platen 12 is consequently a specific function of the degree of rotation and the off-set between the centre of rotation and the centre of geometry of the displacement cam 114.

A force actuator 16 also driven by the motor 24 via the drive shaft 26 and operatively connected to the moving platen 12 transmits the forces required for

compressing the workpiece 8 between the fixed platen 10 and the moving platen 12. The force actuator comprises: a clamping platen 18 that is located below the moving platen 12, two clamping cams 116 mounted on the drive shaft 26, and two clamping cam-followers 216 that link the clamping cams 116 with the clamping platen 18.

Connexion means in the form of two moveable blocks 38 that are moveably mounted on the topside of the clamping platen 18, two pneumatic cylinder block actuators 138 that operate the moveable blocks 38 and the two fixed blocks 39 operatively link the clamping platen 18 and the moving platen 12. The clamping platen 18 is similarly constrained by the guide columns 20 to have the same up-and-down motion path as the moving platen 12. The use of two clamping cams 116 and two clamping cam-followers 216 achieves a relatively even force distribution by placing them one on each side of the displacement actuator 14.

Each clamping cam 116 is a disc with its geometric centre off-set from its centre of rotation by a predetermined distance. The clamping cams 116 share the same axis of rotation as the drive shaft 26. Each clamping cam-follower 216 acts as a linkage rod that converts the rotary motion of the clamping cams 116 into the up-and-down motion of the clamping platen 18. The lower end of each clamping cam-follower 216 has a hole in it containing a roller bearing 30 within which the clamping cam 116 is fitted and can rotate freely. The upper end of each clamping cam-follower 216 is pivotably connected to the clamping platen 18 by a pivot 32, such that the clamping cam-follower 216 is free to pivot on an axis transverse to the up-and-down path of the clamping platen 18 and parallel to that of the drive shaft 26. However, relative translational movement of each clamping cam-follower 216 with respect to the clamping platen 18 is prevented.

The assembly of the clamping cams 116 and the clamping cam-followers 216 with the clamping platen 18 results in up or down displacement of the clamping platen 18 when the clamping cams 116 are rotated. The stroke covered by the movement of the clamping platen 18 is consequently a specific function of the degree of rotation and the off-set between the centre of geometry and the centre

of rotation of the clamping cams 116.

As described earlier, the clamping platen 18 has two moveable blocks 38 on its upperside while the moving platen 12 has two fixed blocks 39 on its underside. The moveable blocks 38 each have two positions, their first positions and their second positions. The spacing and the positions of the fixed blocks 39, relative to the spacing and the positions of the moveable blocks 38, when the moveable blocks 38 are in their first positions are such that substantial relative up-and-down motion between the clamping platen 18 and moving platen 12 can occur. The distance between the moveable blocks 38 is greater than that between the fixed blocks 39, such that the fixed blocks 39 can pass between the moveable blocks 38. However, when the moveable blocks 38 are in their second positions, they are directly beneath the fixed blocks 39. The amount of possible relative up-and-down motion is therefore much less, and in some situations only a few mm. With the moveable blocks 38 in their second positions blocks 38 and 39 can engage each other such that any movement of the clamping platen 18 is directly translated to an equal movement of the moving platen 12. In this way, pressing forces can be transmitted to the moving platen 12 via the force actuator 16 in order to compress the workpiece 8.

The moveable blocks 38 are moved between their first and second positions by block actuators 138 which slide them back and forth as required, under the control of a controller. The block actuators 138 here use pneumatic cylinders.

By aligning the displacement cam 114 and the clamping cams 116 such that they share the same axis of rotation and are both mounted on the drive shaft 26, the movement of the moving platen 12 is effected by the use of a single motor 24 coupled to the one drive shaft 26. By selecting appropriate eccentricity off-sets for the displacement cam 114 and the clamping cams 116, the desired displacement and velocity profile of the moving platen 12 as a result of each actuator 14,16 can be obtained. Further, by suitably setting the relative rotational displacement between the displacement cam 114 and the clamping cams 116, the required timings for the movement of the moving platen 12 and compression of the

workpiece 8 are set.

Operation of the embodiment of the press module 6 will now be described with reference to schematic Figures 2a-2d and 3a-3d. Figures 2a-2d are nominally cross-sections through lines 2-2 Figure 1, whilst Figures 3a-3d are nominally cross-sections through lines 3-3 Figure 1. However, they all additionally show the moveable and fixed blocks 38, 39 and the block actuators 138, for ease of understanding. Additionally, they each show various reference lines so that the various changes in positions are more readily apparent.

Figures 2a-2d each show various positions of the displacement cam 114, the displacement cam follower 214, clamping platen 18, the moveable and fixed blocks 38, 39, the block actuators 138 and the moving platen 12.

An initial position of all the moveable parts can be set, as shown in Figures 2a and 3a, wherein the distance between the moving platen 12 and the fixed platen 10 is at its maximum and the distance between the moving platen 12 and the clamping platen 18 is at its maximum. In the stage shown in Figures 2a and 3a, displacement cam 114 has position 114A uppermost and clamping cams 116 have position 116A uppermost. Cam follower 214 is in contact with displacement cam position 114A and is at its lowest point in this stage. As can be seen, the displacement cam 114 is 180° out of phase with the two clamping cams 116. The moveable blocks 38 are in their first position, with no possible contact with the fixed blocks 39.

Rotation of the displacement cam 114 causes surface 114B of the displacement cam 114 to come into contact with the cam follower 214. The position and extent of this surface 114B relative to the axis of rotation causes the platen post 22, and thereby the fixed blocks 39 and the moving platen 12, to move up rapidly towards the fixed platen 10, through a first distance, such that moulds or other tools on the platens 12 and 10 both come into contact with a workpiece 8 placed between them. Since the fixed blocks 39 move up with the moving platen 12, they move up relative to the moveable blocks 38 as the relative distance between the moving

platen 12 and the clamping platen 18 increases, as shown in Figures 2b and 3b. Due to the eccentricity of the displacement cam 114 relative to surface 114B and the lack of resistance to the movement, this motion is very swift. At this stage none of the movement of the moving platen 12 is due to the clamping cams 116.

However, since clamping cams 116 and displacement cam 114 are mounted on the same drive shaft 26, the clamping cams 116 also rotate while displacement cam 114 rotates to move the platen 12 upwards. As the clamping and displacement cams are 180° out of phase, clamping cam positions 116A represent the clamping cam followers being at their highest points relative to the drive shaft 26. As drive shaft 26 rotates, surfaces 116B of the clamping cams are uppermost. These surfaces are nearer to the centre of rotation than the positions 116A are, which means that the clamping cam-followers 216 actually move downwards. They, in turn, pull the clamping platen 18 downwards, away from the moving platen 12, and maximising the relative distance between the moving platen 12 and the clamping platen 18.

At the point shown in Figures 2b and 3b, the relative distance between the moving and clamping platens 12,18 is at a maximum. At this point the moveable blocks 38 are moved into their second position directly under the fixed blocks 39 by the block actuators 138, the activation of which are synchronised with the rotation of the drive shaft 26. This leads to the positions shown in Figures 2c and 3c.

The workpiece 8 at this point is in contact with both the fixed platen 10 and the moving platen 12. As the cams 114, 116 then continue to rotate, no further upward motion of the moving platen 12 is due to the displacement cam 114, the highest part of which is now uppermost. Instead, as the clamping cam followers 216 are now at their lowest, further rotation brings surface 116C of the clamping cams 116 to the top, which now forces the clamping cam-followers 216 upwards as the clamping cams 116 continue to rotate. This forces the clamping platen 18 upwards and, through engaging the moveable blocks 38 with the fixed blocks 39, the moving platen 12 is also moved up a further second distance. Because the eccentricity of the clamping cams 16 is very slight (it is exaggerated for the

drawings), the second distance is very short. However, the clamping force applied is very strong. In one example, the clamping cams 116 have an eccentricity of 3mm, whilst the displacement cam 114 has one of 200mm.

The positions of the various components at the end of this compression (in the fourth stage) are shown in Figures 2d and 3d. As can be seen, there is, in fact, a continuation of clamping cam surface 116C, beyond the position shown in Figure 3d. The extent of rotation by the end of clamping depends on the torque applied to the drive shaft 26 or can be defined by a certain rotation of the drive shaft 26 measured by a sensor (not shown), for example an encoder. Also at this stage there is a gap between displacement cam 114 and its cam-follower 214, since the position of that cam-follower 214 depends on the position of the moving platen 12.

After the workpiece 8 has been compressed with a suitable force for a suitable duration, with the apparatus 6 in the fourth stage indicated by Figure 3d, the moving platen 12 can be moved down away from the fixed platen 10, in order for the compressed workpiece 8 to be replaced by an uncompressed workpiece. This movement is achieved by a simple reverse rotation of the motor and a reverse activation of the block actuators 138 to restore all the moveable parts back to their initial positions as shown in Figures 2a and 3a. A position sensor (not shown in the drawings) is mounted on the drive shaft 26 to send a signal to the motor when the initial position has been restored, so that the motor control programme can be reset for the start of another compression cycle.

The timing of the reverse activation of the block actuators 138 is after the reverse rotation has already begun, when the cams 114, 116 are in the position shown in Figures 2b and 3b. In that way there is no sudden release, under force, damaging parts and making noise.

Since the displacement actuator 14 is intended only to move the moving platen 12 towards the fixed platen 10 without requiring it to exert any operative compressive forces on a workpiece, in relation to the applied motor torque, the velocity achieved by using displacement cam 114 can be very high. This high velocity

when closing the distance between the platens 12,10 is desirable, since it shortens the cycle time per workpiece and leads to cost-saving in mass production processes.

At the same time, by designing a small off-set for the eccentricity of the clamping cams 116, the compressive displacement of moving platen 12 due to the force actuator 16 can be kept low. Relative to the motor torque required, a low compressive displacement of the moving platen 12 will allow a high compressive force to be transmitted to the workpiece, a result that is desirable in many applications.

The actual force transmitted to the workpiece 8 when it is being compressed is directly proportional to the eccentricity of the clamping cams 116 and the rotation of the shaft 26. By using a closed-loop torque feedback electric motor to drive the clamping cams 114, 116, the compression force of the moving platen 12 as well as the duration of compression and the platen velocities can all be controlled to suit the requirements of the workpiece 8. For higher forces, one only needs to increase the torque of the motor.

In the second preferred embodiment, the press remains largely the same as the first preferred embodiment described above with the exception of the connexion means that allow or prevent relative motion between the moving platen and the clamping platen and of the platen post.

Thus, as can be seen in Figures 4a-4c, in the second embodiment the connexion means has two foldable toggle arms 28 moveably connect the clamping platen 18 to the moving platen 12. These take the place of the moveable blocks 38, the fixed blocks 39 and the pneumatic cylinder block actuators 138 that make up the connexion means in the first embodiment. The platen post 122 now reaches all the way to the underside of the moving platen.

Figures 4a, 4b and 4c are equivalent to Figures 3a, 3b and 3d, showing the positions of the toggle arms 28 at the same positions of the cams as are shown for

the connexion means in Figures 3a, 3b and 3d. Thus they start off folded in Figure 4a. By the end of the movement of the displacement cam, they have become straight and they remain that way until the same position is reached in reverse. Once they are straight, the force from the clamping platen 18 can be transmitted through them to the moving platen 12. The forces involved and the designs of the toggle arms 28 are such that the toggle arms 28 tend to jam in their straight position, as in Figures 4b and 4c. If that happens, they do not fold as intended by Figure 4a and the press will not work as intended. Thus each toggle arm is provided with release means 128 in the form of a piston 129 and a side toggle 130 to help it fold. The piston 129 pulls the pivot of the side toggle 130, and the side toggle 130 in turn pulls the pivot of the toggle arm 28 to allow it to collapse or fold. This activation of the release means 128 is synchronised with the rotation of the drive shaft 26.

A third embodiment is shown in Figure 5, where the release means 128 acts directly on the toggle arms 28, rather than through side toggles.

In the above embodiments, the first distance is exemplified as 200mm, with the second distance only 3mm, with a motor power of 8KW producing a clamping force of 200 tonnes. The normal use range would preferably start at 10 tonnes. Innumerable other variations are possible. The first distance is preferably at least ten times the second distance. It may even be at least twenty times, thirty times, fifty times or over a hundred times.

Although the displacement cam 114 and clamping cams 116 have been described as circular discs with off-set centres of rotation, the cam profiles of these cams 114,116 are not confined to this circular configuration. They may be so designed as to effect other velocity and displacement profiles for the displacement of the moving platen 12, for example so that the displacement cam-follower 214 never, in fact, loses contact with the surface of the displacement cam 114. Other cam profiles can deliver compression forces that are other functions of the degree of rotation of the drive shaft 26.

Another possibility is to have the cams 114, 116 mounted on the drive shaft through their geometric centres, but for the shaft 26 to be provided with cranks where the cams 114,116 are mounted. This would provide the eccentricity required for the described embodiment. The different speeds and timings would be provided by the sizes and relative angles of the cranks. Cranks in the drive shaft 26 could also be combined with non-circular cams 114,116.

Additionally, it is not necessary that the displacement cam 114 and the clamping cams 116 be mounted on the same shaft. There could be two or more shafts, for instance one per cam or one for the displacement cam 114 and one for all the clamping cams 116, provided they are appropriately linked, mechanically or otherwise, e.g. to rotate at the same speed or at least at fixed relative speeds.

For ease of adjustment of the press settings, it is possible for at least the positions of the displacement cam 114 and/or the clamping cams 116 to be adjustable. In this way the gap following the initial motion of the moving platen by the displacement cam 114 can be adjusted. Similarly, it is possible to adjust at least the initial relative angles of the cams.

The bearing 30 is described as a roller bearing. It could be any other type of rotary bearing, e.g. with ball bearings. A rotary bearing is preferred because it is better able to cope with the forces involved and requires less power on behalf of the driver.

Although the above embodiments describe each cycle as a forward-back rotation, it is also possible for the press to be operated with one-directional continuous motor rotation, without having to use a reversible motor with closed-loop torque feedback. The cam shapes and motor drive speed would determine the length of time for which compression is held. In this instance, the compressive force can be altered by changing the cams, the initial positions of the cams and/or the relative angles of the cams.

The present invention has been described using an electric motor. That is not

necessary. Non-electric motors can be used, as can other means for providing the rotational movement of the cams. Linear motion can readily be transformed into the requisite rotary motion, e.g. it could be provided by an hydraulic cylinder with the appropriate linkages.

Closed-loop torque feedback with the electric motor is mentioned above. This can be replaced with other feedback systems, preferably closed-loop. For example, there could be a load-cell connected to a controller, that in turn regulates the motor or other driver.

Also, in order for the press module to work, it is not necessary for the press module to have two clamping cams 116 and two clamping cam-followers 216 as described. One of each will suffice, although two were described for providing a relatively even force distribution if they are positioned on either side of the displacement actuator 14. More may be provided if necessary. Further, the invention is not dependent on four columns 20. It would work with other means for guiding movement or only one column, two columns or three columns or more than four columns.

The blocks 38, 39 described in the first embodiment could be arranged so that the fixed blocks pass outside the moveable blocks when the latter are in their first position. Alternatively, it could be the blocks on the underside of the moving platen that are moveable, whilst those on the clamping platen would be fixed. Further, the motion does not have to be linear between the two positions. The blocks could rotate between their first and second positions. Moreover, other combinations are readily possible, such as having all blocks moveable, or even a combination of moveable blocks and holes. In their first positions, the blocks would pass through the holes in one of the platens, whilst in their second positions, they would not. Alternatively, the holes could move.

While the blocks 38, 39 and the block actuators 138, as well as the toggle arms 28 and release means 128 have been described as the means for allowing the relative motion between the moving platen 12 and the clamping platen 18, as well

as for transmitting the force through clamping platen 18 to moving platen 12, the invention may use other means to provide the same functions, such as telescoping tubes and extensible springs. The block actuators and pistons used (whether hydraulic or pneumatic) can be replaced with other mechanisms to perform the respective functions of repositioning the blocks or folding the toggle arms. Further, rather than using a separate control, a mechanical mechanism linking the angle of rotation of the shaft 26 with the activation of the block actuators 138 or the release means 128 can be easily added.

Whilst release means have been described to cause the toggle arms to fold in the second embodiment, there can as well or instead be support means to hold them in a braced position. The bracing action would have to be synchronised with the cam motion and would preferably occur once the toggle arms are straight at the point shown in Figures 2b and 3b. The same release means described above could be used as such support means.

Whilst the platen post in the first embodiment is shown as attaching to the fixed posts, it could attach to the moving platen instead, as it does in the other embodiments.

Although the locations of the various components have been described with the fixed platen 10 being topmost, followed by the moving platen 12 below it, and the displacement actuator 14 and the force actuator 16 in the lowest positions, these are all relative locations only, and the entire press module may be operated with the components being located in reverse order, or one beside the other etc., i.e., the invention could be used on its side or upside down etc., relative to the way it has been exemplified here. Also, the fixed platen 10 is considered fixed only in a broad sense of the word, and may be adjusted as desired at various positions along guide columns 20. In fact, the fixed platen 10 need not even be mounted onto guide columns 20 in order for the compression of the workpiece to be achieved, for example it could be mounted separately upon stiff springs to absorb some impact forces upon compression.

In the described embodiments, the clamping cam-followers 216 are connected to the clamping platen 18, so that there can only be angular motion therebetween. The present invention also encompasses connections that allow linear motion therebetween, for instance if the pivot 32 were provided in the base of a piston, the upper end of which can move to and away from the moving platen and, when in contact, can lift the moving platen 12 up.

Further, the clamping cam-followers 216 are described as having the clamping cams 116 mounted within them. This is preferred because of the larger forces on them during clamping; the bearing 30 allows easy relative motion. However, it does not preclude the possibility of something more akin to the displacement cam-follower 214, or other variations. Moreover, the displacement cam-follower 214 could mount the displacement cam 114 within it, in the same way as the clamping cam-followers 216 mount the clamping cams 116.

Whilst the specific embodiments and various variations have been described, the invention is not so limited. Numerous other possibilities are also contemplated or within the scope of the invention, including as defined in the appended claims.

Claims

1. Apparatus for compressing a workpiece, comprising:
 a first element;
 a clamping element connected to said first element and moveable relative thereto;
 connexion means operable between at least two states, a first state in which relative motion between the clamping element and said first element is permitted and a second state in which relative motion of the clamping element toward said first element is substantially prevented;
 displacement cam means for displacing the first element; and
 clamping cam means for transmitting a force to said first element, through said clamping element when said connexion means is in said second state;
 wherein activation of said displacement cam means is operable to effect movement of the first element in a first direction and activation of the clamping cam means is operable to transmit a compressing force to the first element.
2. Apparatus according to claim 1, wherein the displacement cam means and said clamping cam means are activated by drive shaft means.
3. Apparatus according to claim 2, wherein said drive shaft means comprises a single shared drive shaft.
4. Apparatus according to any one of claims 1 to 3, wherein the displacement cam means comprises a displacement cam and a displacement cam-follower that releasably engages the displacement cam and engages the first element.
5. Apparatus according to claim 4 when dependent on at least claim 2, wherein said displacement cam is mounted on said drive shaft means.



6. Apparatus according to claim 5, wherein an axis of rotation of the drive shaft means passes through the centre of rotation of the displacement cam.
7. Apparatus according to any one of claims 4 to 6, wherein said displacement cam is circular, with its centre of rotation offset from its geometric centre.
8. Apparatus according to any one of claims 4 to 7, wherein the displacement cam-follower is connected to the first element.
9. Apparatus according to any one of the preceding claims, wherein the clamping cam means comprises at least one clamping cam and at least one clamping cam-follower that engages the clamping cam and the clamping element.
10. Apparatus according to claim 9, wherein the clamping cam-follower includes a rotary bearing around the clamping cam.
11. Apparatus according to claim 9 or 10, when dependent on at least claim 2, wherein said or each clamping cam is mounted on said drive shaft means.
12. Apparatus according to claim 11, wherein an axis of rotation of the drive shaft means passes through the centre of rotation of the or each clamping cam.
13. Apparatus according to any one of claims 9 to 12, wherein the or each clamping cam is circular, with the centre of rotation offset from its geometric centre.
14. Apparatus according to claim 13, when dependent on at least claim 7, wherein the offset of the displacement cam is larger than the offset of the



or each clamping cam.

15. Apparatus according to claim 14 or to claim 13 when dependent on at least claim 7, wherein, when viewed from a position along the axis of rotation of the displacement cam and the at least one clamping cam, a line between the centre of rotation of the displacement cam and its geometric centre, and a line between the centre of rotation of the or each clamping cam and its geometric centre, share no more than the centres of rotation.
16. Apparatus according to any one of claims 9 to 15, wherein said at least one clamping cam comprises two clamping cams.
17. Apparatus according to any one of claims 9 to 16, wherein the clamping cam-follower is pivotably connected to the clamping element.
18. Apparatus according to any one of the preceding claims, wherein the clamping element comprises a clamping platen.
19. Apparatus according to any one of the preceding claims, wherein the first element comprises a first platen.
20. Apparatus according to claim 19 further comprising a second platen for compression of said workpiece between said first and second platens.
21. Apparatus according to claim 20, wherein said second platen is substantially immobile within said apparatus.
22. Apparatus according to any one of the preceding claims, wherein, in the second state, relative motion between the clamping element and said first element is substantially prevented.
23. Apparatus according to any one of the preceding claims, wherein the connexion means comprise:



blocking means on one of said first element and said clamping element and moveable between first and second positions; and

blocking cooperation means on the other of said first element and said clamping element;

wherein, in said first state, said blocking means are in said first position, and, in said second state, said blocking means are in said second position, cooperable with said blocking cooperation means to prevent relative motion of said first element toward said clamping element.

24. Apparatus according to claim 23, wherein:

the blocking means comprise first protrusion means protruding from said one of said first element and said clamping element toward said other of said first element and said clamping element; and

said blocking cooperation means comprise second protrusion means protruding from said other of said first element and said clamping element toward said one of said first element and said clamping element.

25. Apparatus according to claim 24, wherein:

said first protrusion means comprise at least two moveable blocks;
and

said second protrusion means comprise at least two fixed blocks.

26. Apparatus according to any one of claims 23 to 25, wherein said blocking means are on said clamping element.

27. Apparatus according to any one of claims 23 to 26 further comprising moving means for moving said blocking means between said first and second positions.

28. Apparatus according to claim 27, wherein said moving means comprise a piston and cylinder.

29. Apparatus according to any one of claims 1 to 22, wherein the



connexion means comprises at least one foldable toggle arm.

30. Apparatus according to claim 29, wherein, in said first state, the at least one toggle arm is able to be folded and, in said second state, the at least one toggle arm is prevented from folding.
31. Apparatus according to claim 30 further comprising release means to release said toggle arm from said second state.
32. Apparatus according to any one of the preceding claims, wherein the first element and the clamping element are constrained to move parallel to the same axis.
33. Apparatus according to any one of the preceding claims, wherein said clamping cam means is operable to transmit said compressing force in said first direction.
34. Apparatus according to any one of the preceding claims, further comprising a motor for driving both said displacement cam means and said clamping cam means.
35. Apparatus according to claim 2 or any one of claims 3 to 34 when dependent on at least claim 2, wherein rotation of said shaft means in one direction operates the displacement cam means followed by the clamping cam means and reverse rotation of said shaft reverses the movement of said clamping cam means then reverses the movement of said displacement cam means.
36. Apparatus according to any one of the preceding claims, wherein activation of said clamping cam means displaces said first element, through said clamping element.
37. Apparatus according to claim 36, wherein the displacement cam



means and clamping cam means are arranged such that the displacement of the first element by the displacement cam means is at least ten times the displacement of the first element by the clamping cam means

38. A method used in compressing a workpiece comprising the steps of:
displacing a first element in a first direction, using a first cam motion, whilst allowing relative movement between a clamping element the first element;

transmitting a compressing force to said first element through said clamping element, using a second cam motion, without allowing substantial relative movement of the clamping element toward the first element;
wherein

in said step of displacing a first element, the first cam motion does not act through the clamping element to displace the first element.

39. A method according to claim 38, wherein said transmitting step includes the step of displacing said clamping element.

40. A method according to claim 38 or 39, wherein the displacement of the first element in the step of displacing a first element is at least ten times the displacement of the first element in the transmitting step.

41. A method according to any one of claims 38 to 40, wherein said second cam motion transmits said compressing force in said first direction.

42. A method according to any one of claims 38 to 41, wherein said first and second cam motions are activated by a single shared drive shaft motion.

43. A method according to any one of claims 38 to 42, wherein said first and second cam motions are provided by a single shared drive shaft motion.



44. A method according to any one of claims 38 to 43, wherein said displacing and transmitting steps compress said workpiece between said first element and a press platen.
45. A method according to any one of claims 38 to 44 further comprising the step of reversing said first and second cam motions to reverse the motion of the first element and the clamping element.
46. A method according to any one of claims 38 to 44 further comprising the step of moving a blocking means from a first position to a second position between said displacing and transmitting steps.
47. A method according to claim 46, wherein the moving step begins at the end of said displacement step.
48. A method according to claim 46, wherein the moving step occurs during said displacement step.
49. Apparatus according to any one of claims 1 to 37, operable according to the method of any one of claims 38 to 48.
50. A press for compressing a workpiece including apparatus according to any one of claims 1 to 37 and 49.
51. A workpiece compressed using the apparatus of any one of claims 1 to 37 and 49.
52. A workpiece whose manufacture included a method according to any one of claims 38 to 48.
53. A product including a workpiece according to claim 51 or 52.
54. A press arranged to operate substantially as hereinbefore described



with reference to and as illustrated in the accompanying drawings.

55. A method of compressing a workpiece substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.