



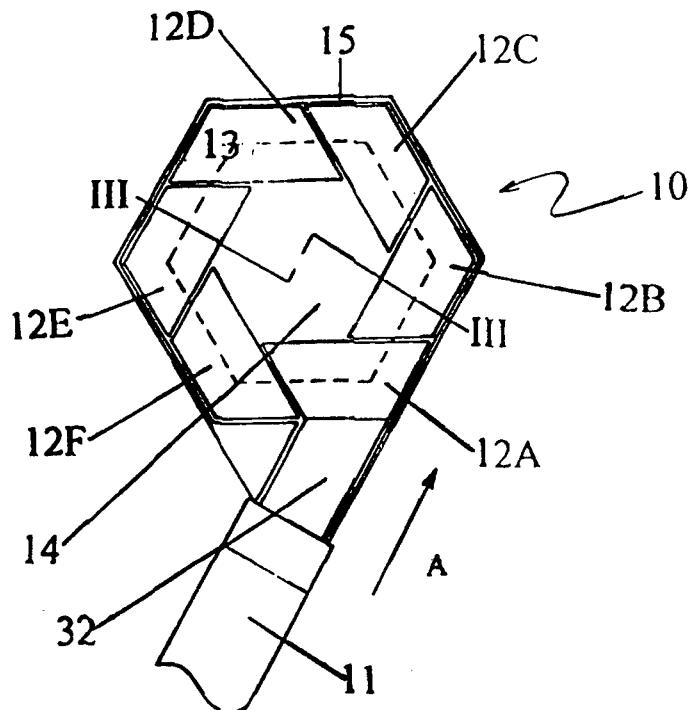
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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		<b>(43) International Publication Date:</b> 7 July 1994 (07.07.94)
<b>(21) International Application Number:</b> PCT/GB93/02658		<b>(81) Designated States:</b> AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).
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(54) Title: **ADJUSTABLE APERTURE APPARATUS**

## (57) Abstract

There is disclosed an iris-type arrangement providing an adjustable diameter aperture, particularly suitable for situations where a gripping arrangement is required. There is described an arrangement comprising a plurality of moveable members defining a polygonal aperture, wherein the aperture is continuously adjustable over a range between a minimum and a maximum aperture, individual members being arranged to move between their maximum and minimum aperture positions with a linear motion, with all the moveable members acting in concert. The arrangement may have a closed or open aperture.

**EDWARDS LIFESCIENCES EX. 1212**Edwards Lifesciences v. Boston Scientific Scimed  
U.S. Patent No. 6,915,560

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ADJUSTABLE APERTURE APPARATUS

This invention relates to an iris-type arrangement for providing an adjustable diameter aperture, suitable for use in tools and the like.

Adjustable spanners comprising a handle and two gripping jaws, one of which is fixed relative to the handle and the other of which is moveable relative to the fixed jaw are well known for loosening or tightening hexagonal-headed nuts or bolts. The provision of a moveable jaw allows a single spanner to be used with a variety of sizes of nuts or bolt heads. The provision of an adjusting mechanism also allows the spanner to be used on metric or imperial size nuts or bolts. A disadvantage of such a spanner lies in the spanner being able to grip a nut or bolt along only two edges thereof. In use, it is a common experience for the spanner to slip off the nut or bolt head. It is known that superior grip on the nut or bolt is obtained by the use of a ring spanner or socket wrench, which grips the nut or bolt on all edges. However, a separate such spanner or socket is required for every size of nut or bolt edge. This results in the need for a large tool set in order to ensure the availability of a suitably sized socket for every eventuality. This is even more the case if it is desired to provide sockets for both metric and imperial sized nuts and bolts.

Accordingly, there is a need for an adjustable ring spanner or socket wrench. Such a tool would provide greater efficiency and improved flexibility of use.

According to the present invention, there is provided an arrangement comprising a plurality of moveable members defining a polygonal aperture, wherein individual moveable members are arranged so that by movement of all the moveable members in concert the aperture is continuously adjustable over a range between a maximum aperture and a minimum aperture.

Preferably, at least one of the moveable members comprises an identical prism, the two similar, equal and parallel faces of which are trapezia and the four edges of which are parallelograms.

Preferably the trapezium faces of the prisms lie in a plane perpendicular to the axis of the aperture.

Typically, the moveable members are arranged to completely enclose the aperture thereby defining a closed aperture. Preferably the moveable members define a regular polygonal aperture. Preferably, there are six such moveable members to provide a hexagonal aperture.

Alternatively, the arrangement of moveable members may be discontinuous around the aperture, thereby defining an open aperture, being an aperture having an opening along at least one edge of the polygon.

Preferably, the moveable members are laterally retained within the arrangement by means of a retaining wall.

Preferably, the moveable members are restrained from substantial movement along the axis of the aperture by being provided with a channel in one or more of their edges, the channel being locatable over a rail extending inwardly from the retaining wall. The moveable members then slide between their maximum and minimum aperture positions along a path defined by the retaining wall.

Alternatively or additionally, the arrangement may be provided with parallel first and second cover means to restrain the moveable members from movement along the axis of the aperture. One of the cover means may include a rotatable element. One or preferably all of the moveable members may then be provided with a projection on one face thereof, the projection locating in an elongate aperture provided in the rotatable element. Rotation of the element causes linear motion of the moveable member and thus variation in the aperture dimensions.

The aperture of the arrangement may be varied by means of an external force applied to one or all moveable members.

The arrangement may be provided formed as an integral component of a spanner, or as an attachment being removably detachable to a separate handle, several such attachments being available each having a different range of apertures from another, such as in a socket set.

The arrangement for providing adjustability is also applicable to many other similar operations where a variable orifice is needed, such as chucks for drills or lathes, or valves.

The edge of each member defining the aperture may be provided with a cutting surface such that a device embodying an arrangement in accordance with the present invention may be used to cut an object such as a wire or branch of a tree placed in the aperture.

The face of a number of the moveable members may further be provided with a projection extending outwardly along the axis of the aperture to provide alternative means for gripping a workpiece. The projection may further be provided with a cutting surface or edge for use as a variable diameter cutting tool.

The above and other aspects of the present invention will now be illustrated in further detail by way of example only with reference to the accompanying drawings, in which:-

Figure 1 illustrates in plan view a first embodiment in

accordance with the present invention, in the form of a ring spanner, at maximum aperture;

Figure 2 illustrates the embodiment of Figure 1 at an intermediate aperture;

Figure 3 is a section along the line III-III of Figure 1;

Figure 4 illustrates in plan view a second embodiment in accordance with the present invention in the form of an open ended spanner, at maximum aperture;

Figure 5 illustrates the embodiment of Figure 4 at an intermediate aperture;

Figure 6 is a sectional view of a third embodiment in accordance with the present invention in the form of a chuck suitable for use in a drill or a lathe;

Figure 7 is an end view of the chuck shown in Figure 6 at maximum aperture;

Figure 8 is an end view of the chuck of Figure 6 at an intermediate aperture;

Figure 9 is an end view of a fourth embodiment in accordance with the present invention in the form of an adjustable socket at maximum aperture;

Figure 10 is an end view of the embodiment of Figure 9 at an intermediate aperture;

Figure 11 is a sectional view along the line XI-XI of Figure 9;

Figure 12 is a section along line XII-XII of Figure 11;

Figure 13 is an end view of a modification of the

embodiment of Figure 9 in accordance with the present invention at maximum aperture; and

Figure 14 is a sectional view along line XIV-XIV of Figure 13.

A first embodiment in accordance with the present invention is illustrated in Figures 1 to 3 in the form of a ring spanner comprising a spanner head shown generally at 10 and a handle 11. Moveable members in the form of jaw members 12 comprising prisms having trapezium faces 13 define a polygonal aperture 14. A peripheral wall 15 serves to retain the moveable members laterally (with reference to the plane of the drawing Figure 1) within the spanner head 10. A linear inner face 20 to the wall 15 is provided, forming a linear track along which the jaw members 12 may slide. Each trapezium-faced prism has two parallel edges 21,22, edge 22 being longer than edge 21, and two non-parallel edges 23,24. Both non-parallel edges 23,24 form an angle  $\theta$  with edge 22. In defining a closed hexagonal aperture 14, six prism-shaped jaw members 12 are used to completely enclose the aperture and angle  $\theta$  is  $60^\circ$ . The jaw members 12 are retained within the wall 15 such that a portion of the longer edge 22 of each jaw member 12 forms the perimeter of the aperture 14. As can be seen from the progression from Figure 1 to Figure 2, the movement of each jaw member 12 is constrained by the wall 15 such that one non-parallel edge 24 slides along a face 20 of wall 15 whilst the other non-parallel edge 23 slides along face 22 of an adjacent jaw member 12. Movement of one member



12 causes movement of the adjacent jaw member and thus the movement of all members 12. To constrain axial movement of the jaw members 12 along the axis of the aperture 14, in the preferred embodiment shown, the peripheral wall 15 is provided with a T-shaped cross-section such that a rail 30 (shown by the dashed line) projects inwardly from the inner face 20 of wall 15. Rail 30 engages in a channel 31 provided in edges 21 and 24 of each jaw member 12.

The dimension of aperture 14 is varied, in the embodiment illustrated in Figures 1 to 3, by means of a conventional *per se* micrometer screw gauge-type mechanism. Rotational motion of handle 11 is converted into linear motion in a direction shown by arrow A in Figure 1, of linear element 32. As shown, the linearly moving element 32 terminates with one of the jaw members (12A) formed integrally therewith, such that the linear motion of element 32 and thus of jaw member 12A causes each of the other jaw members to slide along the path defined by each face 20 of the wall 15. This concerted movement of all jaw members causes the aperture 14 to uniformly reduce in size. Rotation of the handle in the opposite direction causes face 23 of member 12A to act against face 22 of jaw member 12F which thus acts against the other jaw members in the reverse direction thereby enlarging aperture 14. Alternative drive mechanisms will be apparent to those skilled in the art, for example a worm screw mechanism as used in a conventional *per se* adjustable spanner may be equally suitable.

In an alternative embodiment (not shown) covers may be applied to each face of the head 10 of the spanner to restrain the prisms from movement along the axis of the aperture either in addition to or as an alternative to rail 30 of the peripheral wall 15. One or both such covers may be formed integrally with walls 15, however preferably one of the covers is removably secured to the arrangement to allow for the periodic application of a lubricant to the moving surfaces of the apparatus. Additionally, one or both covers may include a rotatable element, one or more of the jaw members 12 then being provided with a projection extending from one or both faces 13 and locatable in an radially elongate aperture in the rotatable element. Rotation of the element causes linear motion of the jaw members and thus a variation in the diameter of the aperture.

Figures 4 and 5 illustrate a further embodiment in accordance with the present invention wherein the arrangement of moveable members is discontinuous around the aperture thereby defining an open aperture and providing an open spanner having an opening 46. The arrangement operates in substantially the same manner as described above. Rotation of handle 40 causes linear motion of element 41, the forward edge of which corresponds generally to the long parallel edge 22 of the jaw member in the embodiment described above. Element 41 acts against the adjacent non-parallel edge of adjacent jaw member 42A which thus acts on jaw member 42B and

thus 42C to reduce the diameter of the aperture. Jaw member 42C is biased towards its maximum aperture position such that when the direction of rotation of handle 40 is reversed and element 41 moves in the direction shown by arrow B in Figure 5, the biasing of jaw member 42C causes jaw members 42A and 42B to return to their maximum aperture positions by sliding along the inner face 43 of peripheral wall 44. Many biasing means will be apparent to those skilled in the art, for example a spring or an elastic element will be suitable. In the embodiment shown, element 41 terminates in a generally claw-shaped form comprising a prism-like portion forming one face of the aperture, and a tooth-like projection 45 extending therefrom providing a further aperture face to contact a nut or bolt positioned in the aperture of the spanner. Projection 45 may be omitted although such a spanner would then not grip a hexagonal nut or bolt on five sides as is advantageously provided for by projection 45.

The embodiment shown in Figures 4 and 5 is particularly suitable, by a provision of a cutting surface to the aperture defining edges of the jaw members 42 and the claw-shaped element 41, for use in cutting objects placed in the aperture. For example, pruning shears, secateurs and wire cutters may be made with slight modification as appropriate to the embodiment described above.

Figures 6 to 8 illustrate the application of the present invention to a chuck, more specifically, a chuck for a drill.

The jaws of a chuck 50 are formed by jaw members 51. The jaw members 51 move in an analogous manner to the movement of the jaw members 12 described in respect of the embodiment of Figures 1 to 3. A key 52 locates in an aperture provided in a side wall 53 of the chuck and engages a rack provided on rear face on one of the jaw members 51. As with a conventional drill chuck, a number of such apertures may be provided each communicating with a different jaw member. Rotation of the key 52 causes linear motion of that jaw member along the path defined by the side wall of the chuck and thus, as described above, movement of all jaw members 51. Jaw members 51 are retained by and slide along rails 55 provided in the side walls 53 of the chuck. Additionally a cover may be provided (not shown). Thus from the point of view of the user, the chuck operates in a conventional manner. The chuck is mountable on the arbor of the drill or lathe by means of screw thread 54 provided in the rear wall of the chuck 50.

Figure 9 illustrates a modification to the spanner head illustrated in Figures 1 to 3 above wherein the jaw members 60 have an L-shaped cross-section thus forming a stepped aperture comprising an outer aperture 61 of larger diameter to that of an inner aperture 62. That portion of the jaw member 60 forming the larger outer aperture 61 is provided with an extension 63 extending outwardly from an edge of the jaw member 60 such that it projects over the step of an adjacent prism thereby providing a continuous periphery to

the larger outer aperture 61. This modification has two main advantages. Firstly a spanner with such a feature can close onto a larger nut than is otherwise the case and secondly, as only the larger outer aperture 61 is used to contact the workpiece, damage to the sliding edges of the jaw members 60 is avoided.

Although suitable for use in any of the embodiments described above, the stepped jaw principle is particularly suitable for embodiments designed to replace conventional socket sets. Such a mechanism for operating the jaws is illustrated more clearly in Figure 11. The conventional square section driver on the lever (not shown) locates in an aperture 64 in the rear end of the body 65 of the socket shown generally at 70. The body 65 of the socket extends towards the front of the socket and forms the peripheral wall 71 along the inside face of which the jaw members 60 slide. As described above, jaw members 60 slide along a rail 72 projecting inwardly from the peripheral walls 71. At least one, preferably all, jaw members 60 are provided with a projection 73 extending outwardly from the rear face thereof. Each projection 73 passes through an axially elongate aperture 74 in the body 65 of the socket, the aperture 74 being coplanar with the stepped aperture. The projection 73 then locates in a radially elongate aperture 75 provided in a collar 76 rotatably mounted around the body 65 of the socket. The collar 76 is rotatably mounted on the body 65 of the socket 70 by means of a screw thread. In use, the size of the

aperture is varied by rotation of collar 76 about the body 65 of the socket. Rotation of the collar 76 forces rotational movement of projection 73 which as the jaw members 60 are constrained to move linearly, causes jaw members 60 to slide along peripheral wall 71 of the socket 70 as projections 73 also move radially outwardly along elongate aperture 75. In the embodiment shown, collar 76 has a two piece structure comprising a front collar element 80 having the elongate aperture 75 through which projection 73 locates; and a rear collar element 81. Each element is screw threaded onto the body of the socket in the same sense - with a left or right handed screw thread. The two collar elements are rotated together to adjust the aperture 61 to the appropriate size. Rear collar element 81 can then be further rotated in the same direction to lock front element 80 and thus the aperture at the chosen size. Alternatively, rear collar element 81 may be reverse rotated, cooperating portions 82 provided on both elements thus engaging each other and again acting to lock the aperture at the chosen size. If the square section driver onto which aperture 64 is located forms a part of a ratchet mechanism it will be necessary for the operator to grip the peripheral wall 71 whilst rotating collar 76 to adjust the diameter of the aperture.

The further embodiment shown in Figures 13 and 14 is again illustrated in the form of a socket but is suitable for incorporation into a spanner. The arrangement is generally the same as Figs. 9 to 12 but with the addition of a stud 90

to the front face of each jaw member. As with the stepped jaw principle, the use of studs 90 allow a larger nut or bolt to be turned and protects the sliding surfaces from damage by the workpiece. Moreover, the studs 90 provide that the workpiece, for example a hexagonal nut, is contacted only along its edges. Thus damage to the corners of the nut is avoided.

The adjustable aperture apparatus described above is suitable for incorporation into many applications where the gripping or holding of a workpiece or other tool is required or where a crushing action is required, for example as nut crackers. By way of example, the apparatus can be used in drill chucks, ring spanners, open ended spanners, socket spanners, mole wrenches, pipe wrenches, laboratory retort clamps and bench vices. The arrangement may also be used in the field of robotics to replace the conventional single axis pinching action of a robotic arm with a two axis gripping action.

The face of the moveable members may be provided with a grinding surface such as diamond or titanium nitride. Alternatively such a surface may be provided on the front edge of studs 90, or the studs may be provided with a cutting edge. Such devices are suitable for grinding or milling workpieces. A single tool is thus suitable, by adjustment of the aperture, for milling a wide range of surface sizes.

The closed aperture is also highly suitable for inclusion as the hitch in a ball and hitch joint as is conventionally used for attaching a trailer or caravan to a car. As such a hitch completely encloses the stem below the ball of the joint a considerably more secure coupling can be provided.

The arrangement is equally applicable with suitable modifications by those skilled in the art to use in valves or as a replacement for the conventional leaf iris on a camera, in which case the apparatus could be used to provide both the aperture and shutter control. By suitable modification the arrangement can be used in the field of architecture as for example adjustable window shutters, and in the chemical engineering and pipeline distribution fields as for example an in-pipe adjustable diameter grinding machine. The grinding machine cleans the inside of the pipe.



## CLAIMS:

1. An arrangement comprising a plurality of moveable members defining a polygonal aperture, wherein the aperture is continuously adjustable over a range between a minimum and a maximum aperture, individual members being arranged to move between their maximum and minimum aperture positions with a linear motion, with all the moveable members acting in concert.
2. An arrangement according to Claim 1, wherein the moveable members are arranged to completely enclose the aperture thereby defining a closed polygonal aperture and at least a number of the moveable members each comprises an identical prism the two similar, equal and parallel faces of which are trapezia and the four edges of which are parallelograms.
3. An arrangement according to Claim 2 wherein the trapezium faces of the prisms lie in a plane perpendicular to the axis of the aperture.
4. An arrangement according to Claim 2 or Claim 3 wherein there are six moveable members defining an hexagonal aperture.
5. An arrangement according to Claim 1 wherein the arrangement of moveable members is discontinuous around the

aperture, thereby defining an open aperture.

6. An arrangement according to any one of Claims 1 to 5 wherein the moveable members are laterally retained within the arrangement by a retaining wall.

7. An arrangement according to Claim 6 wherein the inner face of the retaining wall is provided with an inwardly projecting guide rail and each moveable member is provided with a channel on at least one edge thereof engaging the guide rail.

8. An arrangement as claimed in any preceding claim wherein the aperture of the arrangement is varied by means of an external force applied to one of the moveable members.

9. An arrangement as claimed in any one of Claims 1 to 8 wherein the arrangement forms a spanner.

10. An arrangement as claimed in any one of Claims 1 to 4 or 6 to 8 wherein the arrangement forms a chuck for a drill or lathe.

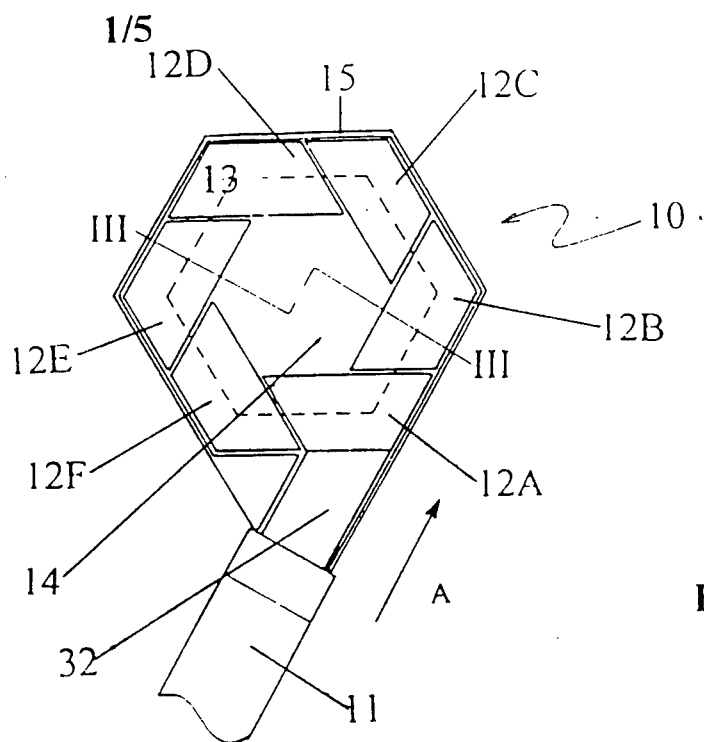


Fig 1

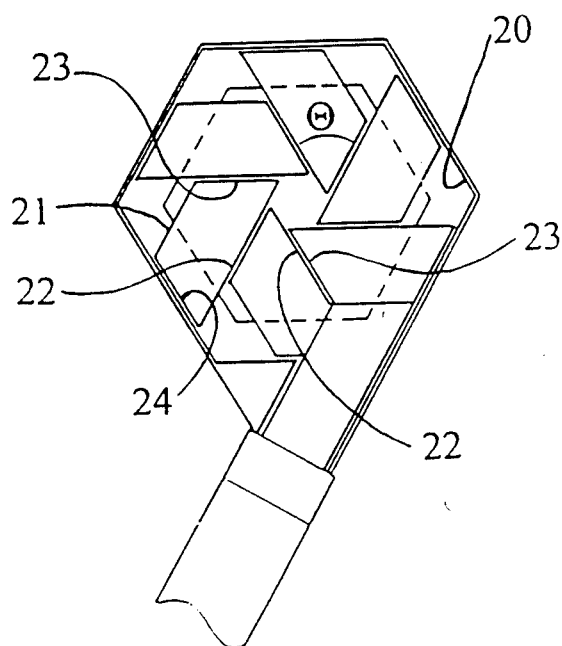


Fig 2

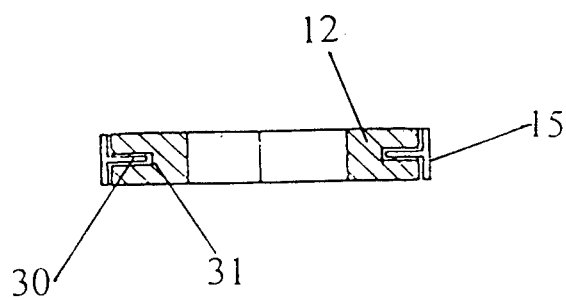


Fig 3

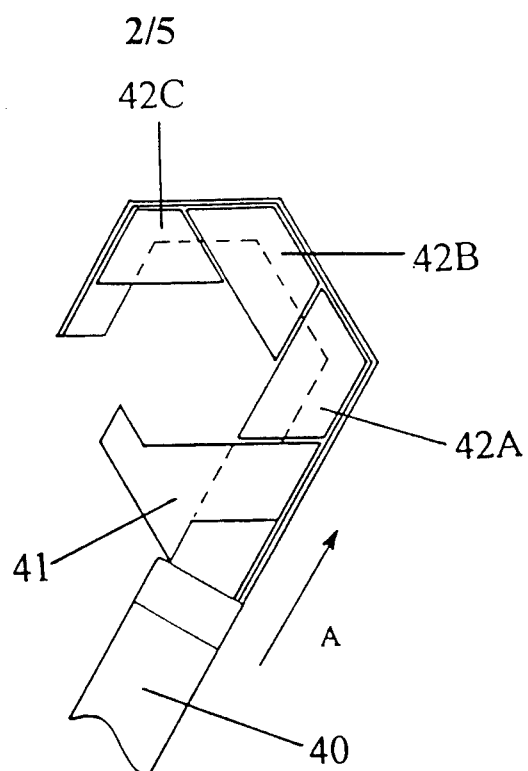


Fig 4

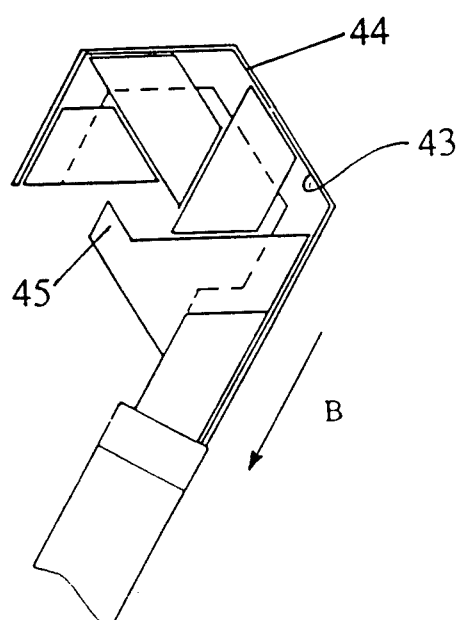
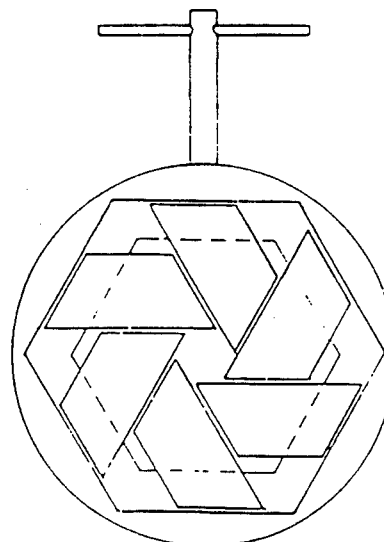
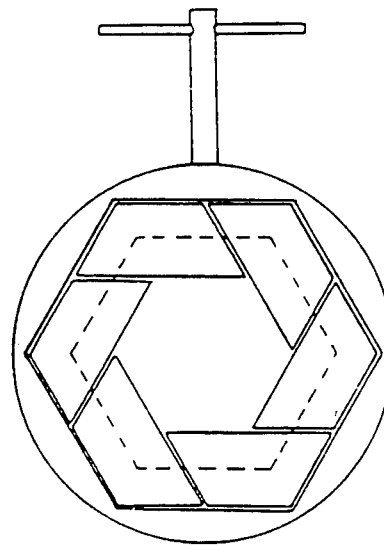
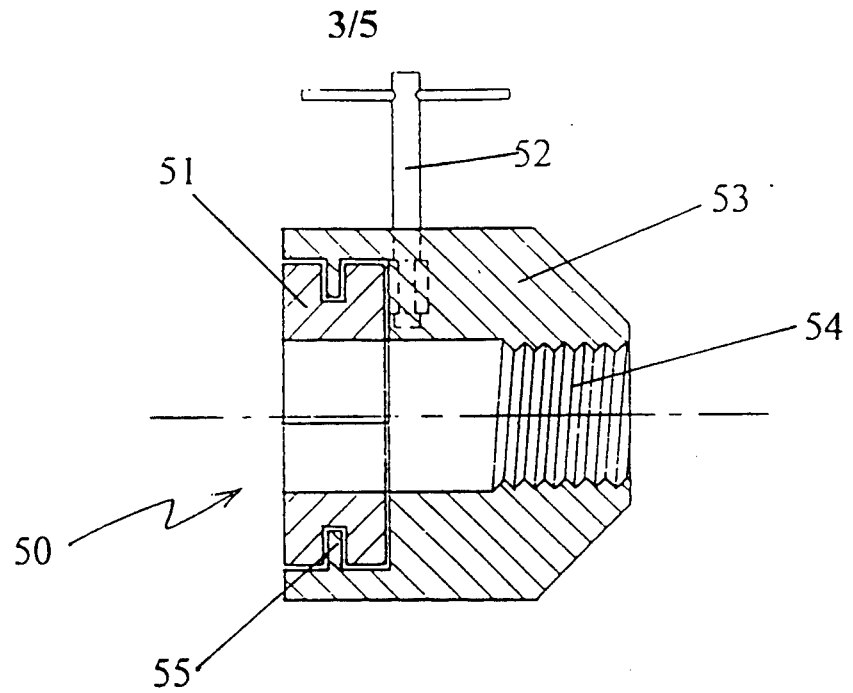


Fig 5



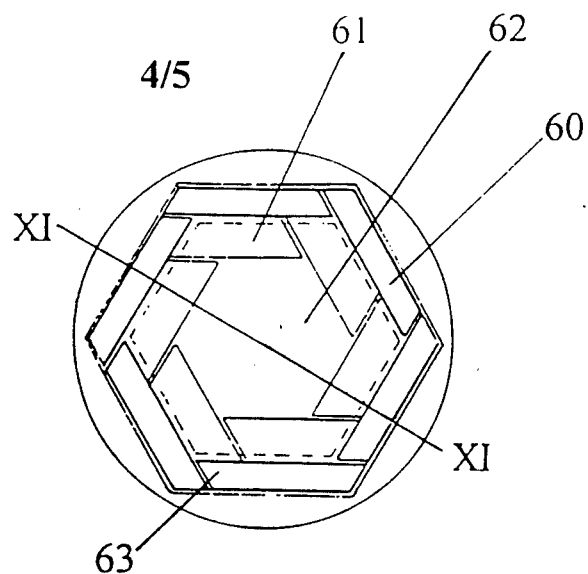


Fig 9

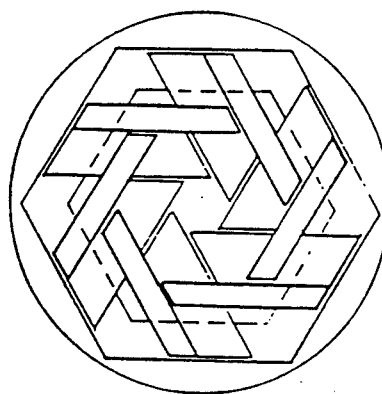


Fig 10

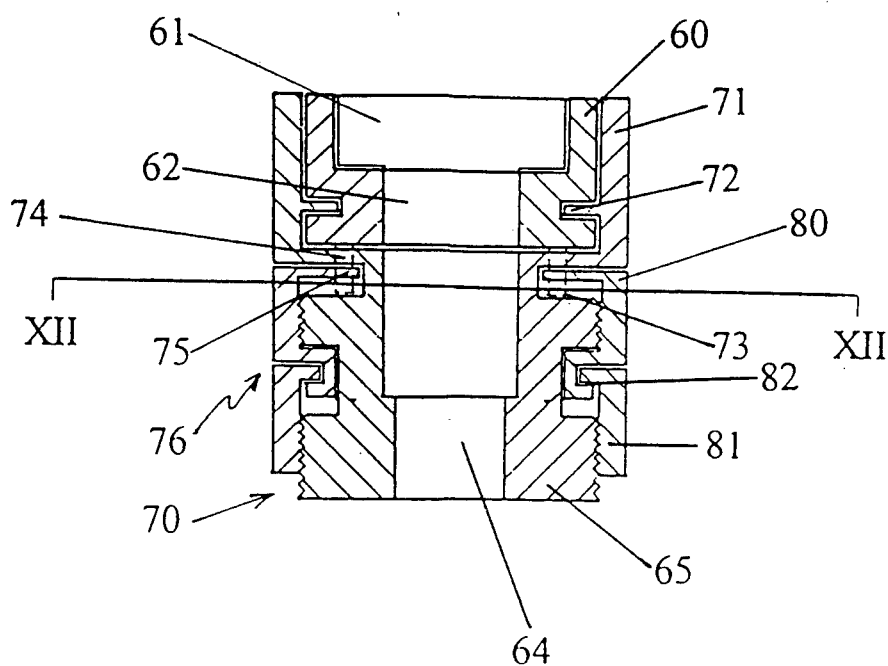


Fig 11

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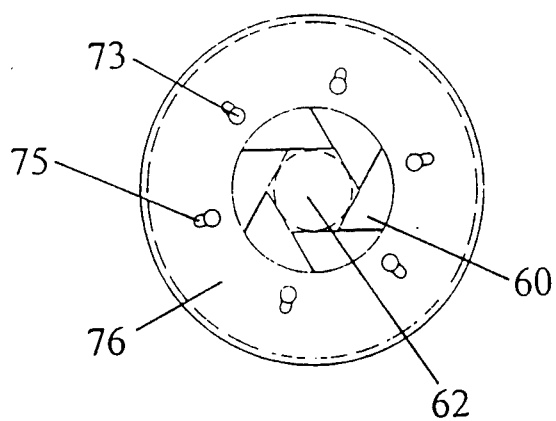


Fig 12

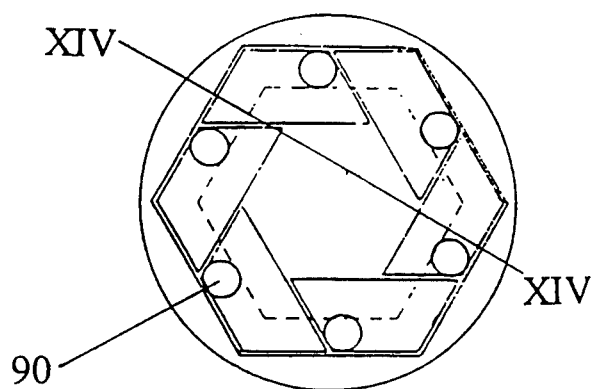


Fig 13

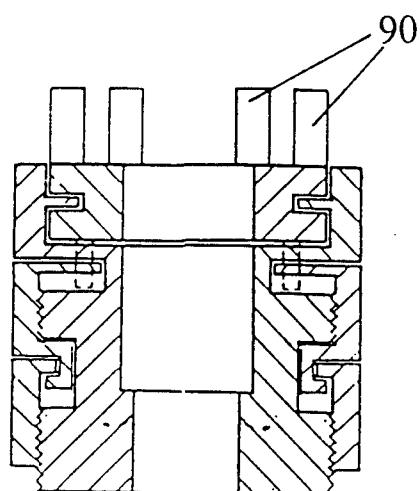


Fig 14

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 93/02658

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 5 B25B13/44 B25B13/18 B23B31/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 5 B25B B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR,A,1 332 313 (B.R.ZANARDELLI) 4 June 1963 see claims; figures ---	1-4,6,8, 10
X	DE,C,879 192 (R.T.ELSEN) 2 October 1952 see page 2, line 120 - page 3, line 18; figure 6 ---	1-4,6,8
X	US,A,1 432 713 (W.W.MARSHALL) 17 October 1922 see page 1, line 13 - line 21; claim; figures 1,2 ---	1,6,9
X	FR,A,623 485 (J.VAILLANT) 21 March 1927 see claims; figures --- -/--	1,9

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

5 April 1994

Date of mailing of the international search report

19. 04. 94

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# INTERNATIONAL SEARCH REPORT

Inter. Application No  
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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 454 657 (M.YASUMI) 19 June 1984 see column 5, line 48 - line 57; figures 2,3,10 ---	1,6,7,10
X	US,A,3 141 363 (L.J.FERRY) 21 July 1964 see figures 4,6 -----	1,5,9

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/GB 93/02658

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A-1332313		NONE	
DE-C-879192		NONE	
US-A-1432713		NONE	
FR-A-623485		NONE	
US-A-4454657	19-06-84	NONE	
US-A-3141363		NONE	