A method and apparatus for a structure having a moving object are disclosed in the present application. The structure, in one embodiment, includes an object and a outside structure. A first side of outside structure is situated at a substantially fixed distance from a second side of outside structure. The structure further includes two links wherein a first end of a first link is coupled to the first side of outside structure and a second end of first link is coupled to the object. Also, a first end of a second link is coupled to the second side of outside structure and a second end of second link is coupled to the object. The object is capable of performing a rotaxially rotation in response to the first and second links.
METHOD AND APPARATUS FOR MOVABLE STRUCTURE HAVING ALTERNATIVE ACCESSIBLE SIDES

PRIORITY

[0001] Pursuant to 35 U.S.C. 119(e) and 37 C.F.R. 1.78, the present application claims priority to the provisional application entitled “Rotatable Storage with Alternatively Accessible Sides” Application No. 60/482,048, filed on Jun. 24, 2003, the inventor of which is William Jefferson Stone III.

FIELD OF THE INVENTION

[0002] The present invention relates generally to rotating storage structures that are used for supporting, holding and safekeeping objects. More particularly, the present invention relates to a reversing storage cabinet.

BACKGROUND

[0003] A typical structure, such as a cabinet, furniture, etc., may contain rotatable unit(s), for example, a cabinet may have a “lazy Susan” tray. These rotatable units have widespread applications from cabinetry design to sophisticated high precision equipment. There are a number of commercially available designs with regard to rotatable units within a structure on the market.

[0004] There are storage cabinets known in the prior art that rotate around an axis. For example, the storage cabinet described in U.S. Pat. No. 6,273,531 by Scheffer (2001) is located on the top of a desk and can be rotated around an axis. By rotating the cabinet around an axis one can alternatively access articles located on different sides of the cabinet. Other examples having similar designs are also described in various references, such as U.S. Pat. No. 4,610,492 by Molander et al (1986), U.S. Pat. No. 5,651,595 by Willis (1997) and U.S. Pat. No. 5,487,599 by Weisburn et al (1996).

[0005] There are disadvantages associated with these conventional designs. For example, the first disadvantage is loss of space because these conventional designs require significant space around the rotating object so that it can perform a rotation around an axis. Space loss in the front of the cabinet can typically be seen as temporary loss because the space is lost only when the cabinet is rotating. The space loss, however, is more wasteful when space is lost behind the cabinet. Space loss behind a cabinet is typically considered permanent loss of space because such space has no practical utilization or compensation temporary or XXX. Such permanent loss of space is illustrated in various conventional designs, such as those described in U.S. Pat. No. 4,610,492 by Molander et al (1986) and U.S. Pat. No. 6,273,531 by Scheffer (2001).

[0006] Another conventional design for rotating an object within a structure uses non-obstructive rotation. To provide non-obstructive rotation of an object or cabinet, it is permanently moved forward away from a wall or other structure. A drawback associated with this design is space loss in front of the cabinet. This type of space loss can become a serious problem if space is at premium.

[0007] A second disadvantage associated with some conventional designs is lack of exclusive access. Conventional designs do not typically offer exclusive accessibility to one side of the storage cabinet while other sides of the cabinet are not accessible. This is not suitable when alternative access to different sides is needed. Examples of these situations are the cabinets in which one of the cabinet sides is used for jewelry or expensive collectibles while another side of the cabinet stores firearms, etc. In order to resolve this problem, conventional designs offer some designs including special enclosures and shields as such those described in U.S. Pat. No. 4,610,492 by Molander et al (1986). However, providing special enclosures and/or shields as solutions are typically impractical in terms of convenience or cost, e.g. when storage cabinet is used for relatively large articles (books, TV sets, etc.).

[0008] A problem associated with the above-referenced designs is safety. For example, if the weight of stored articles in a cabinet is greater than the weight of the cabinet itself, the loaded cabinet can become heavy and cumbersome to rotate and may also create safety issues because it could tip over if it is not supported from the top. However, providing support from the top may increase the complexity and bulkiness of such designs and may also increase the total cost of the storage cabinet.

[0009] As mentioned, the problem in these conventional designs is waste of space. In the case of a bookcase in which the bookcase has two storage sides for accessing stored articles waste of space in significant in conventional rotating designs. To solve the problem of waste of space, a known solution employs a cam system including cam followers and grooves to resolve the problem of waste of permanent space behind a shelf in a cabinet as described in U.S. Pat. No. 4,124,262 by Schill (1978).

[0010] The disclosed cam system can reduce extra space needed for rotation. In other words, with application of the disclosed cam system, the rotating shelf within the cabinet does not require a big clearance for rotation. When rotation is needed, the center of the shelf is moved forward on its two (top and bottom) centered cam followers sliding in the transverse grooves of the enclosure. A pair of followers, mounted on opposite sides of the rotating shelf, guide one side to the opposite side of the stationary enclosure. In order for this rotation to perform correctly, these must be accurate grooves in the enclosure.

[0011] Even though the cam system reduces the problem of space waste, it generates new problems. For example, a problem associate with the cam system is uneven loading of the cabinet weight. The cam system loads the entire weight of the shelf with its content on the bottom center cam follower. In addition to supporting the shelf during the rotation, the bottom center cam follower also guides itself along the transverse groove through out the enclosure. This multi-functionality of the central bottom cam follower lowers the reliability and lifetime of the cabinet.

[0012] Another problem associate with the disclosed cam system is that upper and lower cam followers move independently of each other in the guides. There is no guarantee that these guide will move synchronously. Quite to the contrary, one cam always will tend to move faster than another. This will happen for two reasons. First, uneven weight distribution of the cabinet articles inside the cabinet; and second, uneven pull or push of the shelf by the person rotating the shelf Independent movement of the cam fol-
lowers may cause the cam followers to be jammed in the guides. Even if there is no jam there is a high degree of wear and tear in the guiding system, which shortens the lifetime of the cabinet.

[0013] The conventional design using a cam system with an upper guiding system to support the cabinet in addition to the bottom guiding system, as described in the U.S. Pat. No. 4,124,262, adds an undesirable complication of the shelf design when the cabinet is used for light loads and top support is not needed.

[0014] Another problem with the design of the cam system is that it is dimension dependent. When dimensions of the cabinet are such that it is not deep but wide, the center cam follower of the cabinet is required to extend outside of the cabinet enclosure for shelf rotation. This adds serious complications in the cabinet design by requiring dynamic elongations to the guiding grooves of the enclosure with telescoping guides. Also for heavy loaded cabinets that are not deep but wide it is especially impractical for reliability and safety concerns.

[0015] FIG. 1 of U.S. Pat. No. 4,124,262 also shows wasted space on the left and right sides of the cabinet. In order to compensate for some of this waste, the left and right sides of the shelf are of cylindrical shaped. This design prevents two or more such cabinets to be placed next to each other in close proximity without wasted space. When the user has more than one cabinet it is advantageous to place them next to each other without wasted space for convenience of use and also for saving the total space allocated for the cabinets.

[0016] What is needed, therefore, is a cabinet with alternatively accessible sides that is economical in utilizing the space around it, convenient for accessing different sides of this cabinet, has some practical way of preventing access to side that are supposed to be inaccessible at given time, is strong so it can handle heavy loads using a reliable low wear mechanical arrangement for jam free rotation and is simple in design and not expensive when handling light loads.

SUMMARY OF THE INVENTION

[0017] The present invention comprises a compound movement link mechanism that allows an object to move from the space it occupies in one orientation and return to the same space in a different orientation. Preferably the object is a support structure having at least two selectively accessible sides. In a preferred embodiment, the object is supported by a pair of synchronis compound movement link mechanisms. Objectives of various aspects of the invention are mentioned below.

[0018] In view of the above-stated disadvantages of the prior art, objectives of the invention include providing an improved rotational storage for applications where alternative access to different sides of the cabinet is practical or needed.

[0019] Another objective of the invention is to provide a storage cabinet that is economical in utilizing the space allocated for it. In addition to be economical in utilizing the space around storage the cabinet, its design should provide alternative of access to different sides of the cabinet with convenience and ease.

[0020] A further objective of the invention is to provide limited access to the side or sides of the cabinet that are not being accessed at a given time. This secure access should be achieved economically and with simplicity of design.

[0021] A still further objective of the invention is to provide a storage cabinet that can be utilized for applications with heavy loads such as for example storing books, firearms, electronic equipment, etc.

[0022] Another objective of the invention is to provide a storage cabinet that can be simple in design with low cost for light load applications such as for example CD's, DVD's, stamp collections, etc.

[0023] A reversible storage cabinet with alternatively accessible sides, in one embodiment, includes a storage structure, which is used to hold at least one article. Means for holding the storage structure includes a four-link mechanism, wherein three of the links are serially connected. The three serially connected links are rotatably connected to two outside ends of a fourth link at two substantially separated locations. The fourth link is substantially stationary. The middle link of three serially connected links is a part of the storage structure allowing reorientation of the storage structure relative to the fourth stationary link for alternative access to the sides of storage cabinet.

[0024] Additional features and benefits of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0026] FIG. 1A-1M are diagrams illustrating a storage structure in accordance with one embodiment of the present invention;

[0027] FIG. 2-FIG. 3 are diagrams of storage structure with different storage articles in accordance with one embodiment of the present invention;

[0028] FIG. 4A-4D are diagrams illustrating light articles storage mounted on a desk in accordance with one embodiment of the present invention;

[0029] FIG. 5A-5E are diagrams a compound movement link mechanism for a storage structure in accordance with one embodiment of the present invention;

[0030] FIG. 6A-6E are schematic representations illustrating operations of the storage with outside joints of the four link mechanism moved back on the stationary plate in accordance with one embodiment of the present invention;

[0031] FIG. 7A-7E are schematic representations illustrating operations of the storage with outside joints of the four-link mechanism located in diagonal corners of the stationary plate in accordance with one embodiment of the present invention;

[0032] FIG. 8A-8A are schematic representations illustrating operations of the storage with outside joints of a four
link mechanism located in diagonal corners of the stationary plate and storage moving 90° between positions of alternate access in accordance with one embodiment of the present invention;

[0033] FIG. 9A-9B are diagrams illustrating a storage designed for light loads mounted on a desk with rotational designed illustrated in FIG. 8A-8E;

[0034] FIG. 10A-10C are diagrams illustrating a storage moving between alternate access positions around horizontal axes in accordance with one embodiment of the present invention;

[0035] FIG. 11A-11D are diagrams illustrating an application of the proposed invention with four square storages mounted next to each other on one square stationary plate in accordance with one embodiment of present invention;

[0036] FIG. 12A-12D are diagrams illustrating a wheel system in accordance with one embodiment of the present invention;

[0037] FIG. 13A-13C are diagrams illustrating a best assembly in accordance with one embodiment of the present invention; and

[0038] FIG. 14 is a set of diagrams illustrating a rotating object performing a rotaxial movement in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0039] In the following description, for purposes of explanation, numerous specific details are set forth to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that these specific details may not be required to practice the present invention. In other instances, well-known mechanical, circuitry, and devices are shown in block diagram form to avoid obscuring the present invention.

[0040] In the following description of the embodiments, substantially the same parts are denoted by the same reference numerals. Also, while references such as top, bottom and side may be used throughout the specification, it is to be understood that their orientation requirements are only to facilitate the explanation of the various embodiments and depending on the application, the top could be the side or bottom or vice versa.

[0041] An apparatus for a reversible storage system 100 having a moveable object 102 are disclosed in the present application. The reversible storage system 100, in one embodiment, includes an object 102 and a frame 200. A first side of frame is situated at a substantially fixed distance from a second side of frame. The reversible storage system 100 further includes two links 304 and 308 wherein a first end of a first link 304 is coupled to the first side of frame and a second end of first link is coupled to the object 102. Also, a first end of a second link 308 is coupled to the second side of frame and a second end of second link 308 is coupled to the object 102. The object 102 is capable of performing a rotaxial rotation in response to the first and second links 304 and 308.

[0042] FIG. 1A-1M are diagrams illustrating a design of a structure with a moveable object in accordance with one embodiment of the present invention. FIG. 1A shows one embodiment wherein the structure with a moveable object comprises a reversible storage system 100 which includes a moveable object 102 that holds articles. Rversible storage system 100 also includes an outside structure 200, bottom rotaxial linkage mechanism 300 (shown best in FIG. 1C) and top rotaxial linkage mechanism 400 (shown best in FIG. 1C).

[0043] Referring to FIG. 1A, moveable object 102, in this embodiment, includes a first accessible side 111, a second accessible side 121 (not shown), a bottom plate 104, a top plate 106, and sidewalls 108, 110. The first reversible side 111 in this embodiment is a bookcase includes shelves 112 to hold articles 114. As shown for illustration in given example, these articles 114 are shown. The bookcase 111 also includes vertical wall 116 which is visible behind the books. The vertical wall 116 is one of the strengthening elements of the bookcase 111 together with the sidewalls 108, 110, and the top and bottom plates 104, 106.

[0044] In one embodiment, the shelves 112 are adjustable and form a shelving system. The shelving system may help provide overall support to the moveable object 102. Different shelf arrangements or configurations can provide different support to the bookcase 111. Adjustable shelves provide flexibility so that the shelves 112 can be arranged to a particular need. Vertical wall 116, in one embodiment, separates the first accessible side 111 and the second accessible side 121 of the moveable object 102 for alternative access.

[0045] The outside structure 200 provides structural support for the moveable object 102. The outside structure 200 includes a top stationary plate 210, a bottom plate 202, and two vertical support members 204 and 206. In this embodiment the outside structure 200 is anchored to a wall 212 via two support brackets 214 and 216.

[0046] FIG. 1B depicts the moveable object 102 moved from the original space that it occupied. Portions of the link mechanism 400, which will be described more fully with regard to FIG. 1F can be seen.

[0047] FIGS. 1C and 1D show the second accessible side 121 of moveable object 102, which in this embodiment is an entertainment center. The second accessible side 121 of the moveable object 102, as shown in FIGS. 1C, 1D and 1E, includes shelves 118, articles 120 (TV set), stereo system 122, collection of CD’s 124, and collection of tapes 126. These articles 114, 120, 122, 124 and 126 are shown for illustration purposes and the second accessible side 121 can have different shelving configurations and different articles for holding, storing or safekeeping. Examples of other articles include wine, jewelry, stamps, rifles, and guns.

[0048] The entertainment center embodiment includes protective glass covers 103 and 132 which are preferably attached with hinges as depicted in FIGS. 1C, 1D and 1E. These protective glass covers 130 and 132 may, if desired also be included on the first accessible side 111. To provide secure access to the articles in the entertainment center, keyed (or keyless) locks 134 (FIGS. 1C, 1E, 2) may be installed on the protective glass covers 130 and 132.

[0049] As seen in FIG. 1C, in one embodiment, the shelves include moldings 140 prevent stored articles from sliding off of the shelf during rough, sudden, or fast rotation.
The outside structure 200 of this embodiment, best depicted in FIG. 1F, provides support for the movable object 102 and also supports the rotaxial link mechanisms 300 and 400. In this embodiment, outside structure 200 includes a stationary base 202, a top stationary plate 210 (shown in FIG. 1A) and vertical support members 204, 206 located respectively on the left and right sides of the outside structure 200. Base 202 preferably rests on floor. Vertical support members 204 and 206 at their lower ends are attached firmly to base 202 and their upper ends are firmly connected to top stationary plate 210. All four components (202, 204, 206 and 210) form the strong outside structure 200. A strong outside structure 200 is desirable when heavy loads are introduced. For additional vertical stability, the top plate 210 is anchored to a wall 212 of the environment where the reversible storage structure 100 is located by security brackets 214 and 216. In another embodiment, vertical support members 204 and 206 may be directly anchored to a concrete floor for heavy loading applications. In yet another embodiment, vertical support members 204 and 206 may be anchored to a ceiling or roof. In certain applications it may be desirable to eliminate both the base 202 and the top plate 210 and attach the vertical supports directly to the floor or ceiling of the environment in which the reversible storage structure is located.

Referring back to FIG. 1F, the reversible storage structure 100 further includes a bottom rotaxial link mechanism 300 and a top rotaxial link mechanism 400. Depending on the application, and the loading, of the movable object 102, top rotaxial linkage 400 may not be necessary.

The rotaxial linkage mechanism includes multiple links capable of rotaxially, that is a combination of a rotating movement and a transverse movement. Preferably the rotaxial linkage mechanism is constructed to allow an object to be moved from an original space in a first orientation and returned to the original space in a different orientation. Preferably the rotaxial linkage mechanism includes a first link 304 and a second link 308. The outer ends of first and second links 304 and 308 of rotaxial linkage mechanism 300 may be rotatably connected to the base 202. Preferably base 202 has risers on each side to which the first and second links are preferably rotatably connected by first and second pins 310 and 312. The inner ends of first and second links 304 and 308 are preferably rotatably connected to plate 306 by third and fourth pins 314 and 316. A plate 306, in this embodiment, is preferably bolted to the bottom plate 104 of the movable object 102. First and second links 304 and 308 and plate 306 are connected serially and form a three movable link chain. This three-link chain together with the stationary base 202 form the preferred rotaxial linkage mechanism 300. The inner ends of the first and second links are preferably also rotatably attached to a low friction contact device such as for example, wheels, rollers, gliders or casters that are attached between the links and the base. The low friction contact device may also simply include the use of low friction materials for the base and the links or a low friction piece of material attached to the inner end of the links. The risers may be used to elevate the first and second links to compensate for the space needed for the low friction contact device. The preferred embodiment employs wheels 350 and 352 as the low friction contact device.

Depending on the application, plate 306 can be eliminated and first and second links 304 and 308 may be connected directly to bottom plate 104. In the embodiment where the first and second links 304 and 308 are connected directly to bottom plate 104, the first and second links, the bottom plate 104 and the base 202 form the rotaxial linkage mechanism. In yet another embodiment the outer ends of the links can be rotatably attached to the floor to form the rotaxial linkage mechanism. In the latter embodiment appropriate spacers between the floor and the links should be employed to compensate for the distance needed by low friction contact device.

Top rotaxial linkage mechanism 400 is preferably located between the outside structure 200 and movable object 102. The top rotaxial linkage mechanism 400 is constructed, in one embodiment, substantially similar bottom rotaxial linkage mechanism 300. Top rotaxial linkage mechanism 400 provides top support for the movable object 102. The outer ends of top first and top second links 404 and 408 may be rotatably connected to top plate 210. Preferably the links 404 and 408 are rotatably connected to vertical support members 204 and 206 by pins 410 and 412. The inner ends of links 404 and 408 are preferably connected to a plate 406 by pins 414 and 416. Plate 406, in one embodiment, is bolted to top storage plate 106. As described with regard to the bottom rotaxial linkage mechanism, links 404 and 408 and plate 406 are connected serially and form a three link chain. As with the bottom rotaxial linkage mechanism 300 there are various embodiments that will provide the desired rotaxial movement. Top and bottom rotaxial linkage mechanisms 300 and 400 together with outside structure 200 form means to hold and support the movable object 102 and provide a predetermined path for its transitional movement from one alternate orientation to another.

Top rotaxial linkage mechanism 400, in one embodiment, is constructed similar to the bottom rotaxial linkage mechanism 300. As such, the length of the links of top rotaxial linkage mechanism 400 is substantially same as the links in bottom rotaxial linkage mechanism 300. Because of this, the respective pins of both bottom and top rotaxial linkage mechanisms 300 and 400 are located on the same axes allowing relatively jam free rotation of the movable object 102.

In the presently preferred embodiment, bottom and top rotaxial linkage mechanisms 300 and 400 are connected to each other to form a synchronized rotaxial linkage mechanism. This facilitates the movement of the movable object helping to form a strong and rigid reversible storage structure that can hold significant load. The synchronized rotaxial linkage mechanism preferably comprises two rotaxial linkage mechanism interconnected in a manner that such that the first bottom link and the first top link rotate around their respective outer ends simultaneously and strike the same length arc. Similarly, the second bottom link and the second top link rotate around their respective outer ends simultaneously and strike the same length arc. In the preferred embodiment, a torsion bar 430 is used to interconnect the two rotaxial linkage mechanisms. Preferably the outer end of torsion bar 430 is connected to the first bottom link 304 at its pin 310 and the other end of the torsion bar 430 is connected to first top link 404 at its pin 410 to form a rigid coupling between first bottom link 304 and first top link 404. Partially due to the rigid coupling, links 304 and 404 are able
to rotate synchronously and reduce the possibility of jamming. Minimizing the possibility of jamming is an advantage of the present invention over the conventional rotating cabinetry design, such as described in U.S. Pat. No. 4,124, 262. Another advantage of employing vertical bar 430 is to enhance the safety of the reversible storage system 100 since it reduces the possibility of being tip-over.

[0057] To provide additional strength, a fully synchronized rotaxial mechanism may be employed. The fully synchronized rotaxial mechanism comprises a synchronized rotaxial mechanism with a rigid connection between the second top and second bottom links. The rigid connection, is preferably accomplished by adding a second torsion bar 440 and connecting one end of torsion bar 440 to second bottom link 308 at pin 312 while the other end of torsion bar 440 is connected to second top link 408 at pin 412 to form a rigid connection between links 408 and 308. This second torsion bar 440 increases the strength of the reversible storage system 100 and with the first torsion bar 430 further decreases the likelihood of jamming during movement.

[0058] FIGS. 1G and 1H illustrate preferred features of wheels 350 and 352 in accordance with one embodiment of the present invention. Referring to FIGS. 1G and 1H, wheels 350 and 352 are attached to the bottom rotaxial linkage mechanism 300. They are attached to the inner ends of bottom first and bottom second links 304 and 308 of the rotaxial linkage mechanism. The wheels support the load from the movable object 102 when it rotates and also when it is in stationary position. Weight of the movable object 102 is transferred by the wheels to base 202. The wheels roll across the base 202 in an arc as constrained by the rotation of the bottom links. The wheels 350 and 352 in this embodiment are non-rotatably attached to the links 304 and 308. It should be noted that the wheels may also be rotatably attached. The non-rotatable attachment simplifies the design. Base 202 preferably has smooth surface along the arc struck by the rotation of the links to provide for smooth rotaxial movement of the movable object 102.

[0059] FIG. 11 illustrates an embodiment that includes an electrical, phone or other data type outlet or connection in the movable object 102. This is preferably accomplished by attaching cables 250 which may carry electricity, phone signals, cable TV signals or other data signals, to top second link 408. For example cable 250 is shown used for transporting electrical power and signals running from outside of the reversible storage system 100 along link 408 to the articles such as TV 120, stereo system 122, lamp 138, and et cetera. In one preferred embodiment, the cable 250 includes a loop 252 at each point of attachment that is sufficient large to compensate for the movement of the second top link 408. While other types of cable connections exist for making these types of connections and may certainly be employed, this loop type connection which may be used because the present invention allows an object to be alternatively reoriented without exceeding a 360 degree movement, may improve service life of the cables. In another embodiment, cables 250 run inside of link 408 or inside a torsion bar 440 that is hollow.

[0060] FIGS. 1J and 1K illustrate a reversible storage system 100 with a locking device 136 in accordance with the present invention. Locking device 136 attached to frame wall 116. It has locking bolt 144 and spring loaded wedged bar 146. When locks are engaged they go inside the holes in the vertical member 206 of the outside structure 200. A purpose of having a locking device 136 is to secure stationary position of the frame from unintentional movements. The locking device 136, in one embodiment, is operable with a key to protect cabinet from unauthorized rotation and from unauthorized access to the other side of the cabinet. The rotating object 102, in one embodiment, has handles 240 on the side of the object facilitating the rotation.

[0061] FIG. 1L shows a reversible storage system 100 having a control system 1019 in accordance with the present invention. Control system controls the rotation of the movable cabinet through electrical systems and mechanical devices including a motor. Gear motor 260 is mounted at the top of the vertical member 206 with hinge 262. Square telescopically built shaft 264, 266 transfers rotation to a worm 268 and then to a worm gear 270. Worm 268 and worm gear 270 with ball bearings 274 and 276 located in the gear housing not shown in FIG. 1L. Output shaft of the worm gear attached to the top plate 106 of the storage. Rotation of the motor is transferred by described mechanism to the rotation of the storage. Change of the storage position relative to the outside structure is compensated by telescopic shaft 264, 266 and also by hinge 262.

[0062] FIGS. 1M and 1N illustrate a structure having an additional compartment 170 in accordance with the present invention. In this embodiment, there is one more vertical wall 116 is installed inside of the rotating object 102. This second wall 116 is installed with small distance from the first one. On the right side of the storage wall as shown in FIG. 1M there is opening on the sidewall 110. So there is additional “secret” compartment 170 in the storage that can be useful for many applications such as storing maps and drawings. FIG. 1N shows a fully displayed map 180 pulled out of the compartment 170.

[0063] In operation, movable object 102 shown in FIG. 1A is positioned with one side of the movable object 102 open for access. This side is holding books. Most of the time cabinet is in one of the stationary positions or orientations with one or two main sides open for access. In one embodiment, some modifications of the built storage protective covers 130, 132 should be unlocked for access to “open” side. FIG. 1A also illustrates another side of the movable object 102 faces the wall 210 and therefore is not accessible.

[0064] To access the other side of the movable object 102, operation starts from release the locking device 136 if it is engaged. Then one pulls the cabinet frame away from the wall 210 using one of the handles 240. Because the pins 314 and 316 are part of the outside structure 200, the motion can be deduced from knowing the directions of the movement of these pins. The direction of the motion of the pins 314 and 316 is perpendicular to their links themselves. In starting position, links 304 and 308 are parallel, therefore motion of the movable object 102 at starting point is rectilinear without rotation. Moveable object 102 is directed away from the wall 212 with small angle to the one of the left or right sides. Transitional positions of the storage rotation are shown on FIGS. 1B-1D. FIG. 1E shows second standard position for access of the articles that are held on opposite side to the first access side. This second side is shown with articles related to TV and stereo system. One can engage locks 136 if needed.
FIG. 2 illustrates a storage structure 100 with different storage articles in accordance with one embodiment of the present invention. FIG. 2 shows the application of the storage structure 100 for holding or safekeeping collectibles 152 and 154, such as knives and coins. Holder 160 holds knives and coins in place. The second side of storage structure 100 may be used for storing books. Above one of the cabinet shelves lamps 138 may be mounted to provide light when it is needed. For keeping articles from sliding off the movable object 1202, holders, such as 160 can be added for stronger attachment of the articles to one of the accessible sides. In addition to the depicted holder, cells, clamps, brackets, hooks, locks, etc., can be used.

FIG. 3 illustrates a structure with different storage articles in accordance with one embodiment of the present invention. FIG. 3 shows the safekeeping of the firearms 156 and 158, wherein the firearms 156 and 158 are held to the movable object by holders 142.

FIG. 4A-4D illustrate a structure 1300 having light articles 1106 and 1116 mounted on a desk 1202 in accordance with one embodiment of the present invention. FIG. 4A shows two designs of light article storage 1106 and 1116 that are shown in two alternate positions. There are two minor differences in their common components. In one embodiment, the length of the fourth, stationary link defined by distance from joint 1310 to joint 1312 is shorter than the size of the bottom plate 1104. This particularity that length of the stationary links 1310 and 1312 is larger than the bottom plate 1104 allows implementation of simple straight torsion bars outside of the storage frame to connect lower and upper outside links (1304 with 1404 and 1308 with 1408).

Second difference between common components of invention implementations shown in FIG. 4A and FIGS. 1A-1E is as follows. In FIG. 4A-4D, one access side is shown with shelves, second opposite access side is shown blank without shelves. It can be used for simplified storage to post notes, calendars, list of things to do, or just to use it as a black board or screen, etc. If desired, opposite access side can have more developed storage accommodations. They can be different depending on articles to be stored.

All common parts in FIGS. 1 and 4 are designated with the same numbers. FIG. 4A shows a right storage 1106 in first starting position with side labeled “open” available for access. A left storage 1116 is shown in rotated 180° in opposite and alternate position as the right storage 1106. Side labeled “open” is facing back wall 1212 and this side is closed for access. Both storages 1102 are mounted on the simplified outside structure that in this embodiment is the top plate 1202 of the desk or table. Back wall 1212 is optional.

FIG. 4B shows exploded view of FIG. 4A with visible parts of bottom rotaxial linkage mechanism 1300. Mechanisms of both storages are identical but shown in alternate positions corresponding to the storages being in opposite positions.

FIG. 4C shows exploded view of the structure 1320 when storages are in reversed position relative to FIGS. 4A and 4B. FIG. 4D shows cross-section of the bottom rotaxial linkage mechanism 1300 through the link 1308. This cross-section shows standard design of the all links and their hinged connection to the stationary base 1202 and to the movable link 1104 where it is at the same time the bottom plate of the storage 1102. Joints 1312 and 1316 in this embodiment are constructed substantially the same. For simplicity of the example, joints 1312 and 1316 are shown without special rotation bearings. Joints 1312 and 1318 are made from metal. Link 1308 is made from plastic with good tribological performance to provide good friction pair to the joints. Being made from plastic link 1308 will have also good friction performance when it is sliding on the surfaces of the stationary plate 1202 or bottom plate 1104. In another optional configuration joints and links can be made from metal with bearings installed between them. To improve sliding between the links and the plates 1202 and 1104, links can be covered on their sliding surfaces with fabric or felt with good friction properties.

FIGS. 5A-5E, 6A-6E, 7A-7E, 8A-8E show examples of different geometrical variations of link system for performing rotaxial movement in accordance with the present invention. Also these figures demonstrate the principle of how these implementations work. To simplify the demonstration of working principle of present invention, only bottom plate 104 of rotating storage is shown. All movements of the bottom plate 104 as shown in FIG. 1A, will represent the movements of the proposed reversible storage relative to the stationary base 202.

FIG. 5A illustrates a bottom plate 104 of the reversible storage system 100 at points B and C connected respectively by revolute joints 314 and 316 to links 304 and 308. Outside ends of the links 304 and 308 connected by revolute joints 310 and 312 to stationary base 202. In the theory of mechanisms stationary plate 202 can be viewed as stationary link AD. Three links AB, BC and CD represent movable serially connected part of the mechanism where bottom plate 104 of the reversible storage can be viewed as middle link BC also designated as 306. Movable three-link chain AB, BC and CD together with stationary link AD represents four-link mechanism that determines the positions and the process of movement of bottom plate 104 and therefore determines the positions and the process of movement of reversible storage cabinet whereby is being means of holding storage cabinet relative to stationary base 202.

FIG. 5A-5E are diagrams illustrating a compound movement link mechanism for the storage structure in accordance with one embodiment of the present invention. Referring to FIG. 5A-5E, figures show the essence of inner workings of implementation shown on FIG. 4A-4D. These figures can represent also invention embodiment illustrated in FIGS. 1A-1E with shortened stationary link AD. For more exact representation illustrated in FIGS. 1A-1E, joints A and D should be outside of the bottom plate 104 (or plate 104 should be shorter than link AD).

In one implementation, revolute joints A and D are located at remote sides of the stationary base generally in the middle area of short, left and right sides of the storage frame. Points B and C for revolute joints 314 and 316 are located on different sides of the line AD generally symmetrical relative to this line. Also joints B and C located at the middle of the front and backsides of the bottom plate 104. In order for bottom plate 104 to rotate between alternate positions spaced generally 180° apart BC is generally perpendicular to AD in starting position of the storage, i.e. FIG. 5A.
The process of reversing the position of the plate 104 (i.e. movable storage) from the starting position of FIG. 5A to 180° reversed final position in increments of 45° is shown on FIGS. 5B-5F. Rotation of the plate 104 starts by pulling right side of the movable object represented here by plate 104 in direction from back to front. In all transitional positions as seen on FIGS. 5B-5D storage as represented here by bottom plate 104 is not crossing backside of the stationary plate 202. Available clearance shown as dimension “a” serves as needed margin for this requirement. In this embodiment for not obstructed rotation of the storage there should be some clearance on left and right sides of the movable object 102.

FIG. 6A-6E are schematic representations illustrating an operations of the storage with outside joints of the four link mechanism moved back on the stationary plate in accordance with one embodiment of the present invention. FIG. 6A shows, in one embodiment, the locations of points A and D representing revolute joints 310 and 312, which are moved back on stationary base 202. Locations of revolute joints B and C are shifted left as shown in FIG. 6A on bottom plate 104. Line BC remains perpendicular to AD on starting position.

FIGS. 6B-6D show transitional rotation of plate 104 in steps of 45° to a position shown in FIG. 6E in which plate 104 is in 180° reversed position relative to starting position of FIG. 6A. Previously back side of bottom plate 104 shown in FIG. 6A that did not have access to it occupies now front position in FIG. 6E and become accessible now. This embodiment shows that in transitional positions especially close to position as shown in FIG. 6C points B and C are not moved so much forward as shown in FIG. 6C. This means that stationary plate 202 that supports wheels 350 and 352 (see FIG. 1C) located generally under the revolute joints B and C does not need to extend much forward, it can be smaller. Also this variation of present invention saves space in front of the storage for transitional positions of the storage and can be more stable against tip-over.

For clarity of the explanation of the principal differences between different modifications of the present invention the changes are shown on the drawings but secondary differences, mostly dimensional are not reflected on the drawings. For example, FIG. 6A shows joints A and D, B and C that are located at positions that allow some uniformity with the other drawings but for optimization of each particular embodiment locations of these joints could be changed. For example, joints A, D shown in FIG. 6A could be moved more apart from each other to allow even better clearance than shown on FIG. 6C.

FIGS. 7A-7E are schematic representations illustrating operations of the storage with outside joints of the four link mechanism located in diagonal corners of the stationary plate in accordance with one embodiment of the present invention. In this embodiment, joints A and D as shown in FIG. 7A are located at diagonal corners of stationary plate 7202. Joints B and C are located on the bottom plate 7104 approximately in the middle areas of its front and back sides at positions on different sides of the line AD and line BC in starting position as shown in FIG. 7A is perpendicular to line AD.

FIGS. 7A-7E show transitional rotation of plate 7104 in steps of 45° to position shown in FIG. 7E where plate 7104 is in 180° reversed position relative to starting position of FIG. 7A. Previously back side of bottom plate 7104 shown in FIG. 7A that did not have access to it occupies now front position in FIG. 7E and became accessible now. One of the most important advantages of this embodiment is that during rotation for 180° in all transitional positions the movable storage generally does not need clearance or additional space for rotation. This is because during rotation of the storage its transitional positions are shifted away from the generally short side, particularly the side where one of the joints A and D is moved forward. The left side as shown in FIG. 7A does not need extra clearance. One of the applications when this advantage can be realized is when two storage cabinets are located side by side next to each other as shown in FIGS. 8A-9A.

FIG. 8A-8A are schematic representations illustrating operations of the storage with outside joints of the four link mechanism located in diagonal corners of the stationary plate and storage rotating 90° between positions of alternate access in accordance with one embodiment of the present invention. FIG. 8A shows another modification of present invention. It can be viewed in comparison with previous example as having stationary base 8202 and bottom plate 8104 generally as square plates.

As shown on FIG. 8A, for clarity but not necessary in real embodiment, stationary plate 8202 is larger than bottom plate 8104. Joints A and D are located at remote diagonal locations of the stationary plate 8202. Joints B and C joints are located at positions of bottom plate 8104 generally symmetrically to the center point O of the line AD in a such way that line BC forms 45° angle with the line AD. Plate 8104 has optional rounded corners 170. On back and right sides of the storage are shown obstacles 8220 and 8222. They can be walls, barriers, other similar cabinets, etc. For easier understanding of the process of rotating the storage from starting access position as shown in FIG. 8A to reversed, final access position as shown in FIG. 8E bottom plate 104 has labels marking all four sides as viewed from starting position.

Because of 45° degree angle between BC and AD angular distance between two alternate access positions is 90° (not 180° as in previous examples). Transitional position from starting to final position are shown in intervals of 22.5° shown in FIGS. 8B-8D. During rotation of the bottom plate 8104 this plate will not interfere with back and sidewalls of 8220 and 8222 especially if it has rounded corners 8170 or if there is even minor clearance between bottom plate 104 and walls 220 and 222. Because of the rotation of the plate 104 for alternating access to the sides of the storage is 90° (not 180° as in previous examples) alternating access to the sides of the storage is planned differently. For example, a storage structure may be organized into front and backside (as shown in FIG. 8A) for holding articles. Left and right sides are blank. Only front side as shown in FIG. 8A has access to its articles and backside is blocked from accessing to articles by wall 8220. After storage rotation by 90° clockwise to position as shown in FIG. 8E front labeled side has no access because it is blocked by wall 8222. “Back” labeled side is open for access from the right side.

Second example of storage structure is that only front side has developed storage structure for holding essen-
articles while other three sides could be just blank walls. Then rotation of storage by 90° will block access to storage completely. Rotation of the storage back to starting position will open front side again for access. There could be more other applications of present inventions that could differ in details but follow the essentials of proposed inventions. To rotate bottom plate 8104 as representing storage rotation backward from final alternate access position to starting alternate access position for all four previous examples one has to follow shown figures from “E” to “A”.

[0086] FIG. 9A-9B are diagrams 900-920 illustrating a storage designed for light loads mounted on a desk with rotaxial designed illustrated in FIG. 8A-8E. FIG. 9A represents practical implementation of proposed invention per modification shown on FIG. 7A-7E. FIG. 9A shows two storages 9002 and 9004 as shown. For clarity the sides for storage access are labeled “open”. In this example, they are on the front sides of starting position. Details of operation and construction are similar to steps shown in FIG. 4A-4D.

[0087] FIG. 9B shows exploded view of FIG. 9A. FIG. 9C shows exploded view of the storage when it is rotated 90° counterclockwise for left storage and clockwise for right storage. In these alternated positions, open sides of the storage are blocked by neighboring storage. In this example, two storages are located next to each other and do not interfere with each other during rotation utilizing the advantages of the scheme represented in FIGS. 7A-7E.

[0088] FIG. 10A-10C are diagrams 2100 illustrating a storage rotating between alternative accessing positions around horizontal axes in accordance with one embodiment of present invention. FIGS. 10A, 10B and 10C show simplified and modified version of structure shown in FIG. 1A in which FIG. 10A shows nominal starting position of the storage while FIG. 10B shows an 180° reversed of the storage with alternative accessing position of the storage. FIG. 10C shows exploded view of the storage in starting position. Simplification is achieved by omitting optional features of the design shown in FIG. 1A-11, including omitted torsion bars, wheels, lamps, cables, glass covers, locks, trimmings, etc. A modification of this embodiment is means for holding the storage frame whereby giving the storage its kinematical determination are located not at the bottom and top sides of the frame but on the left and right sides of the storage frame. It looks like vertical storage as shown in FIG. 1A was turned back 90° from vertical to horizontal position. In this position previously front side shown in FIG. 1A became upper side of storage shown in FIG. 10A. Previously bottom side became right side and previously right side became front side as shown in FIG. 10B.

[0089] All common parts shown in FIG. 10A and FIG. 1A are shown with the similar number designations. The storage 2100 includes movable object 2102 that is to hold articles, also the storage includes means to hold proper storage 2102 in which box 2200 represents optionally developed outside structure and rotaxial linkage mechanisms 300 (right one) and 400 (left one). Movable object 2102 is build in this example as flat horizontal box open from top and bottom includes right plate 2104, left plate 2106, and optional front and back walls 2108 and 2110. The frame also includes cellular holder 2160 to hold articles that are not shown here for generalization purposes. Top holder is arbitrary shown in this example as having 48 cells for articles and bottom holder 2162 shown in FIG. 10B has 24 cells.

[0090] Holding means include box 2200. Box 2200 has optional cover 2250. Right and left walls 2202 and 2210 of the box 2200 serve as stationary bases of the left side and right side rotaxial linkage mechanisms 2300 and 2400 respectively for holding of proper storage 2120. There are also front and back walls 2204 and 2206, respectively.

[0091] Right rotaxial linkage mechanism 2300 and left rotaxial linkage mechanism 2400 connect storage 2120 with outside box 2200. FIG. 10C shows details of the right rotaxial linkage mechanism 2300. Left rotaxial linkage mechanism 2400 is not visible on this view but it is generally the same rotaxial linkage mechanism 2300 as being symmetrical to it on the other side of the storage. Links 304, 306 and 308 of rotaxial linkage mechanism 2300 connected serpentine represent the movable part of the rotaxial linkage mechanism 2300 and by their outside ends connected to the stationary box wall 2202 by pins 2310 and 2312. Links 2304 and 2308 by their inner ends connected to the right plate 2104 of the storage 2102 by pins 2314 and 2316.

[0092] Movable three-link chain 2304, 2306 and 2308 together with stationary link 2202 represents four-link mechanism, which determines the positions and the process of movement of bottom plate 2104 and therefore determines the positions and the process of movement of reversible storage 2120 whereby is being means of holding storage cabinet relative to the stationary base 2202. The same is true for left rotaxial linkage mechanism 2400. Because of the substantial symmetry of the right and left rotaxial linkage mechanisms 2300 and 2400 and the relative uniformity of the gravitational load this embodiment even without torsion bars is providing generally jam free reversing of the storage 2102 for alternative accesses to upper and bottom sides of storage 2112. If there is more demanding application for strength, reliability and smoothness of the operation of the storage then storage can be modified, e.g. by introducing torsion rods.

[0093] FIG. 11A-11D are diagrams 2400 illustrating application of proposed invention with for four square storages mounted next to each other on one square stationary plate in accordance with one embodiment of present invention. FIGS. 11A-11D show an embodiment of four substantially identical storages located next to each other in circular symmetry around central axis. There is no obstruction around this group of storages. This group of storages can be accessed from all four sides. Stationary plates of all four storages combined into one common stationary plate 3202 serving all four proper storages 3102. Each proper storage 3102 has one side with developed shelving 3112. For clarity on the top of each storage label “open” is placed on the side with shelving for each storage 3112.

[0094] Detailed mechanical operation of this embodiment is similar to the operation shown in FIGS. 8A-8E. FIG. 11B shows all four proper storages rotated 90° clockwise to the second alternated positions. All four “open” sides with open shelves are closed for access.

[0095] FIG. 11C shows a top view of the structure shown in FIG. 11B including rotaxial linkage mechanism 300 links conditionally shown as visible through the storage parts. Designations of the components are similar to designations...
There could be many different schemes applied for simultaneous rotation of these four boxes. FIG. 11D shows top view of one of the simpler designs in accordance with the present invention. Generally, square shape member 3330 rotates around central axis “O”. This member has at each of its corners four identical joints 3332. Each of these joints 3332 connected by link 3334 to links 3304 at joints B. Because of circular symmetry of the system, rotation of all storages 3102 is synchronized. Theoretically, there is dead point for rotation when link 3306 and link 3308 are on one line, but as with other similar mechanisms continuation of the storage rotation by inertia resolves these situations for all practical purposes.

Another example of interchangeability of words relates to the words rotate, reverse, transpose, etc. Description is using the word rotate in wide application of it—rotation not necessary about static axis but rotation about axis that can be different at different moments (like rotation about momentary axes). Reverse and transpose relates mostly to results of motion than to process of motion.

Although the description above contains much specificity, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Thus the scope of this invention should be determined by the appended claims and their legal equivalents. Therefore, it will be appreciated that the scope of the present invention encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean “one and only one” unless explicitly so stated, but rather “one or more”. All structural, chemical, and functional equivalents to the elements of the above-described preferred embodiment that are know to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention for it to be encompassed by the present claims.

FIG. 12A-12D are diagrams illustrating a wheel system attached to a link in accordance with one embodiment of present invention. FIG. 12A shows a top view of wheel system 4200 having two wheels 4202-4204 and a wheel frame 4210. The wheels 4202-4204 are mounted in a middle bar 4212 of the wheel frame 4210. The wheels 4202 contact the ground or track while a portion of wheel frame 4210 attaches to the rotating object. During the operation, the wheels 4202-4204 can move in a predefined trajectory while a portion of wheel frame 4210 that attaches to the rotating object can move in a different orientation so that a rotational movement can be accomplished.

FIG. 12B shows a cross-section view of a wheel system 4250 in accordance with one embodiment of the present invention. Referring to FIG. 12B, a portion of the wheel frame 4210 attaches to the rotating object or moving cabinet 4232 while another portion of the wheel frame 4210 attaches to a link 4230 for performing link assisted rotational turning.

FIG. 13A-13C are diagrams illustrating a rotating frame capable of attaching a set of wheels in accordance with one embodiment of present invention. FIG. 13A illustrates a rotating frame 4300 having top plate 4302 and bottom plate 4304. In one embodiment, the bottom plate 4304 further includes two wheel-mounting places 4306-4308. The wheel mounting places 4306-4308 are capable of mounting wheel frames 4210 with sets of wheels 4202-4204. The wheels 4202-4204 are further attached to two links for controlling the turning of the movable object.

FIG. 13B is a 3D picture illustrating a structure 4310 having a two-link system with wheels wherein the bottom plate 4304 of the rotating frame has turned in 90 degree (extending forward) from a set position. Set position means one side of rotating object is accessible while another side of rotating object is not accessible because it is covered by the back wall. The structure 4310 includes a bottom plate 4304, two links 4312-4314, ground plate 4320, and wheels 4210. In one embodiment, the bottom plate 4304 performs a rotational movement in response to the movement of the links 4312-4314.

FIG. 13C is a 3D structure 4350 having a bottom plate 4304 of the rotating frame 4300 in accordance with one embodiment of the present invention. The structure 4350 shows the bottom plate 4304 in a set position.

FIG. 14 is a set of diagrams illustrating a rotating object 4400 performing a rotational movement in accordance with one embodiment of present invention. FIG. 14 is a top view of the rotating object 4400 wherein the rotating object 4400 has a rotating axis 4402. Also, the object 4400 has two sides 4404-4406. The set of diagrams shows a sequence of rotational movement to reverse the side between side 4404 and side 4406 of the object 4400. During the operation of rotational movement, the object 4404 is transported from front side to back side by compound motion. Compound motion, in one embodiment, means rotating the object around its rotating axis while the rotating axis moves along a predefined trajectory. Upon the completion of the rotational movement or rotational rotation, the object is back to the same space with a different orientation.

In the foregoing specification the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than restrictive sense.
What is claimed is:

1. An apparatus comprising:
   an object having a first side and a second side;
   an outside structure having a first side and a second side, wherein said first side of said outside structure is situated at a substantially fixed distance from said second side of said outside structure;
   a first end of a first link coupled to said first side of said outside structure and a second end of first link coupled to said object;
   a first end of a second link coupled to said second side of said outside structure and a second end of second link coupled to said object, wherein said object is capable of performing a rotaxially rotation in response to said first and second links.

2. The apparatus of claim 1 further comprising:
   a first end of a third link coupled to said first side of said outside structure and a second end of third link coupled to said object; and
   a first end of a fourth link coupled to said second side of said outside structure and a second end of fourth link coupled to said object, wherein said object is capable of performing a rotaxially rotation turning from said first side of said second side of object in response to said third and fourth links.

3. The apparatus of claim 2 further comprising:
   a first end of a first bar coupled to said first link and a second end of first bar coupled to third link; and
   a first end of a second bar coupled to said second link and a second end of second bar coupled to said fourth link, wherein said first and second bars assist said object to perform a rotaxially movement.

4. The apparatus of claim 1, wherein said object is a storage structure.

5. The apparatus of claim 1, wherein said first end of first link is pivotally attached to said first side of said outside structure and said first end of second link is pivotally attached to said second side of said outside structure.

6. The apparatus of claim 5, wherein said second end of first link is pivotally attached to a third side of object and said second end of second link is pivotally attached to said third side of object.

7. The apparatus of claim 1, wherein said rotaxially rotation includes a compound motion that allows said object to return to the same space at the end of motion with one of multiple predefined object orientations.

8. The apparatus of claim 2 further comprising:
   a first wheel coupled to said third link for supporting said third link; and
   a second wheel coupled to said fourth link for supporting said fourth link.

9. The apparatus of claim 1 wherein said object is a storage device having two separate storage sections, wherein one storage section is on said first side of object and another storage section is on said second side of object.

10. An apparatus comprising:
    a outside structure having a first side and a second side, wherein said first side of said outside structure is situated at a substantially fixed distance from said second side of said outside structure;
    a first link rotaxially attached to said first side of said outside structure and a first plate;
    a second link rotaxially attached to said second side of said outside structure and said first plate;
    a third link rotaxially attached to said first side of said outside structure and a second plate; and
    a fourth link rotaxially attached to said second side of said outside structure and said second plate.

11. The apparatus of claim 10, further comprising a movable structure having a top plate and a bottom plate, wherein said top plate of said structure is coupled to said first plate and said bottom plate of said structure is coupled to said second plate, wherein said structure is capable of performing rotaxially movement in response to said first, second, third, and fourth links.

12. The apparatus of claim 11, wherein said movable structure is a storage device, wherein said storage device includes two storage sections.

13. The apparatus of claim 10, wherein said first side of said outside structure is situated at a substantially fixed distance from said second side of said outside structure further includes a top frame plate and a bottom frame plate, wherein said top and bottom frame plates are coupled to said frame and provide support of said substantially fixed distance between said first side and second sides of said outside structure.

14. The apparatus of claim 10, wherein said first link rotaxially attached to said first side of said outside structure and a first plate further includes:
    a first end of said first link pivotally coupled to said first side of said outside structure;
    a second end of said first link pivotally coupled to a first end of said first plate;
    a second end of said first plate pivotally coupled to a second end of said second link; and
    a first end of said second link pivotally coupled to said second side of said outside structure.

15. The apparatus of claim 14, wherein said third link rotaxially attached to said first side of said outside structure and a second plate further includes:
    a first end of said third link pivotally coupled to said first side of said outside structure;
    a second end of said third link pivotally coupled to a first end of said second plate;
    a second end of said second plate pivotally coupled to a second end of said fourth link; and
    a first end of said fourth link pivotally coupled to said second side of said outside structure.

16. The apparatus of claim 11 further comprising:
    a first end of a first bar coupled to said first link;
    a second end of said first bar coupled to said third link;
    a first end of a second bar coupled to said second link; and
a second end of said second bar coupled to said fourth link, wherein said first and second bars assist said rotaxially movement.

17. A device having multiple access sides comprising:
a movable structure for holding at least one article;
means for holding said movable structure, said means including a first two link mechanism so that said movable structure is capable of performing a rotaxial movement.

18. The device of claim 17, wherein said movable structure is a cabinet having a front storage section and a back storage section.

19. The device of claim 17, wherein said two link mechanism includes a first link and a second link.

20. The device of claim 19, wherein said two link mechanism includes a third link, wherein said first, second, and third links are movable and serially connected, two outside links are pivotally coupled.

21. The device of claim 17 further comprising a second link mechanism located at opposite side of movable structure, wherein said second two link mechanism includes a third link and a fourth link.

23. The device of claim 21, wherein said first link of said first two link mechanism is rigidly connected to corresponding third link of said two link second mechanism.

24. The device claim 17, wherein said means for holding said movable structure further includes a motor system for facilitating rotaxially rotation automatically.

25. A method for providing a structure having movable object comprising:
  attaching a first end of a first link to a first surface of an object;
  attaching a first end of a second link to said first surface of object;
  moving said object through a trajectory from its original space through a rotaxially rotation in response to said first and second links;
  changing orientation of said object; and
  moving said object back to its original space.

26. The method of claim 25 further comprising:
  attaching a second end of first link to a first support; and
  attaching a second end of second link to a second support.

27. The method of claim 25, wherein moving said object through a trajectory away from its original space with rotaxially rotation further includes transporting said object by moving object axial alone a predefined trajectory while said object rotates around its axial.

28. The method of claim 25, wherein changing orientation of said object further includes rotating said object by moving object axial alone a predefined trajectory while said object rotates around its axial.

29. The method of claim 25, wherein moving said object back to its original space further includes rotating said object back to its original space by moving object axial alone a predefined trajectory while said object rotates around its axial.

30. The method of claim 25 further comprising:
  attaching a third link to a second surface of an object; and
  attaching a fourth link to said second surface of object

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