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(54) **ANTI-TILTING, PIVOTABLE, SLIDING PANELS**

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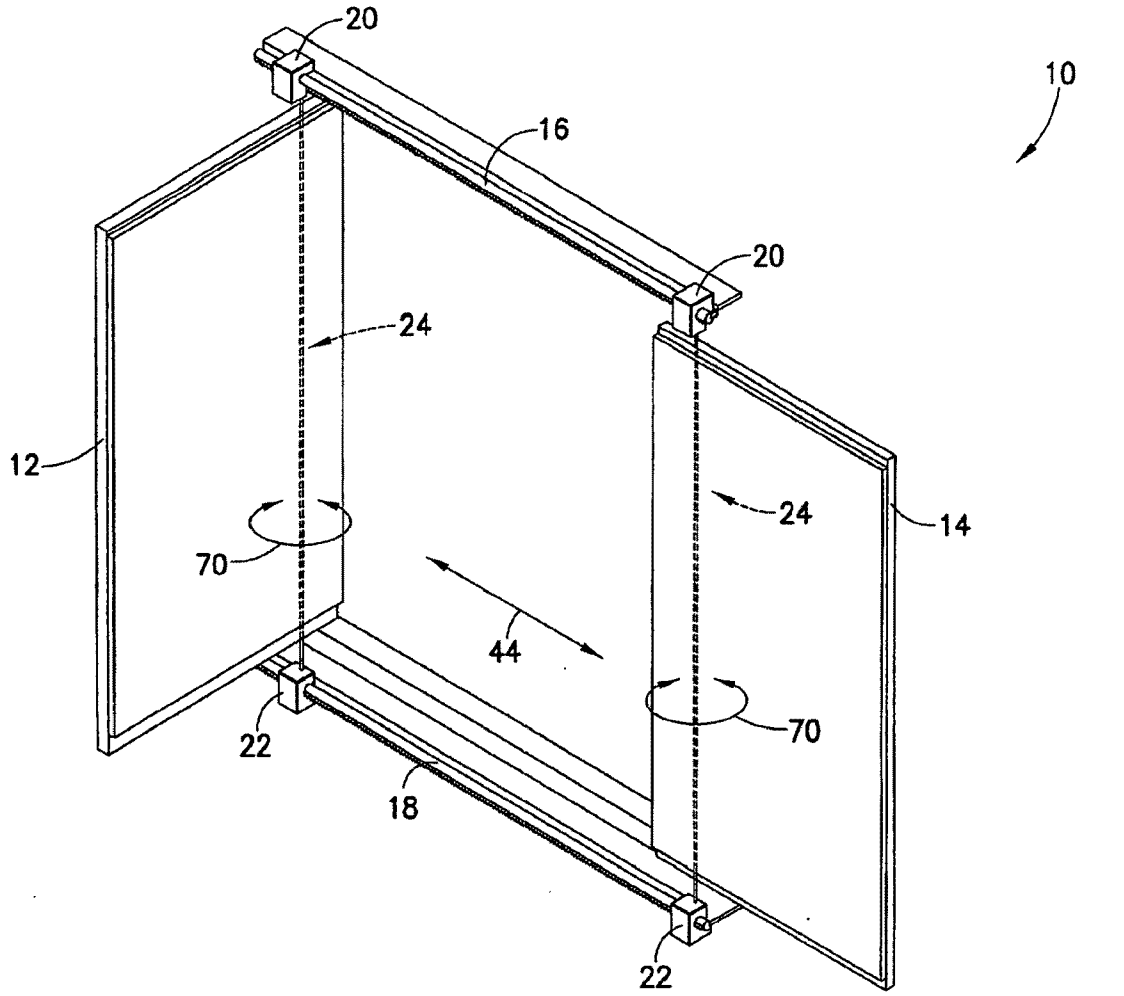
(57) **ABSTRACT**

Disclosed herein is a panel movement system. The panel movement system includes top and bottom rails, top and bottom rail attachments, and a gear movement system. The top and bottom rails include threaded screw members along their lengths and first cog members rotatively coupled to the threaded screw members. The top and bottom rail attachments are movably attached to respective ones of the rails for lateral movement along lengths of the rails. Each rail attachment includes a rotatable second cog member engaged with the first cog member on respective ones of the rails. The gear movement synchronization system connects the rotatable second cog member of the top rail attachment to the rotatable second cog member of the bottom rail attachment such that the top and bottom rail attachments move along the rails in unison. The top and bottom rail attachments are adapted to have a panel connected therebetween.



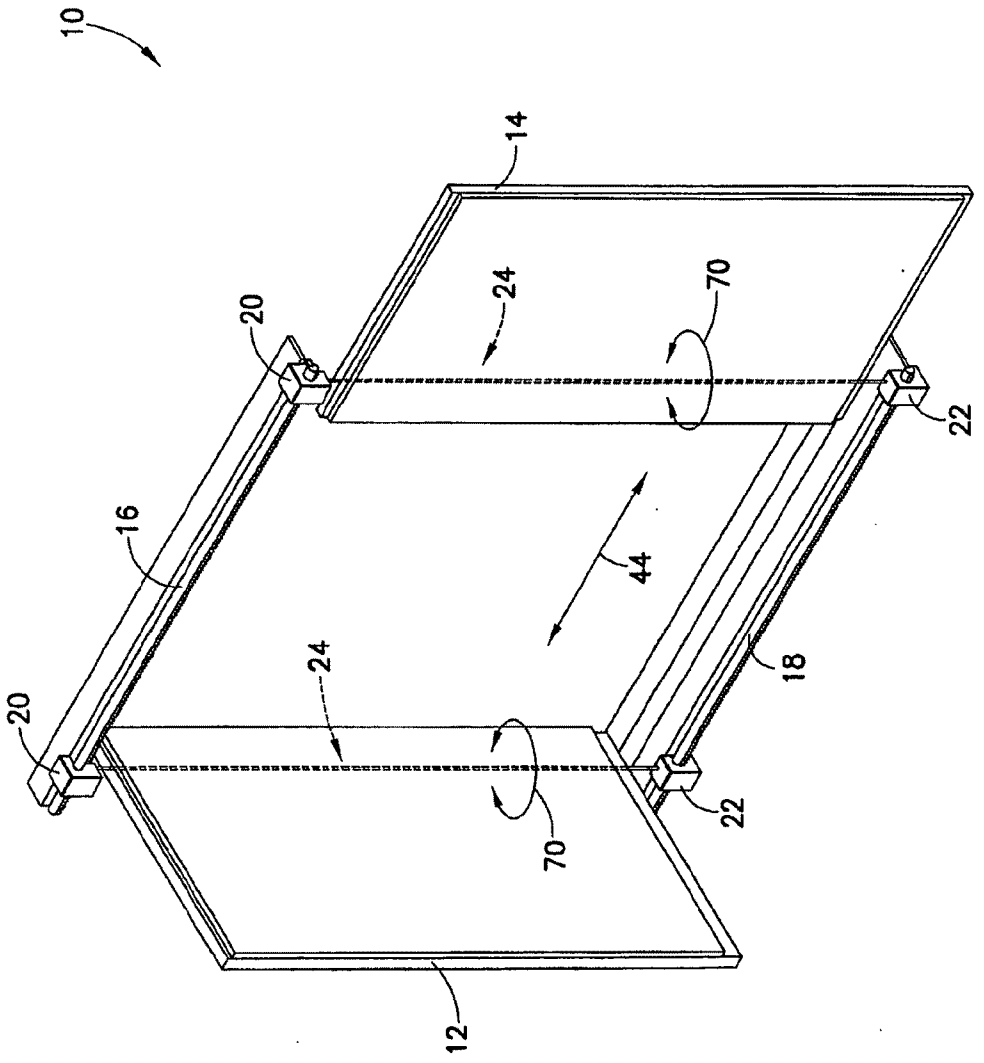


FIG. 1

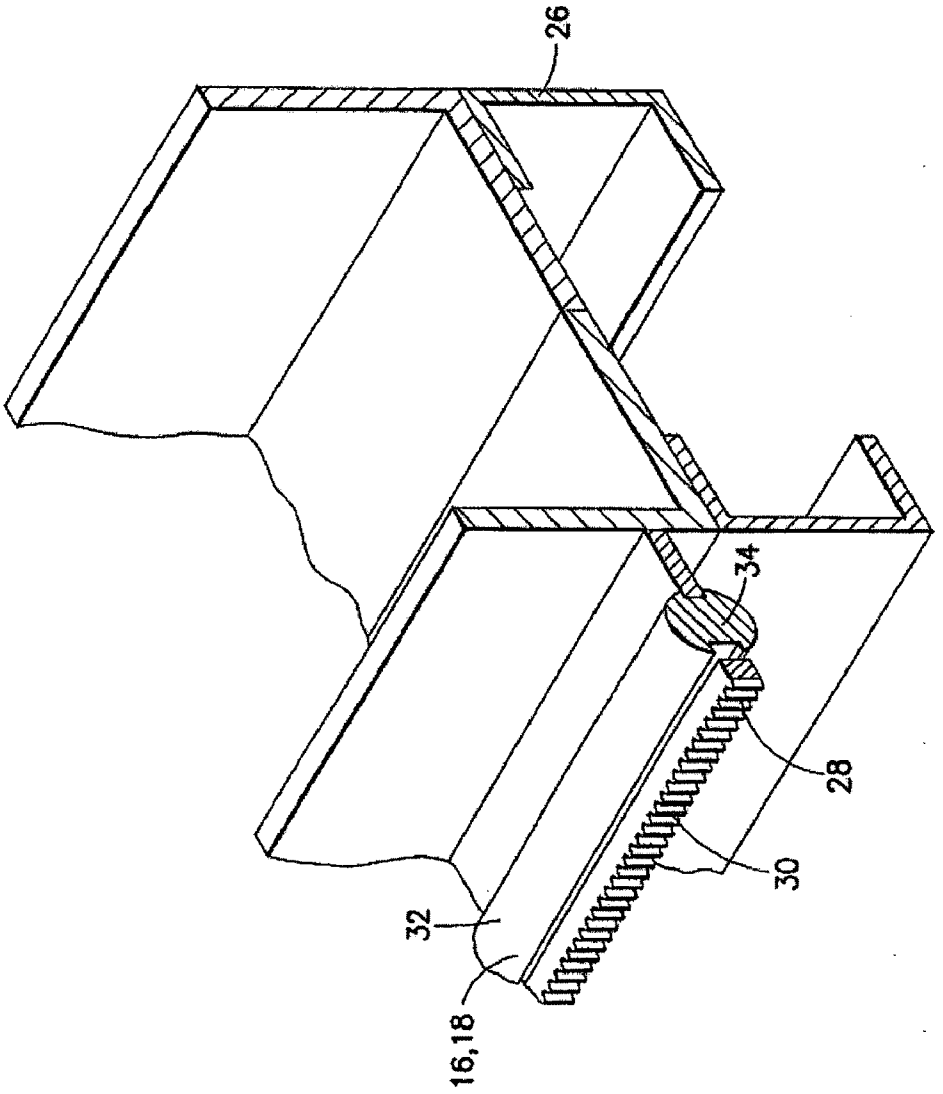


FIG. 2

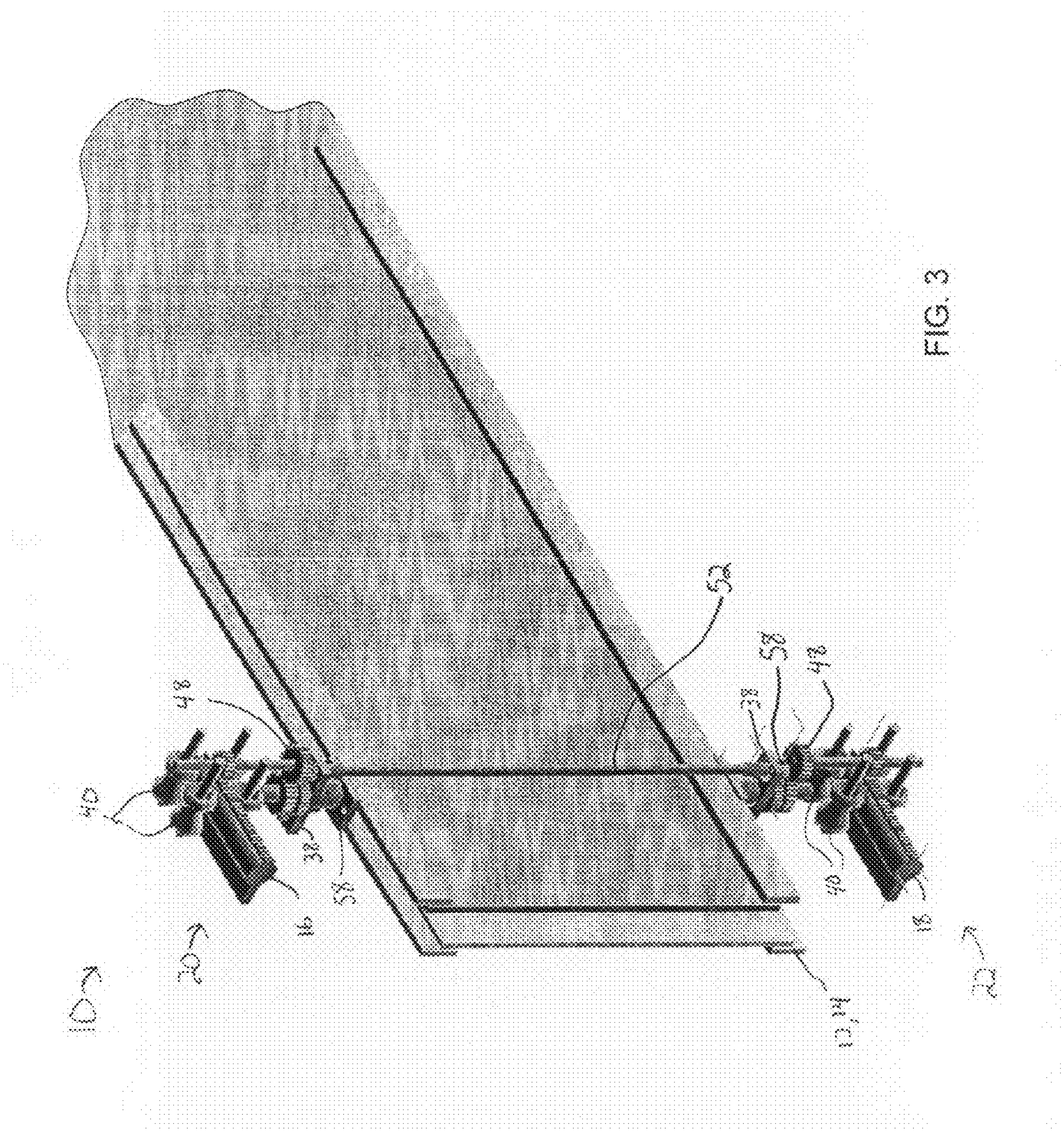


FIG. 3

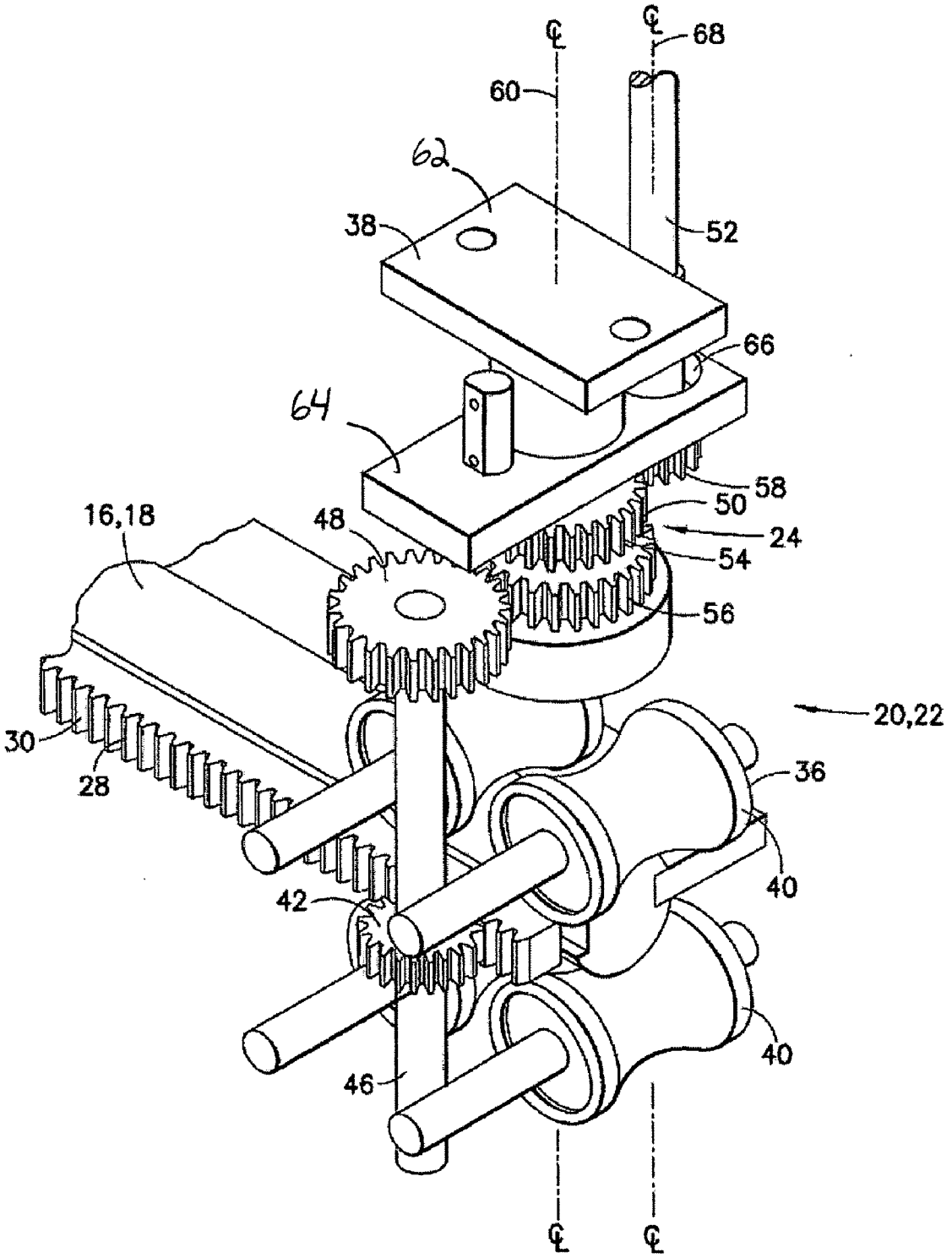


FIG. 4

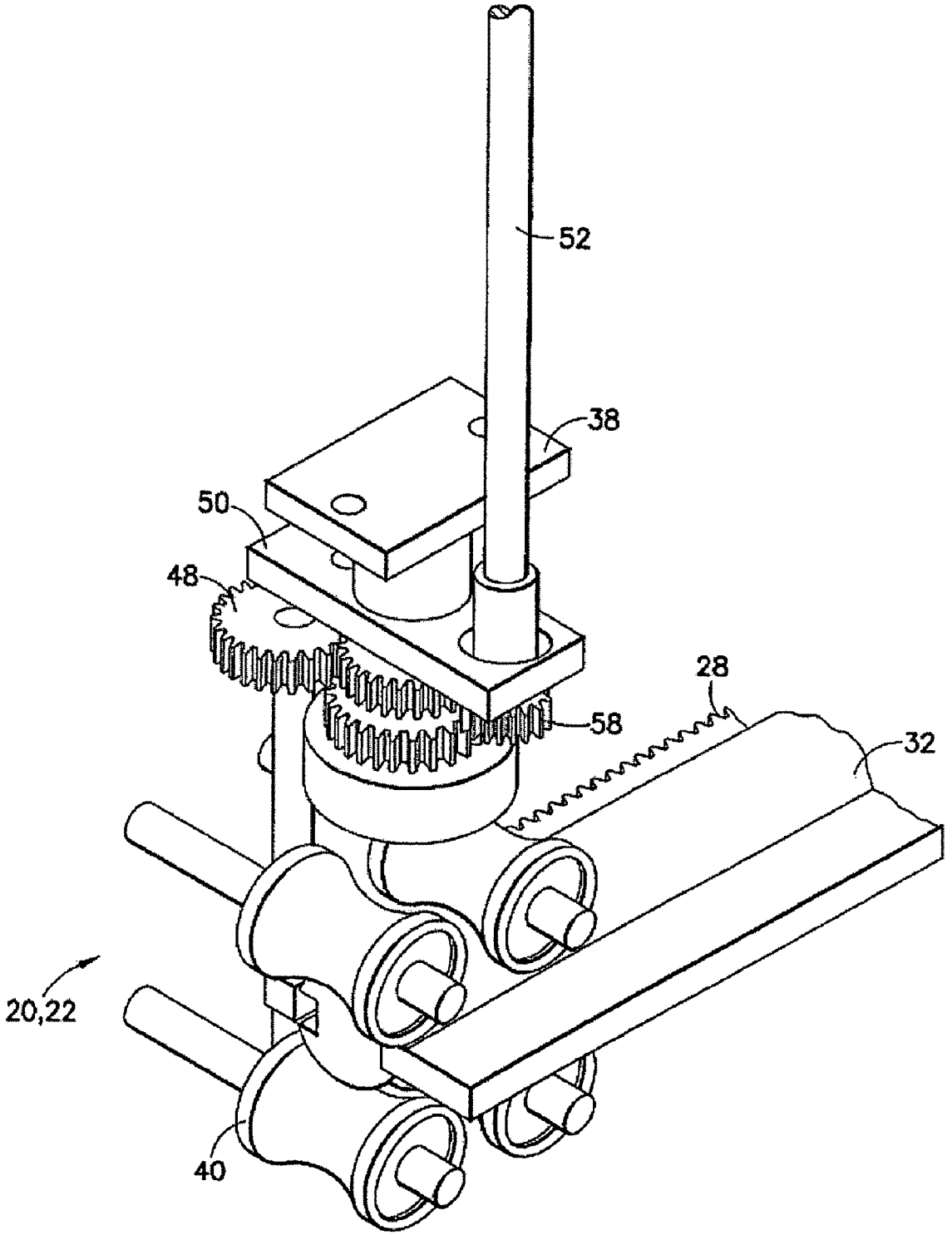


FIG. 5

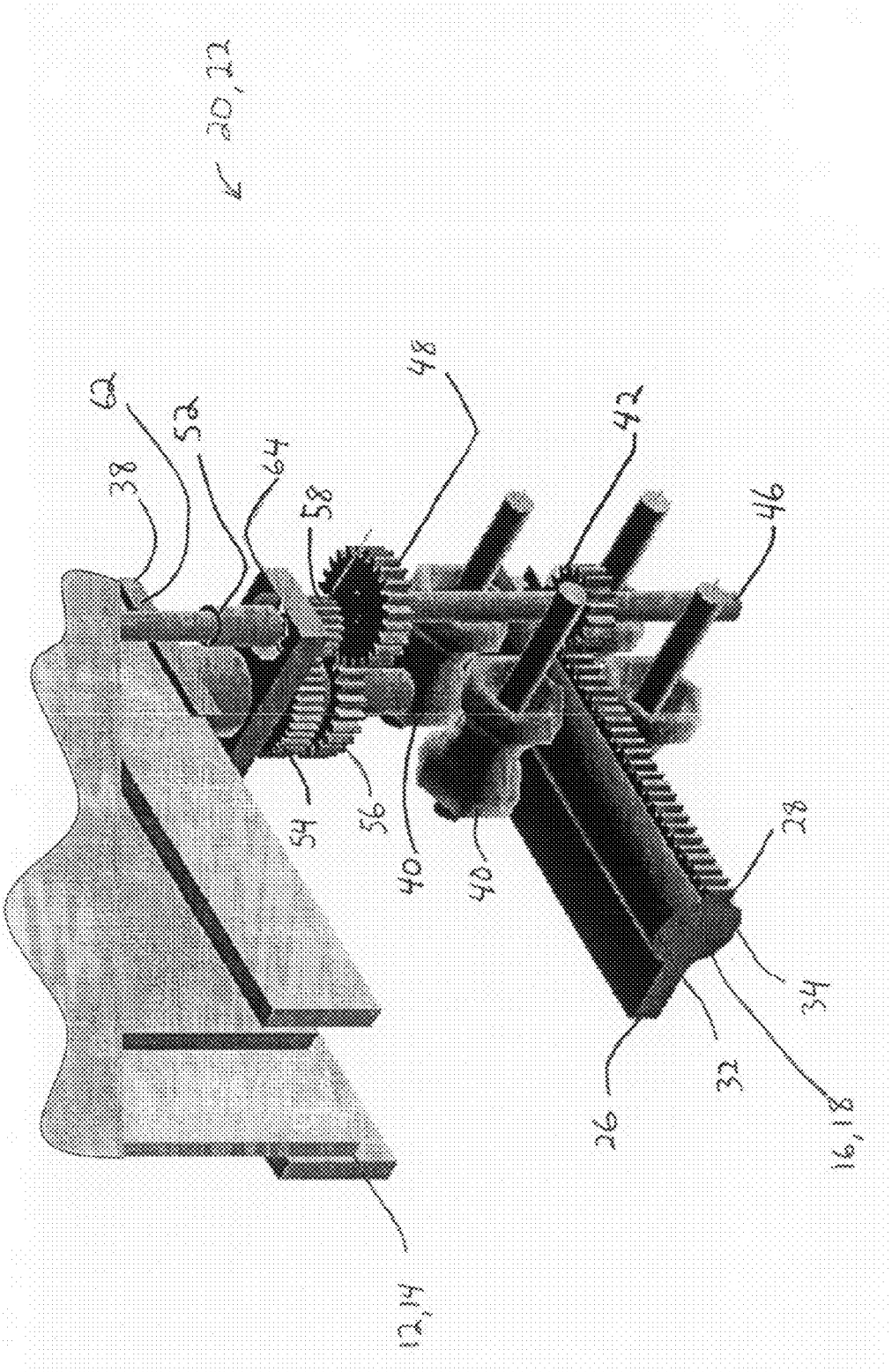


FIG. 6

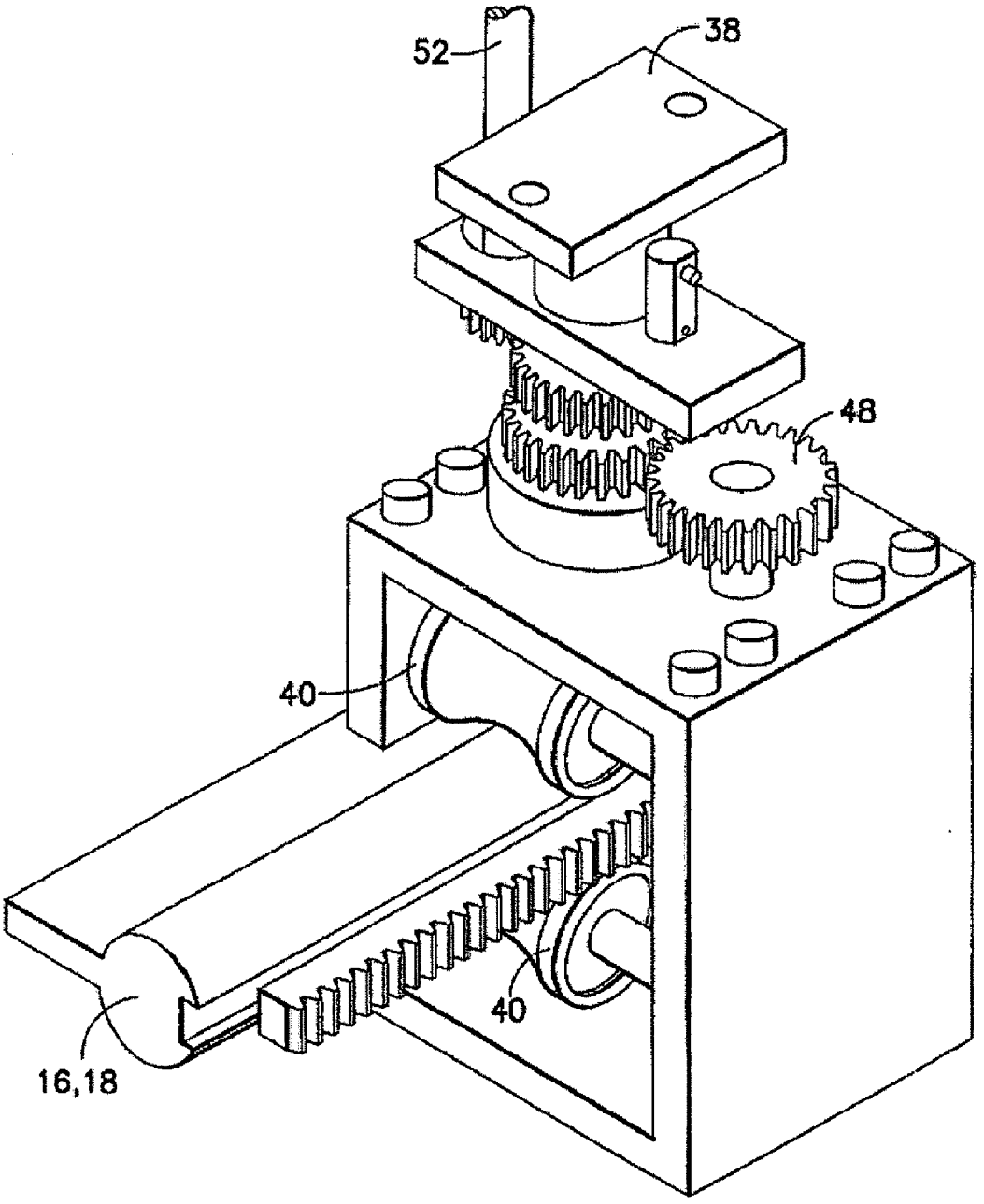


FIG. 7

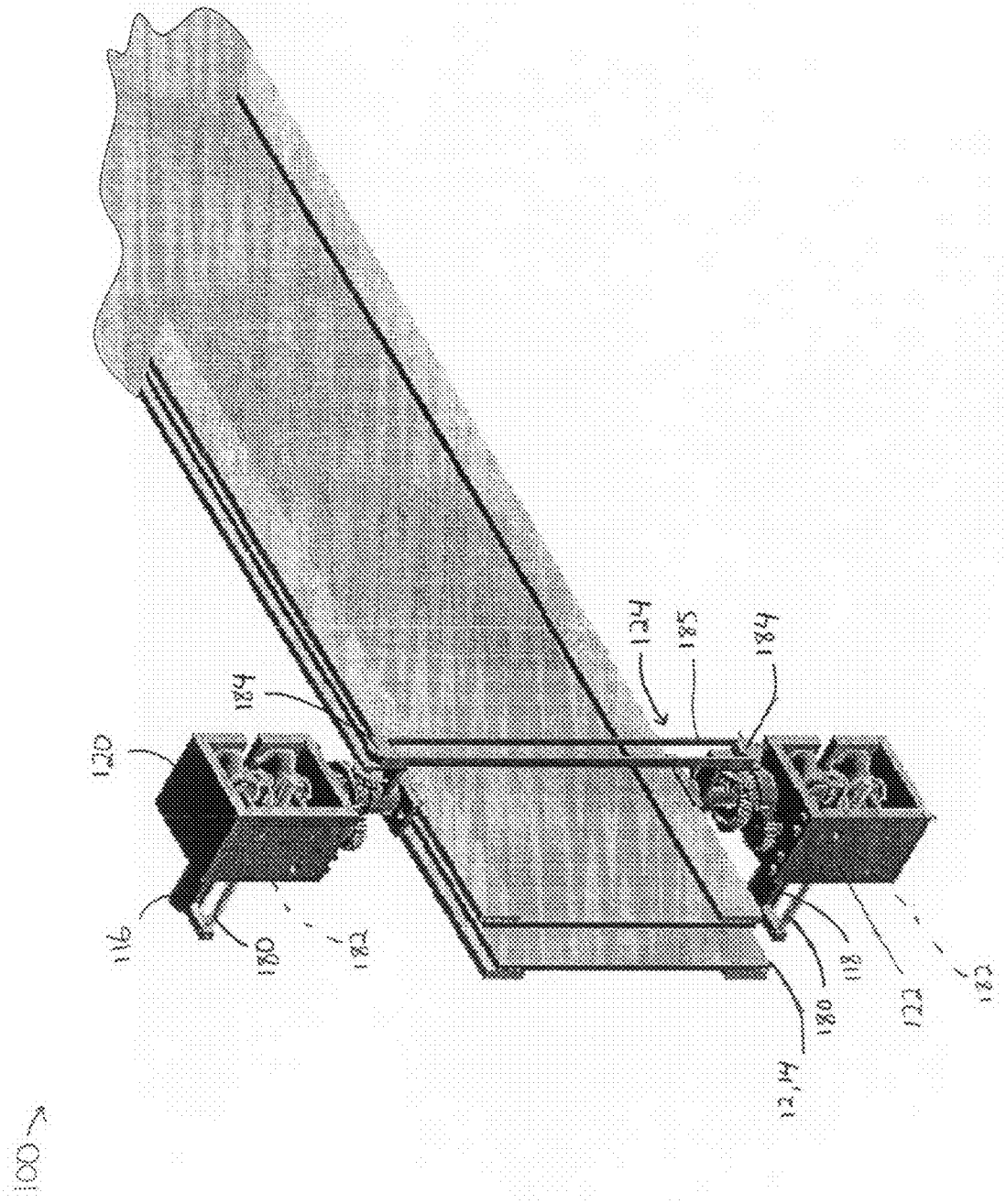


FIG. 8

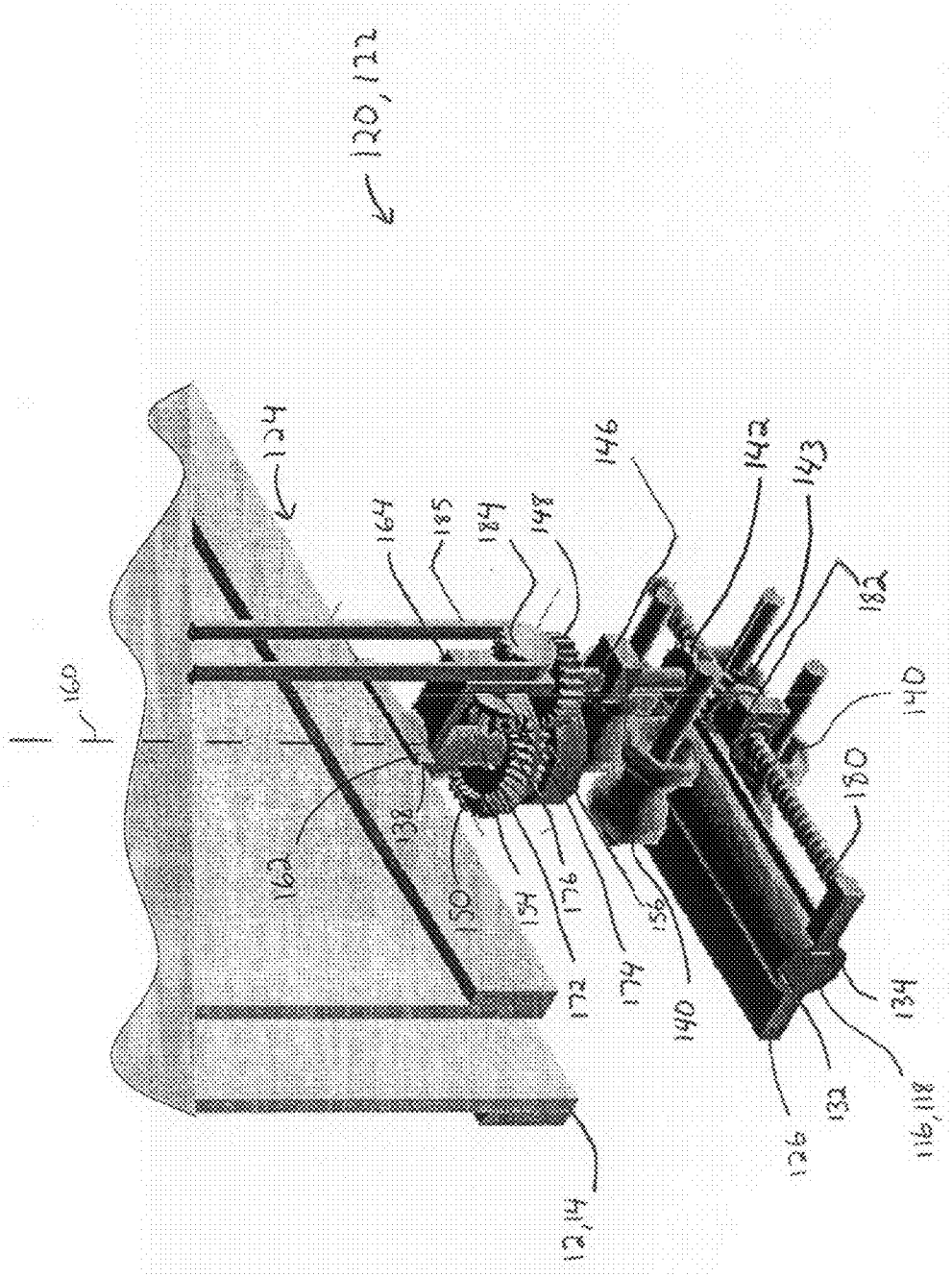

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FIG. 9

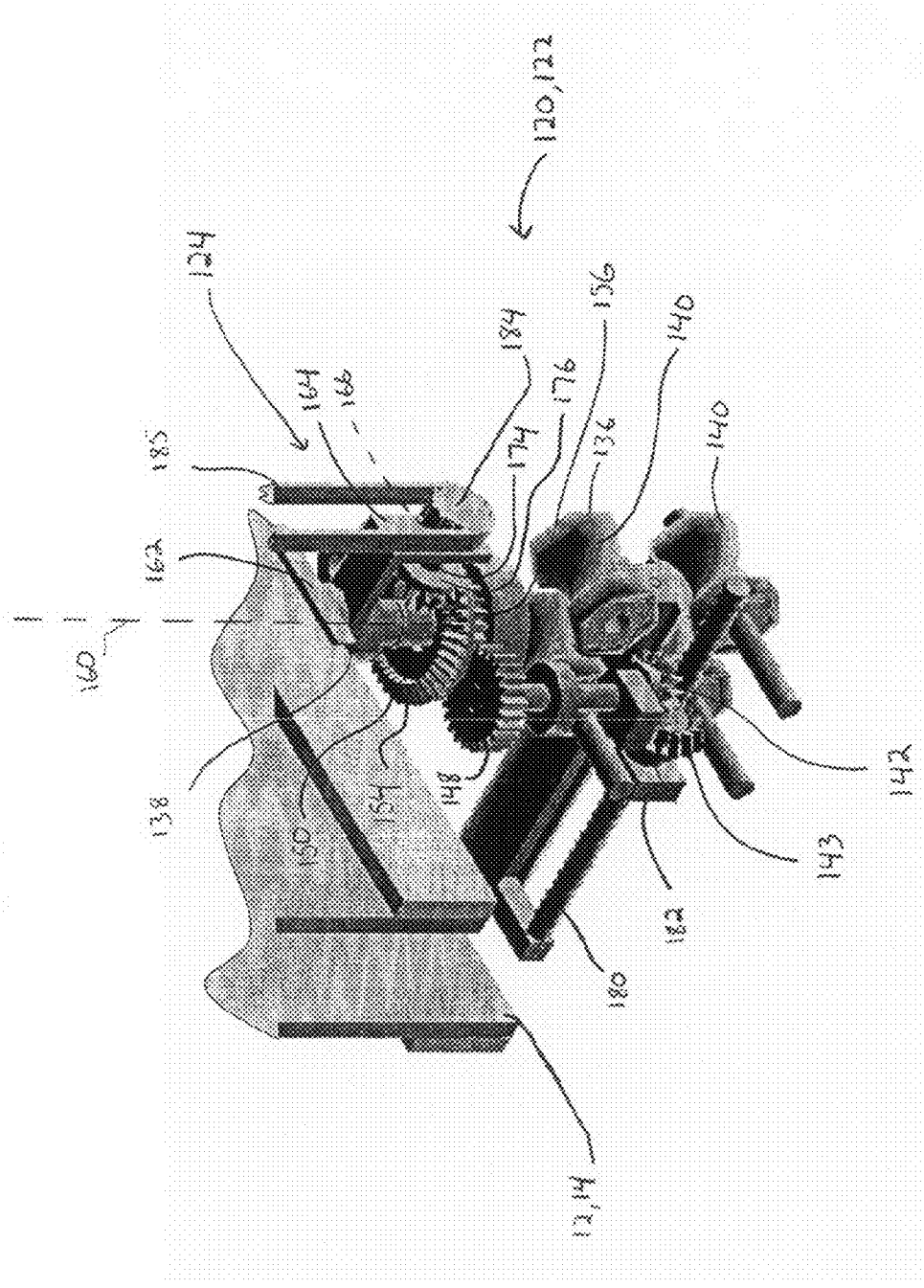
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FIG. 10

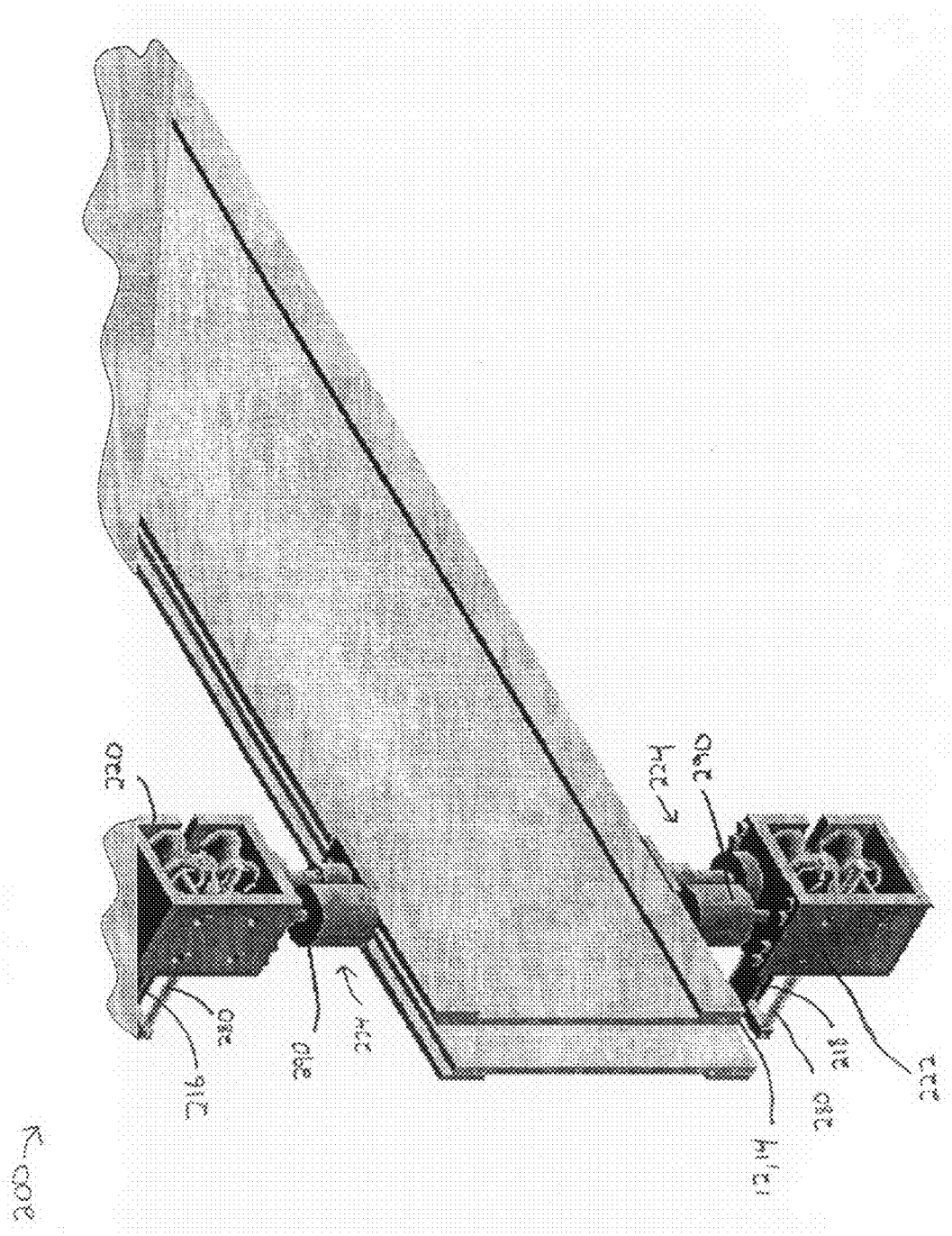

FIG. 11

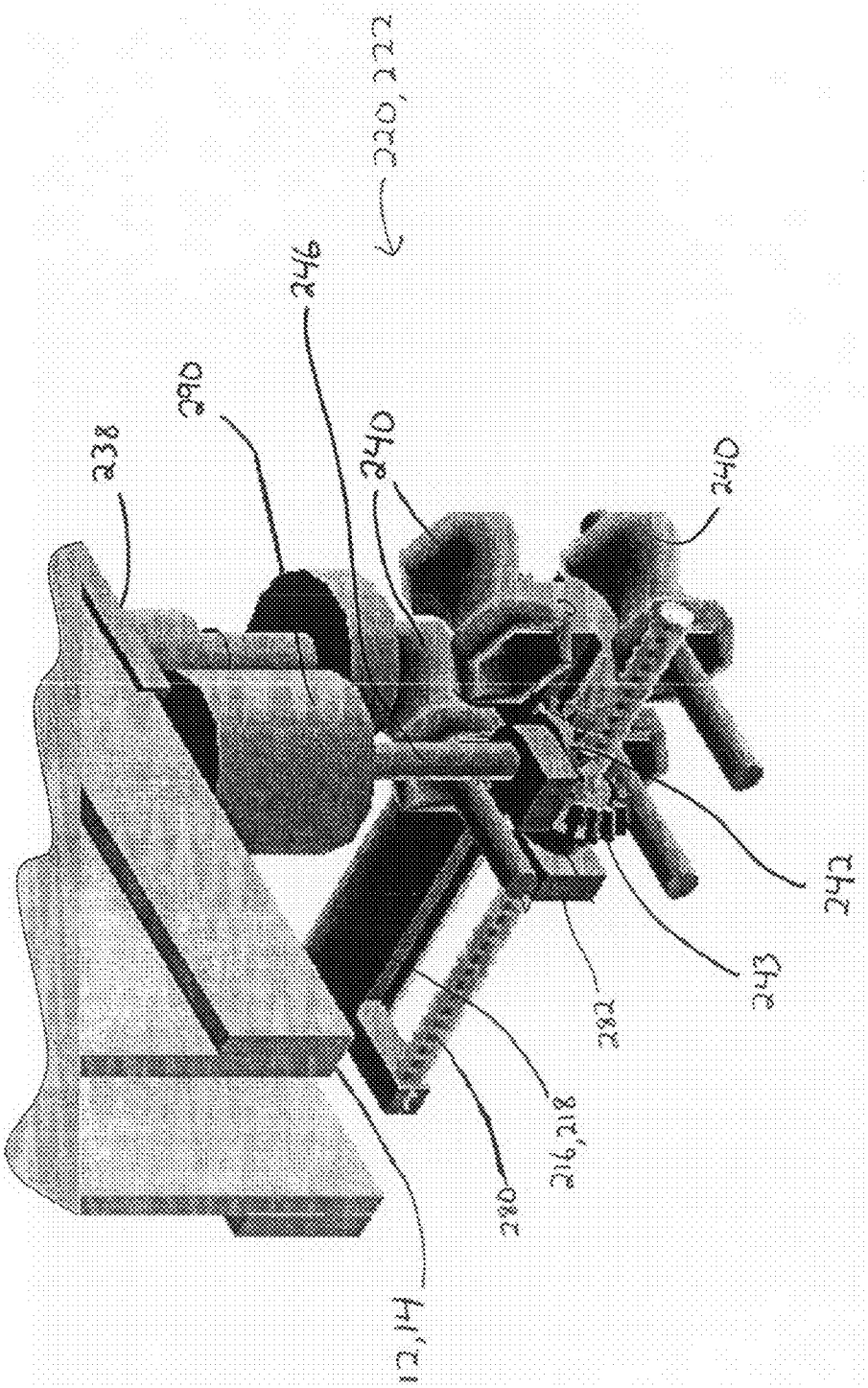

FIG. 12

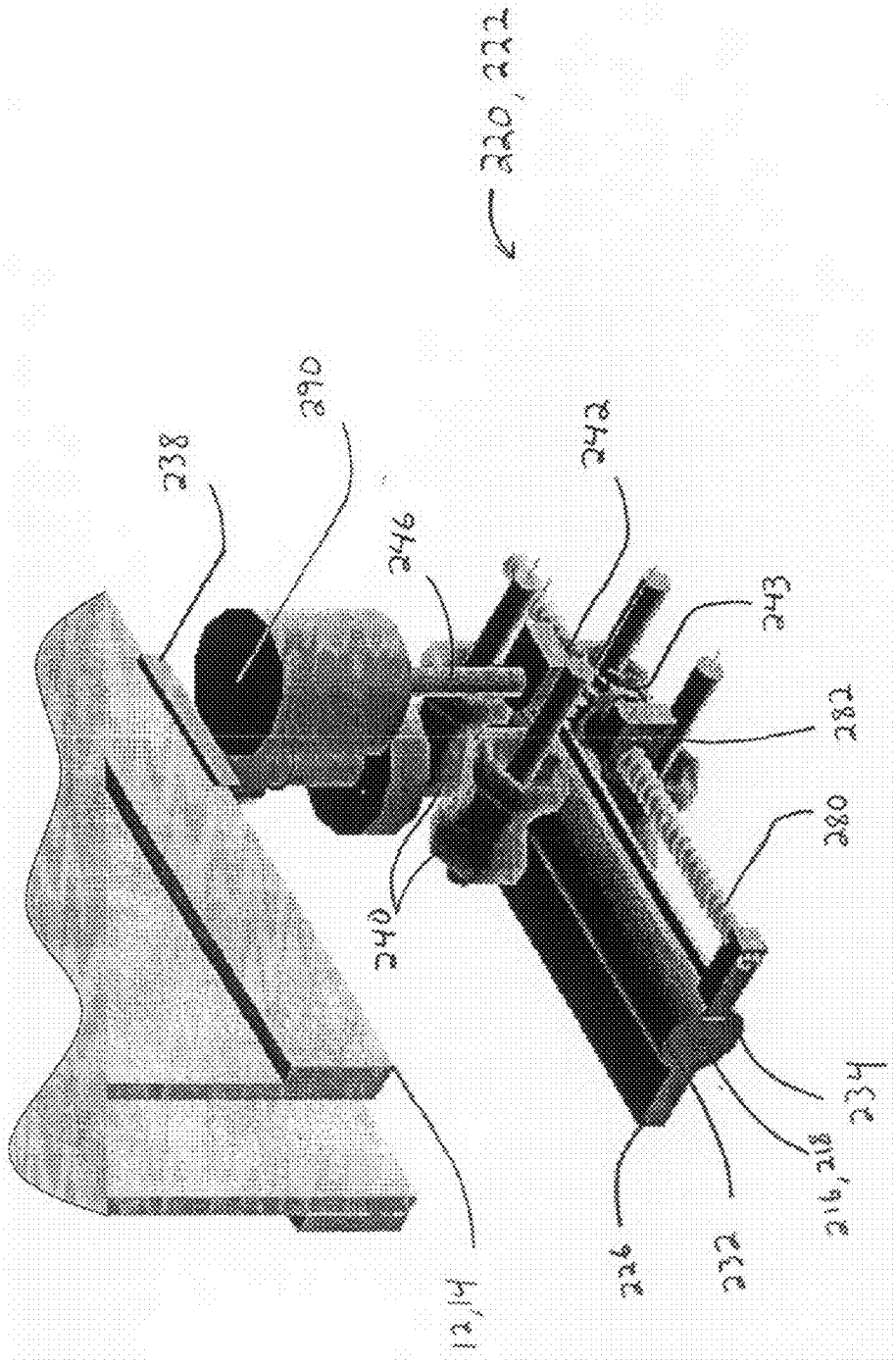

FIG. 13

ANTI-TILTING, PIVOTABLE, SLIDING PANELS

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part patent application of U.S. patent application Ser. No. 11/190,282 filed Jul. 26, 2005, which claims the benefit under 35 U.S.C. §119(e) of U.S. provisional patent application No. 60/602,387 filed on Aug. 17, 2004 which are hereby incorporated by reference in their entireties.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to an anti-tilting mechanism for a pivotable, sliding panel made from any rigid material such as glass, wood, or fiber structure intended for use such as on balconies, verandas, piscine, wall separation, etc.

[0004] 2. Brief Description of Prior Developments

[0005] Traditional glazing for balconies or the like consists of a plurality of sash glass panels mounted on upper and lower guide rail and adapted to slide laterally past one another. A major disadvantage with this type of glazing is that at most only 50 percent of the glazed-in area can be opened. Furthermore, the outer surface of the pane is awkward to clean.

[0006] Glazing structures have been proposed in which the panes can be stacked against a side wall of the balcony by pivoting about a vertical axis. In WO 89/05389 this is achieved by means of a double upper rail arrangement having a straight outer rail and an inner rail. Within the curved portion of the inner rail the trailing edge of the pane turns inwards and the pane can opened against the side wall of the balcony. Such an arrangement is, however, not particularly aesthetically pleasing and friction can arise in the system and still be a lot of effort to clean

[0007] In an effort to eliminate these drawbacks, WO 90/121183 proposes a structure in which the top edge pivot pin of the glass pane is held stationary, no curved guide rail for the trailing edge is required. Whilst eliminating some of the disadvantages of the prior systems, the arrangement according to WO 90/121183 introduces its own drawbacks; one being that the pane must be tilted to disengage the upper trailing wheel from its guide rail before pivoting can commence. Since the leading edge of the pane is locked first only when pivoting has commenced, there is a risk that the trailing wheel may not disengage should the pane topple back before pivoting commences. The fact that the leading edge is locked only once rotation has commenced further implies that a flange protruding from the upper guide rail adjacent the opening for the trailing wheel is required to support the trailing wheel during the initial opening operation. Such protruding flanges hinder the possibility to mount curtains or blinds across the glazing. In addition, because only the upper leading pivot pin is immobilized, the pane cannot be opened through more than 90 degree, due to the fact that the lower leading pivot pin would otherwise be forced along the lower guide rail as a result of the change in position of the center of gravity of the pane.

SUMMARY OF THE INVENTION

[0008] In accordance with one aspect of the invention, a panel movement system is disclosed. The panel movement system includes top and bottom rails, top and bottom rail attachments, and a gear movement system. The top and bottom rails include threaded screw members along their lengths and first cog members rotatively coupled to the threaded screw members. The top and bottom rail attachments are movably attached to respective ones of the rails for lateral movement along lengths of the rails. Each rail attachment includes a rotatable second cog member engaged with the first cog member on respective ones of the rails. The gear movement synchronization system connects the rotatable second cog member of the top rail attachment to the rotatable second cog member of the bottom rail attachment such that the top and bottom rail attachments move along the rails in unison. The top and bottom rail attachments are adapted to have a panel connected therebetween.

[0009] In accordance with another aspect of the invention, a panel movement system is disclosed. The panel movement system includes a first rail, a first rail attachment, and a gear movement synchronization system. The first rail includes a threaded screw member and a first cog member. The threaded screw member extends along a length of the first rail. The first cog member is rotatively coupled to the threaded screw member. The first rail attachment is movably attached to the first rail for lateral movement along the length of the first rail. The first rail attachment includes a rotatable second cog member engaged with the first cog member on the first rail. The gear movement synchronization system is connected to the rotatable second cog member of the first rail attachment. The first rail attachment is configured to be connected to a first side of a panel. The first rail attachment includes a top and a bottom roller located on opposite sides of the first rail.

[0010] In accordance with another aspect of the invention, a method of manufacturing a movable panel system is disclosed. Top and bottom movement systems are connected to top and bottom ends of a panel. The top and bottom movement systems each include a rotatable gear member. The movement systems are connected to respective top and bottom rails such that the movement systems can traverse along the rails. Threaded screw members are connected adjacent to the top and bottom rails. The threaded screw members extend along lengths of the rails. First cog members are rotatively coupled to the threaded screw members. The rotatable gear members of the top and bottom movement systems are engaged with the first cog members. The top and bottom movement systems operate in registration with each other and traverse along the rails in unison with each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing aspects and other features of the invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

[0012] FIG. **1** is a perspective view of a movable panel assembly incorporating features of the invention;

[0013] FIG. **2** is a perspective view of a portion of one of the rails of the frame of the assembly shown in FIG. **1**;

[0014] FIG. **3** is a perspective view of components of the assembly shown in FIG. **1**;

[0015] FIG. **4** is another perspective view of components of the assembly shown in FIG. **1**;

[0016] FIG. **5** is a perspective view of the components of the assembly shown in FIG. **4** from an opposite side;

[0017] FIG. **6** is a perspective view of the components of the assembly shown in FIG. **4** with a panel attachment of the assembly rotated;

[0018] FIG. **7** is a perspective view of the components of the assembly shown in FIGS. **4-6** in a gear box frame;

[0019] FIG. **8** is a perspective view of an alternate embodiment of a movable panel assembly incorporating features of the invention;

[0020] FIG. **9** is a perspective view of components of the assembly shown in FIG. **8**;

[0021] FIG. **10** is a perspective view of the components of the assembly shown in FIG. **8** with a panel of the assembly rotated;

[0022] FIG. **11** is a perspective view of another alternate embodiment of a movable panel assembly incorporating features of the invention;

[0023] FIG. **12** is a perspective view of components of the assembly shown in FIG. **11**; and

[0024] FIG. **13** is a perspective view of the components of the assembly shown in FIG. **11** with a panel of the assembly rotated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] Referring to FIG. **1**, there is shown a perspective view of a movable panel assembly **10** incorporating features of the invention. Although the invention will be described with reference to the exemplary embodiments shown in the drawings, it should be understood that the invention can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

[0026] The panel assembly **10** in this embodiment is a window or glass door for use in a building. However, in alternate embodiments the invention could be used in any suitable type of assembly where panels are intended to be moved relative to each other. The assembly **12** comprises two panels **12**, **14** which are window panes. Non-window panels could be provided. More or less than two movable panels could be provided. The assembly **12** also comprises a frame with two rails **16**, **18**, top and bottom movement sections **20**, **22** for each panel **12**, **14**, and a synchronization system **24** for each panel **12**, **14**.

[0027] Referring also to FIG. **2**, the two rails **16**, **18** are identical to each other. In alternate embodiments the rails could be different. The rails **16**, **18** extend in a general cantilever fashion from the frame **26**. As shown in FIG. **2**, the rails **16**, **18** may comprise a groove section for receiving or fitting a portion of the frame **26** therein. This provides for a cantilever fixing of the rails **16**, **18** to the frame **26**. However, in alternate embodiments any suitable configuration for attaching the rail **16**, **18** to the frame **26** may be provided. Preferably, the rails **16**, **18** extend substantially the entire width of the window. Each rail **16**, **18** has a track section with upper and lower convex curved sections **32**, **34** and a rack section **28** with registration teeth **30**. As shown in FIG. **2**, the rails **16**, **18** may comprise another groove section for receiving or fitting a portion (opposite the teeth **30**) of the rack section **28** therein. However, in alternate embodiments any suitable configuration for attaching the rack section **28** to the rail **16**, **18** may be provided. Referring also to FIGS. **4-6**, the top and bottom movement systems **20**, **22** are identical to each other, but reversely oriented or flipped relative to each other. In alternate embodiments the movement sections could be different from each other. Each panel **12**, **14** has the pair of the movement sections **20**, **22** attached to its top and bottom ends. The top movement sections (or upper synch gear boxes) **20** are mounted on the top rail (or upper guide rail) **16** and the bottom movement sections (or lower synch gear boxes) **22** are mounted on the bottom rail (or lower guide rail) **18**.

[0028] Each movement section **20**, **22** comprises a rail attachment **36**, a panel attachment **38** and part of the synchronization system **24**. The rail attachment **36** comprises rollers **40** and a rotatable gear **42**. Four rollers **40** are provided; two against the top convex curved section of the rail and two against the bottom convex curved section of the rail. However, in alternate embodiments more or less than two rollers on each top and/or bottom side could be provided. This provides for the panel **12**, **14** to be supported on the rails **16**, **18** by the rollers **40**. The rollers **40** have general cylindrical shape wherein the center is depressed with respect to the edges forming a general concave profile to mate with the convex shapes of the rail sections (or segments) **32**, **34**. However, in alternate embodiments, any suitable complementary shapes could be provided. The concave profile of the rollers adapts the rollers to slide on the convex rail sections **32**, **34** to minimize (or substantially eliminate) any sideways movement and/or noise motion of the rollers. The rollers are attached by shafts to a gear box frame (or body) of the movement sections **20**, **22**. With the rollers **40** attached and fixed to the gear box frame (best shown in FIG. **7**), this ensures that the rollers **40** (and the panel **12**, **14**) stay in place concerning vertical movement. The rollers **40** are able to rotate to roll the movement sections **20**, **22** along the rails **16**, **18**. This allows the panel **12**, **14** mounted to the rails by a pair of the top and bottom movement sections **20**, **22** to longitudinally slide along the rails in general lateral directions as indicated by arrow **44** in FIG. **1**. The rollers **40** may also transfer the weight of the system onto the rails **16**, **18** while providing an easy sliding motion.

[0029] The rotatable gear **42** is connected to a rotatable shaft **46**. The shaft (or beam) **46** is rotatably mounted to the gear box. An intermediate gear **48** is also connected to the shaft **46**. Thus, intermediate gear **48** is rotated when the gear (or cog) **42** is rotated. The gear **42** has its teeth engaged with the teeth **30** of the rack section **28**. The gear **42** forms a pinion in a rack and pinion system. When the panel **12**, **14** is longitudinally moved along the rail **16**, **18**, the gear **42** moves along the length of the rack section **28** and rotates because of interaction between the teeth. This causes the gear **48** to rotate.

[0030] The panel attachment (or platform) **38** comprises a first section **62** adapted to be directly attached to one of the ends of one of the panels **12**, **14**. With the panel fixed onto the platform **38** and the platform **38** fixed through several processes to the gear box frame, any horizontal movement made by the gear box frame is transmitted to the panel. The panel attachment **38** also comprises a second section **64** fixedly attached to the first section **62**. The second section **64** has a hole **66**. A rod **52** of the synchronization system **24** extends through the hole **66**. The rod (or synch axe) **52** is rotatably mounted in the hole **66** by a bearing such that the rod can axially rotate in the hole. The axis **68** of rotation of the rod **52** is offset from the axis **60** of rotation of the panel attachment **38**. The panel attachment **38** can rotate about the axis **60** relative to the gear box.

[0031] Synchronization system **24** includes another intermediate gear **50** and the vertical axially rotatable rod **52**. The gear (or cog) **50** is fixed to the gear box for axial rotational movement only about the axis **60**. The gear **50** has a top gear section (or cog) **54** and a bottom gear section (or cog) **56**. The bottom gear section **56** is engaged with the teeth of the gear

(or cog) **48**. The top gear section **54** engages teeth of a gear section **58** on the end of the rod **52**. The rod **52** has gear sections (or cogs) **58** at both its top and bottom ends.

[0032] The rod (or synch beam) **52** provides two different types of movement synchronizations. For each panel **12**, **14**, the respective rod **52** can help synchronize translation movement of the rail attachments **36** of the top and bottom movement sections **20**, **22** relative to each other on their respective top and bottom rail **16**, **18**. In addition, for each panel **12**, **14**, the respective rod **52** can help synchronize rotational movement of the panel attachments **38** of the top and bottom movement sections **20**, **22** relative to each other.

[0033] For synchronized translation movement of the rail attachments **36** of the top and bottom movement sections **20**, **22** relative to each other on their respective top and bottom rail **16**, **18**, the rod acts as a mechanical connection between the movement sections **20**, **22**. The gears **42** of the two movement sections **20**, **22** are connected to each other by the respective intermediate gears **48**, **50** of the two movement sections **20**, **22** and by the rod **52** and its gears **58** at its opposite ends. Thus, as the gear **42** of the bottom movement section **22** moves along the teeth **30** of the bottom rail **18**, the two sets of shafts **46** and gears **48**, **50**, **58**, and the rod **52** insure that the gear **42** of the top movement section **20** moves along the teeth **30** of the top rail **16** in the same direction and with the same amount of movement. Likewise, as the gear **42** of the top movement section **20** moves along the teeth **30** of the top rail **16**, the two sets of shafts **46** and gears **48**, **50**, **58**, and the rod **52** insure that the gear **42** of the bottom movement section **22** moves along the teeth **30** of the bottom rail **18**. This insures a synchronized movement of the top and bottom ends of the panel **12** or **14** along the width of the window. The panel **12**, **14** is, thus, prevented from tilting and perhaps jamming during this lateral translation movement.

[0034] The panels **12**, **14** can also be individually rotated inward and/or outward as indicated by arrows **70** in FIG. **1**. For synchronized rotational movement of the panel attachments **38** of the top and bottom movement sections **20**, **22** relative to each other, as the panel attachments **38** are rotated along axis **60** at each of the movement sections **20**, **22** the gear **50** can remain stationary. The rod **52**, because of its connection at the hole **66** to the panel attachment **38**, rotates about the axis **60**. The teeth of the gear sections **58** rotate about the perimeter of the top gear section **58** resulting in axial rotation of the rod **52** about its axis **68**. Thus, as the panel **12** or **14** is rotated open or closed the gear section **58** at the bottom movement section **22** moves along the teeth of the gear **50** of the bottom movement section **22** and the rod **52** axially rotates to insure that the gear section **58** at the top of the rod at the top movement section **20** moves along the teeth of the gear **50** at the top movement section **20** for the top and bottom panel attachments **38** to move in synchronized unison rotation. The rotational movement can also occur at the same time as translational movement if desired.

[0035] The invention can comprise interlocking air-tight panels that are able to slide laterally guided by an upper and a lower rail. As described above, each of the panels follows the movement of the gearbox **20**, **22**. Wherein the gearbox **20**, **22** follows movement of the rollers **40** when the rollers **40** move on the convex segments **32**, **34** of the rails **16**, **18**. The concave profile shape of the rollers **40** allows for horizontal movement. This provides for the panel **12**, **14** to follow the rollers **40** movements and move in a horizontal fashion. This can occur with simultaneous pivoting on their axes of rotation **60**. This was accomplished by the introduction of specialized gearboxes, located at the extremities of the panels, connecting it to the rails. In order to keep the panel stable while in motion, the gearboxes holding the panels preferably move synchronously else, the panel could be subject to tilting; since one end of the panel may be leading or lagging the other end. The synchronization of the gearbox movements is made possible using a solid beam; the rod **52**. The beam **52** connects gear or cog **58** of the lower gearbox with cog **58** of the upper gearbox, enabling them to rotate simultaneously. Rotation of the cog **58** is controlled by a series of other cogs which link it to the rack **28** that lines the rails on which the panel slides aided by the four rollers or pulleys **40**.

[0036] As the panel is moved laterally, the rack causes pinion **42** to rotate which, in turn, causes the other cogs to rotate relaying rotation to cog **58**. Solid beam **52** relays rotation to the upper gearbox. Similarly, the upper gearbox moves the exact distance as that covered by the lower gearbox. The assembly is configured to enable the panels **12**, **14** to slide on a horizontal axis while being able to pivot simultaneously on their axis. The assembly is designed to allow those motions all while being free of any tilting motions the panels are prone to while attempting to move them.

[0037] When the panel needs to be rotated on its axis **60**, one can simply turn the panel by hand. Cog **58** would travel on the perimeter of cog **50**, since the panel is fixed on platform **38** which is secured onto axis **60** known as the synch axis, resulting in the rotation of cog **58**. This would cause the simultaneous rotation of both cogs, thus maintaining the vertical parallel position of the beam **52** with respect to the panel; avoiding collision of the beam with the panel while in rotation. The end result is a panel, made out of any rigid material, which can be moved laterally guided by rails, while being simultaneously rotated onto its axis. The panel's motion is smooth and easy to move regardless of its weight. With the invention, the panels **12**, **14** can also rotate more than 90 degrees; such as 360 degrees for example. In the embodiment described above, the gears **48** only rotate when the panel laterally slides/rolls along the rails. The platform **38** does not rotate with the gear **48**. The platform **38** only rotates when the user pivots the panel and rotation of platform **38** causes gear **58** to circle around the gear section **54**. The panels **12**, **14** can preferably overlap each other when then are slid towards each other, such as more than 50 percent overlap.

[0038] The invention comprises a movement and synchronization system having an anti-tilting mechanism and a rotating mechanism which provides for advantages over conventional configurations. For example, in conventional configurations if the top edge of the panel moves faster than the lower edge of the panel, this would result in the panel tilting forwards or backwards (depending on which edge moved faster or traveled a greater distance). To alleviate any possible tilting movements, it is helpful to promote the movement of both edges in unison. The invention provides for movement in unison by configuring the top and bottom movement sections to be connected. As such, when the rollers **40** move forwards on the rails **16** and **18**, the rack **28** moves accordingly and causes the gear **42** to rotate. This motion is transmitted sequentially through the gears **48**, **56**, **54**, **58**, and finally to rod **52** which is attached to an identical setup on the opposite edge of the panel. This provides for both of the movement sections **20** and **22** to move the same distance and at the same speed when the panel slides horizontally. This

implies that the panel does not tilt forwards or backwards while sliding or starting to slide horizontally.

[0039] Additionally, the rotating mechanism also provides for advantages over conventional configurations. With the panel **12**, **14** fixed on the first section **62** of the platform **38**, the second section **64** of the platform **38** keeps the synch beam **52** parallel to the panel **12**, **14**. The gear **58** relays motion from the gear **54** to the synch beam **52** such that the gear **58** runs on the perimeter of gear **54**. When the gear **58** rotates, the synch beam component **52** relays motion to the synch box **20**, **22** on the opposite side of the panel **12**, **14** causing an identical displacement of the beam on both ends of the panel **12**, **14**. Also, the synch beam **52** is placed at an offset relative to the panel **12**, **14** fixed on the platform **38**. This allows two different panels each fixed to their own synch boxes **20**, **22** to overlap as much as the design desires to allow the formation of air tight junctions between the adjacent panels **12**, **14**. This provides for the synch beam **52** to function as a movement relay when it comes to horizontal position and moves out of the panel's **12**, **14** way when the panel is rotating, since it is designed to stay parallel to it. Further, offsetting the position of the synch beam **52** relative to the panel's **12**, **14** axis allows an air-tight design to be realized if desired.

[0040] Referring now to FIG. **8**, there is shown a perspective view of a movable panel assembly **100** in accordance with another embodiment of the invention. The panel assembly **100** is similar to the panel assembly **10** and similar features are similarly numbered.

[0041] In this embodiment the panel assembly **100** has two panels **12**, **14**, a frame with two rails **116**, **118**, top and bottom movement sections **120**, **122**, and a synchronization system **124** similar to the panel assembly **10** shown in FIGS. **1-7**. One difference between the assembly **100** and the assembly **10** is that the movement sections **120**, **122** of the assembly **100** comprise a screw **180** and nut **182** arrangement instead of a rack and pinion arrangement. Another difference between the assembly **100** and the assembly **10** is that the synchronization system **124** of the assembly **100** comprises a timing belt **185** connected between the movement sections instead of a rod.

[0042] Referring also to FIGS. **9** and **10**, the two rails **116**, **118** are identical to each other. In alternate embodiments the rails could be different. The rails **116**, **118** extend in a general cantilever fashion from the frame **126**. Preferably, the rails **116**, **118** extend substantially the entire width of the window. Each rail **116**, **118** has a track section with upper and lower convex curved sections **132**, **134**, the free-edged infinite screw **180**, and the nut **182** that screws (or threads) on to the screw (or threaded screw member) **180**, moving forwards and backwards on the screw **180** registration while rotating simultaneously. The screw **180** extends along the length of the rail **116**, **118**. The screw **180** may be connected to the rail **116**, **118** by cantilevered members extending from the rail **116**, **118** such that the screw **180** is substantially parallel to the rail **116**, **118**. However, any suitable mounting configuration may be provided. Additionally a gear (or gear member) **143**, which may be a bevel gear for example, is fixed onto the nut (or threaded nut member) **182**. The top and bottom movement systems **120**, **122** are identical to each other, but reversely oriented or flipped relative to each other. In alternate embodiments the movement sections could be different from each other. Each panel **12**, **14** has the pair of the movement sections **120**, **122** attached to its top and bottom ends. The top movement sections **120** are mounted on the top rail **116** and the bottom movement sections **122** are mounted on the bottom rail **118**.

[0043] Each movement section **120**, **122** comprises a rail attachment **136**, a panel attachment **138** and part of the synchronization system **124**. The rail attachment **136** comprises rollers **140** and a rotatable gear (or gear member) **142**. Four rollers **140** are provided substantially the same as the rollers **40** in the panel assembly **10**. The rollers are attached by shafts to a gear box frame of the movement sections **120**, **122**. The rollers **140** are able to rotate to roll the movement sections **120**, **122** along the rails **116**, **118**. This allows the panel **12**, **14** mounted to the rails by a pair of the top and bottom movement sections **120**, **122** to longitudinally slide along the rails in general lateral (or horizontal) directions substantially the same as described above for the panel assembly **10**.

[0044] The rotatable gear **142**, which may be a bevel gear for example, is connected to a rotatable shaft **146**. The shaft **146** is rotatably mounted to the gear box. An intermediate gear **148** is also connected to the shaft **146**. Thus, intermediate gear **148** is rotated when the gear (or cog) **142** is rotated. The gear **142** is engaged with the gear (or cog) **143** of the rail **116**, **118**. This provides for the gear (or cog member) **143** to relay motion between the nut **182** and the gear (or cog member) **142**.

[0045] The panel attachment **138** comprises a first section **162** adapted to be directly attached to one of the ends of one of the panels **12**, **14**. The panel attachment **138** also comprises a second section **164** fixedly attached to the first section **162**. The second section **164** has a hole **166**. A rod **174** extends through the hole **166**. The rod **174** relays motion between a gear **176** at one end of the rod **174** and a gear **184** at an opposite end of the rod **174**. The rod **174** may be rotatably mounted in the hole **166** by a bearing such that the rod can axially rotate in the hole. However, any suitable mounting configuration may be provided.

[0046] The synchronization system **124** includes another intermediate gear **150** and the timing belt **185**. The gear **150** is attached to a rod **172** and fixed to the gear box for axial rotational movement only about the axis **160**. The gear **150** has a top gear section **154** and a bottom gear section **156**. The top gear section **154** and the bottom gear section **156** are fixedly attached to provide for movement in unison. The bottom gear section **156** is engaged with the teeth of the gear **148**. This provides for relaying motion between the gear section **156** and the gear **148**. The top gear section **154** is engaged with the teeth of the gear **176**. The gear **150** is attached to rod **172** such that the rod **172** relays motion between the gear sections **154**, **156** and the gear **176**. The gear (or cog) **184** engages the timing belt **185** (which may be a water clear urethane timing belt for example). In one embodiment, the cog **184** may comprise teeth which engage with teeth on the timing belt. In another embodiment, the cog **184** may comprise a pulley which engages the belt (such as in a belt and pulley system). However, any suitable configuration may be provided, such as a timing chain configuration for example.

[0047] Similar to the rod **52** of the panel assembly **10**, the timing belt **185** provides different types of movement synchronizations. The timing belt **185** extends substantially perpendicular to the length of the rail **116**, **118** and relays motion between the cog **184** of the lower synch box **122** and the cog **184** of the upper synch box **120**. For each panel **12**, **14**, the timing belt **185** can help synchronize translation movement of

the rail attachments **136** of the top and bottom movement sections **120**, **122** relative to each other on their respective top and bottom rail **116**, **118**. When the rollers **140** move forwards or backwards, the nut **182** screws (or threads/registers) on to threads of the screw **180**. This causes the nut **182** to move forwards or backwards and rotate along the screw **180**. Since the gear (or cog) **143** is fixed on to the nut **182**, the nut **182** and the gear **143** both rotate simultaneously (which provides for the nut **182** to be rotatively coupled to the screw **180**). This motion is transmitted sequentially through the gear **142**, the gear **148**, the gear **156**, the rod **172**, the gear **154**, the gear **176**, the rod **174**, the timing gear **184** and finally to the timing belt **185**, which is attached to an identical setup on the opposite edge of the panel **12**, **14**. However, it should be noted that the movement section on the opposite edge of the panel **12**, **14** need not be identical and a different movement section may be provided. The movement described above provides for the movement sections **120**, **122** to move the same distance and at the same speed when the panel **12**, **14** slides horizontally. This guides the panel so that the panel does not tilt forwards or backwards while sliding or starting to slide (or move) horizontally.

[0048] In addition, for each panel **12**, **14**, the respective timing belt **185** can help synchronize rotational movement of the panel attachments **138** of the top and bottom movement sections **120**, **122** relative to each other. The panel **12**, **14** is fixed on the section **162**. The section **162** is fixed to the section **164**. The section **164** comprises a general "L" shape to allow the gear **176** to relay motion to component the gear **154**, forming a gear train where the gear **176** runs on the perimeter of the gear **154** when the panel **12**, **14** is rotated. When the gear **176** runs on the perimeter of the gear **154**, this causes the gear **184** to rotate. In turn, the gear **184** relays motion to the timing belt **185** which relays motion to the same setup on the opposite side of the panel **12**, **14**. This provides for the timing belt **185** to function as a movement relay when it comes to horizontal position and moves out of the panel's way when the panel is rotating since it is designed to stay parallel to it. However, in alternate embodiments, any suitable configuration may be provided.

[0049] Referring now to FIG. **11**, there is shown a perspective view of a movable panel assembly **200** in accordance with another embodiment of the invention. The panel assembly **200** is similar to the panel assembly **100** and similar features are similarly numbered.

[0050] In this embodiment the panel assembly **200** has two panels **12**, **14**, a frame with two rails **216**, **218**, top and bottom movement sections **220**, **222**, and a synchronization system **224** similar to the panel assembly **100** shown in FIGS. **8-10**. One difference between the assembly **200** and the assembly **100** is that the synchronization system **224** of the assembly **200** comprises a motor **290** connected to the movement sections instead of a timing belt.

[0051] Referring also to FIGS. **12** and **13**, the two rails **216**, **218** extend from the frame **226** and comprise upper and lower convex curved sections **232**, **234**, a free-edged infinite screw **280**, a nut **282**, and a cog (or gear) **243** substantially the same as the rails **116**, **118**. Each panel **12**, **14** has the pair of the movement sections **220**, **222** attached to its top and bottom ends.

[0052] Each movement section **220**, **222** comprises a rail attachment **236**, a panel attachment **238**, rollers **240**, and part of the synchronization system **224** substantially the same as movement sections **120**, **122**.

[0053] The synchronization system comprises the motor **290**, a rotatable shaft **246** extending from the motor **290**, and a cog (or gear) **242** fixed to the end of the shaft **246**. The motor **290** may be linked to an electronic drive and a synchronization box. However, any suitable configuration may be provided.

[0054] Horizontal movement of the panels **12**, **14** along the rails **216**, **218** is provided when the motor **290** is energized to rotate the shaft **246** clockwise or counter clockwise depending on the user's wish to move the panel **12**, **14** forwards or backwards (along the length of the rail). When the motor **290** energized, the movement is transferred to the nut **282** through the engagement of the gears **242** and **243**. Since the motor **290** is fixed to the gear box frame (or body) of the movement sections **220**, **222** (best shown in FIG. **11**), the panel **12**, **14** moves when the motor **290** is activated (as the motor **290** drives the nut **282** along the threaded portions of the screw **280**).

[0055] Similar to the rod **52** of the panel assembly **10** and the timing belt **185** of the panel system **100**, the motor **290** provides different types of movement synchronizations (such as anti-tilting and rotation for example). The two motors **290** of each end of the panel **12**, **14** are set to move in unison by means of an electrical system ensuring precise and equal rotation of both motors in the same instant. Since both ends of the panel **12**, **14** are moving at the same speed and time and are displaced a substantially exact distance, there is no tilting observed. Additionally, the motor may be configured to provide synchronized rotational movement of the panels **12**, **14**. The motors **290** may provide motor synchronization of the panel system **200** in connection with an electronics circuit connected to a home automation system for example. However, any suitable motor configuration may be provided.

[0056] It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

What is claimed is:

1. A panel movement system comprising:

top and bottom rails comprising threaded screw members along their lengths and first cog members rotatively coupled to the threaded screw members;

top and bottom rail attachments movably attached to respective ones of the rails for lateral movement along lengths of the rails, wherein each rail attachment comprises a rotatable second cog member engaged with the first cog member on respective ones of the rails; and

a gear movement synchronization system connecting the rotatable second cog member of the top rail attachment to the rotatable second cog member of the bottom rail attachment such that the top and bottom rail attachments move along the rails in unison, wherein the top and bottom rail attachments are adapted to have a panel connected therebetween.

2. The panel movement system of claim **1** wherein the gear movement synchronization system comprises a timing belt connected between the rotatable second cog member of the top rail attachment and the rotatable second cog member of the bottom rail attachment.

3. The panel movement system of claim **2** wherein the gear movement synchronization system comprises the top and

bottom rail attachments having intermediate gears connecting the second cog members to the timing belt.

4. The panel movement system of claim **1** wherein the gear movement synchronization system comprises a motor connected to the rotatable second cog member of the top rail attachment.

5. The panel movement system of claim **4** wherein the gear movement synchronization system comprises a motor connected to the rotatable second cog member of the bottom rail attachment.

6. The panel movement system of claim **1** wherein the top and bottom rails further comprise threaded nut members, wherein the first cog members are fixed to the threaded nut members, and wherein the threaded nut members are threadably engaged with the threaded screw members on respective ones of the rails.

7. The panel movement system of claim **1** wherein at least one of the rail attachments comprises a top roller and a bottom roller located on opposite sides of one of the rails.

8. The panel movement system of claim **1** wherein the first cog members and the second cog members are bevel gear members.

9. A panel movement system comprising:

a first rail comprising a threaded screw member and a first cog member, wherein the threaded screw member extends along a length of the first rail, and wherein the first cog member is rotatively coupled to the threaded screw member;

a first rail attachment movably attached to the first rail for lateral movement along the length of the first rail, wherein the first rail attachment comprises a rotatable second cog member engaged with the first cog member on the first rail; and

a gear movement synchronization system connected to the rotatable second cog member of the first rail attachment, wherein the first rail attachment is configured to be connected to a first side of a panel, and wherein the first rail attachment comprises a top and a bottom roller located on opposite sides of the first rail.

10. The panel movement system of claim **9** wherein the gear movement synchronization system further comprises a motor connected to the rotatable second cog member.

11. The panel movement system of claim **9** wherein the gear movement synchronization system further comprises a timing belt connected to the rotatable second cog member.

12. The panel movement system of claim **11** further comprising a second rail and a second rail attachment, wherein the timing belt is connected between the first rail attachment and the second rail attachment.

13. The panel movement system of claim **11** wherein a length of the timing belt is substantially perpendicular to the length of the first rail.

14. The panel movement system of claim **9** wherein the first rail further comprises a threaded nut member, wherein the first cog member is fixed to the threaded nut member, and wherein the threaded nut member is threadably engaged with the threaded screw member.

15. The panel movement system of claim **9** wherein the top and bottom rollers are rotatably connected to roller shafts, wherein the roller shafts are attached to a gearbox frame of the gear movement synchronization system, and wherein the threaded screw member extends between the roller shafts.

16. The panel movement system of claim **9** wherein the first cog member is configured to be movable along a length of the threaded screw member.

17. A method of manufacturing a movable panel system comprising:

connecting top and bottom movement systems to top and bottom ends of a panel, wherein the top and bottom movement systems each comprise a rotatable gear member;

connecting the movement systems to respective top and bottom rails such that the movement systems can traverse along the rails;

connecting threaded screw members adjacent to the top and bottom rails, wherein the threaded screw members extend along lengths of the rails;

rotatively coupling first cog members to the threaded screw members; and

engaging the rotatable gear members of the top and bottom movement systems with the first cog members, wherein the top and bottom movement systems operate in registration with each other and traverse along the rails in unison with each other.

18. The method of claim **17** further comprising connecting a timing belt between the top and bottom movement systems.

19. The method of claim **17** further comprising connecting a motor to at least one of the top and bottom movement systems.

20. The method of claim **17** further comprising providing top and bottom rollers on opposite sides of at least one of the top and bottom rails.

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