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Godovalov

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(54) **SECTIONAL FOLDING UP GARAGE DOOR**

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E05D 15/00 (2006.01)

(52) **U.S. Cl.** **160/201**; 160/35; 160/188

(58) **Field of Classification Search** 160/36, 160/207, 201, 183, 188, 35, 32, 187, 203, 160/204, 211–213
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,833,252	A *	11/1931	Hayman	160/190
1,872,489	A *	8/1932	Mitchell	160/191
1,892,340	A *	12/1932	Guth	160/147
1,962,913	A *	6/1934	Rutledge	160/190
2,020,544	A *	11/1935	Gill et al.	160/191
2,423,987	A *	7/1947	Levikow	160/35
2,786,523	A *	3/1957	Phillips	160/191
2,909,718	A *	10/1959	Lawick	318/266
3,270,572	A *	9/1966	Zimmerle et al.	74/89.22
3,280,888	A *	10/1966	Davis	160/35
3,344,837	A *	10/1967	Young	160/189
3,494,406	A *	2/1970	Roodenburg et al.	160/188
3,618,656	A *	11/1971	Young	160/9
3,678,985	A *	7/1972	Kummerman	160/188
3,757,845	A *	9/1973	Pagliaro	160/189
4,303,117	A *	12/1981	Lindbergh	160/189
4,374,537	A *	2/1983	Lindbergh	160/189
4,460,030	A *	7/1984	Tsunemura et al.	160/35
4,610,289	A *	9/1986	Sugihara	160/35
5,065,806	A *	11/1991	Kondoh	160/36
5,172,742	A *	12/1992	Iwasaki et al.	160/36
5,685,355	A *	11/1997	Cook et al.	160/202
5,893,403	A *	4/1999	Megens	160/35
7,089,989	B2 *	8/2006	Pfender	160/195
2002/0084041	A1 *	7/2002	Craig	160/35
2005/0072537	A1 *	4/2005	Pfender	160/211
2010/0282418	A1 *	11/2010	Lucas	160/54

* cited by examiner

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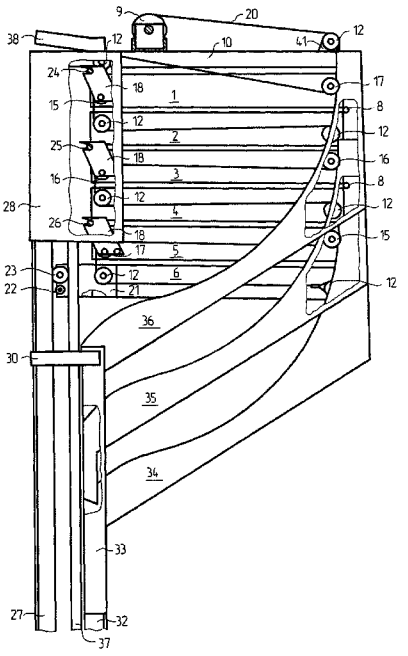
(57) **ABSTRACT**

A sectional folding up garage door refers to constructions with moving sectional elements intended for closing apertures in buildings and edifices. The area of invention's application is its use as automatically operated door both for private and commercial use. A sectional folding up garage door provides the sectional panel lifting up in vertical plane, folding such panel in consecutive order by two sections inside a premise as the door is being lifting, and piling compactly inside in the top part of an aperture. The door includes a panel of sections joint one by one like an accordion, a frame and sections power mechanism.

6 Claims, 8 Drawing Sheets



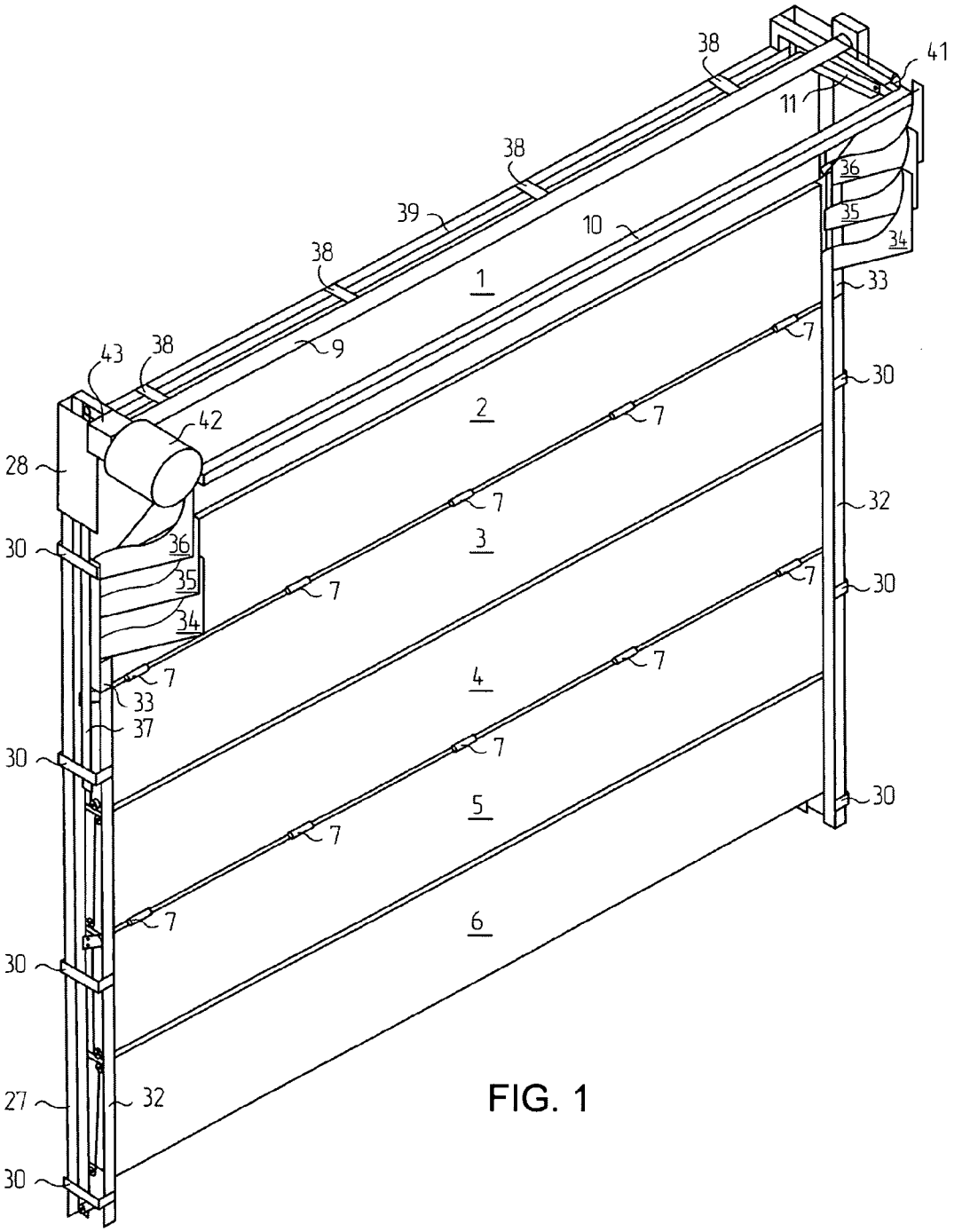

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FIG. 1

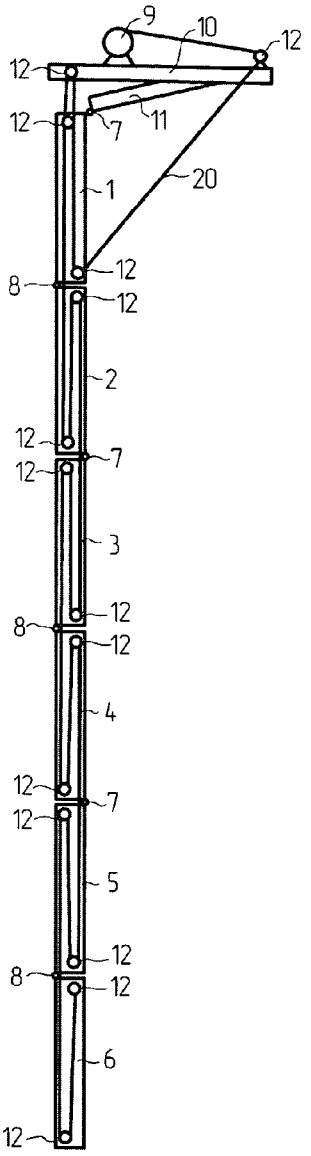
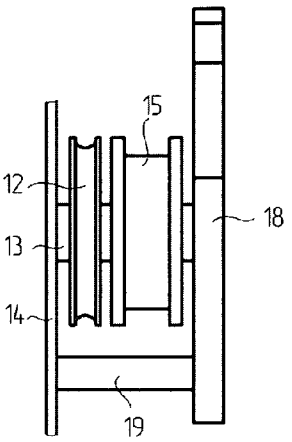


FIG. 2



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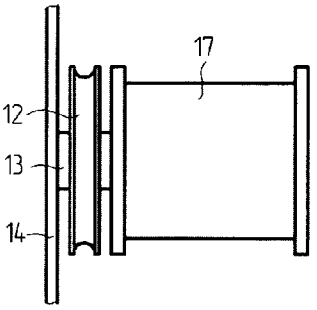

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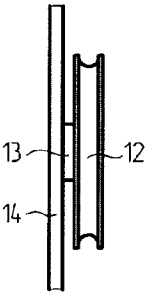

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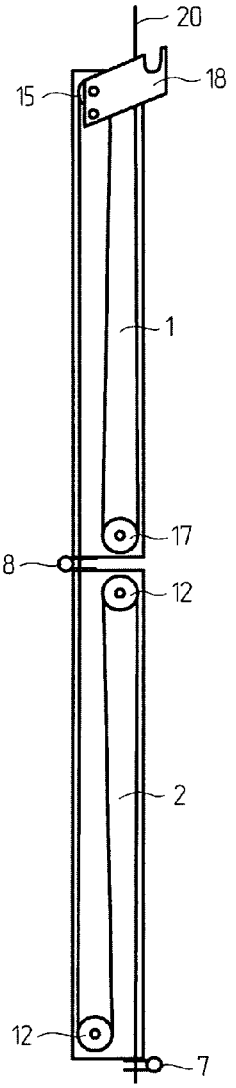

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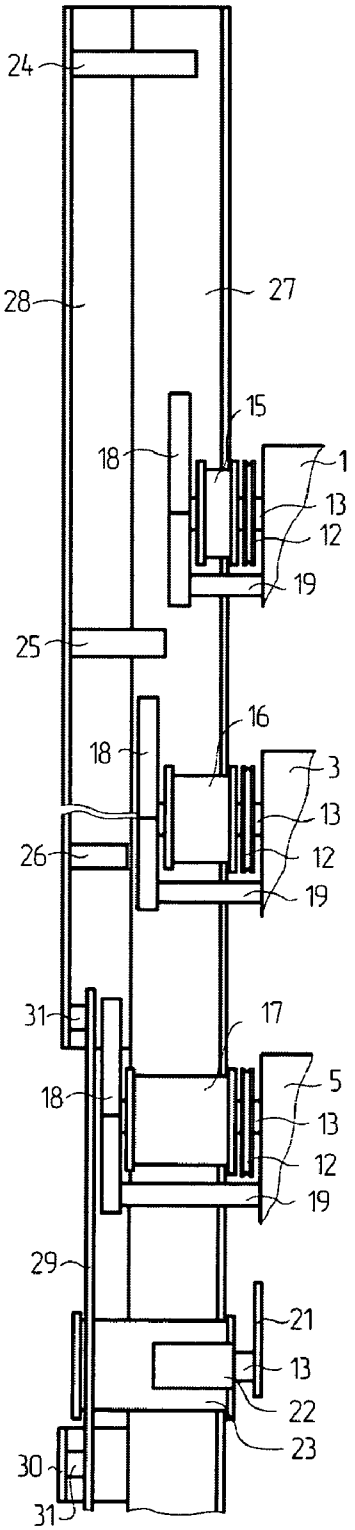
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FIG. 7

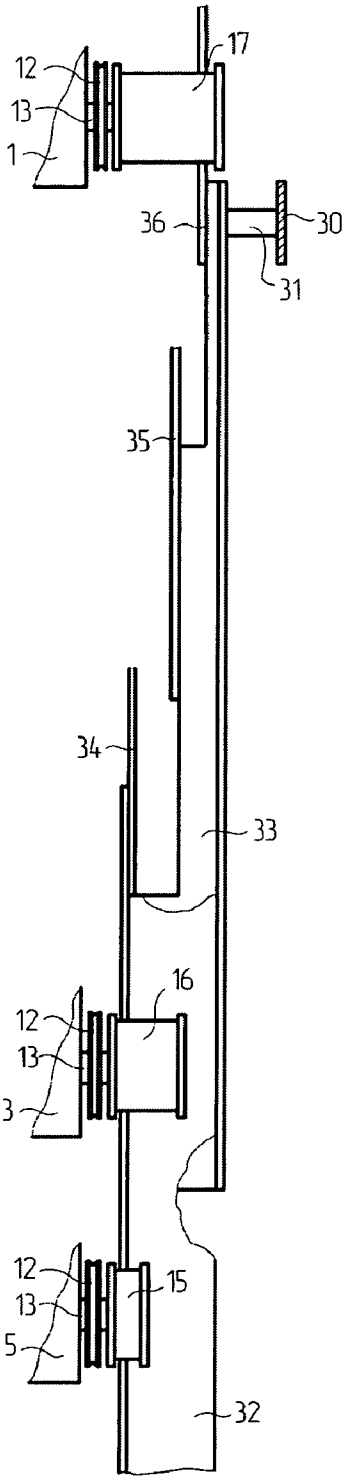
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FIG. 8

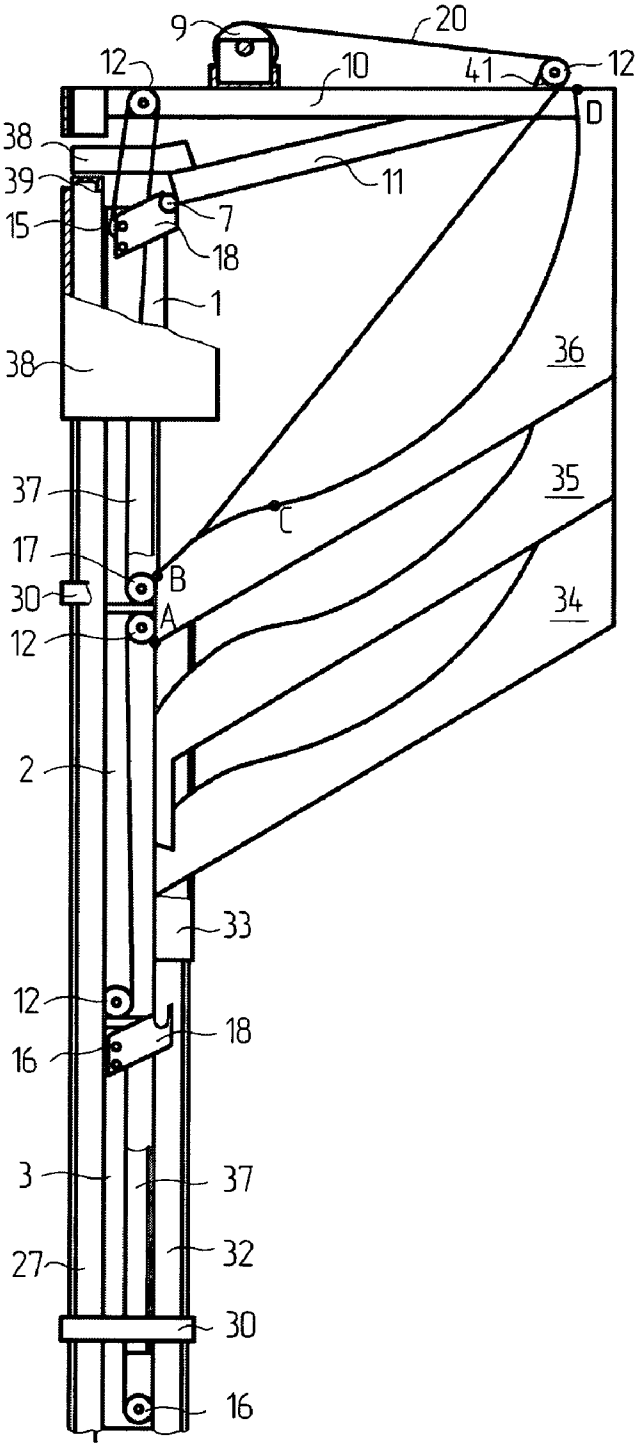
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FIG. 9

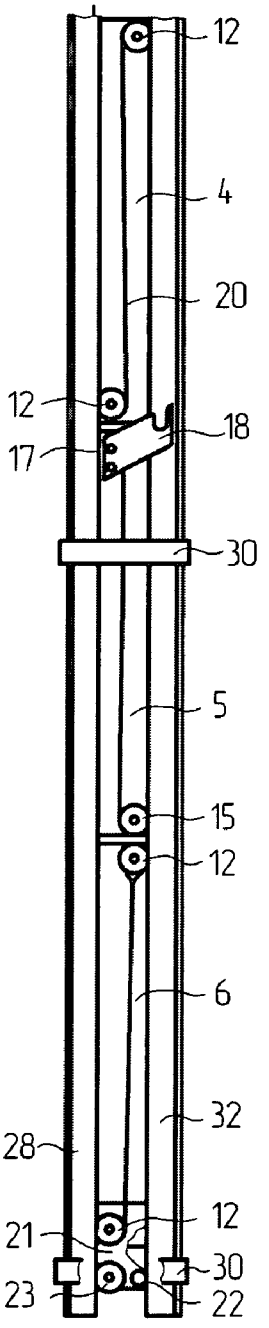
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FIG. 10

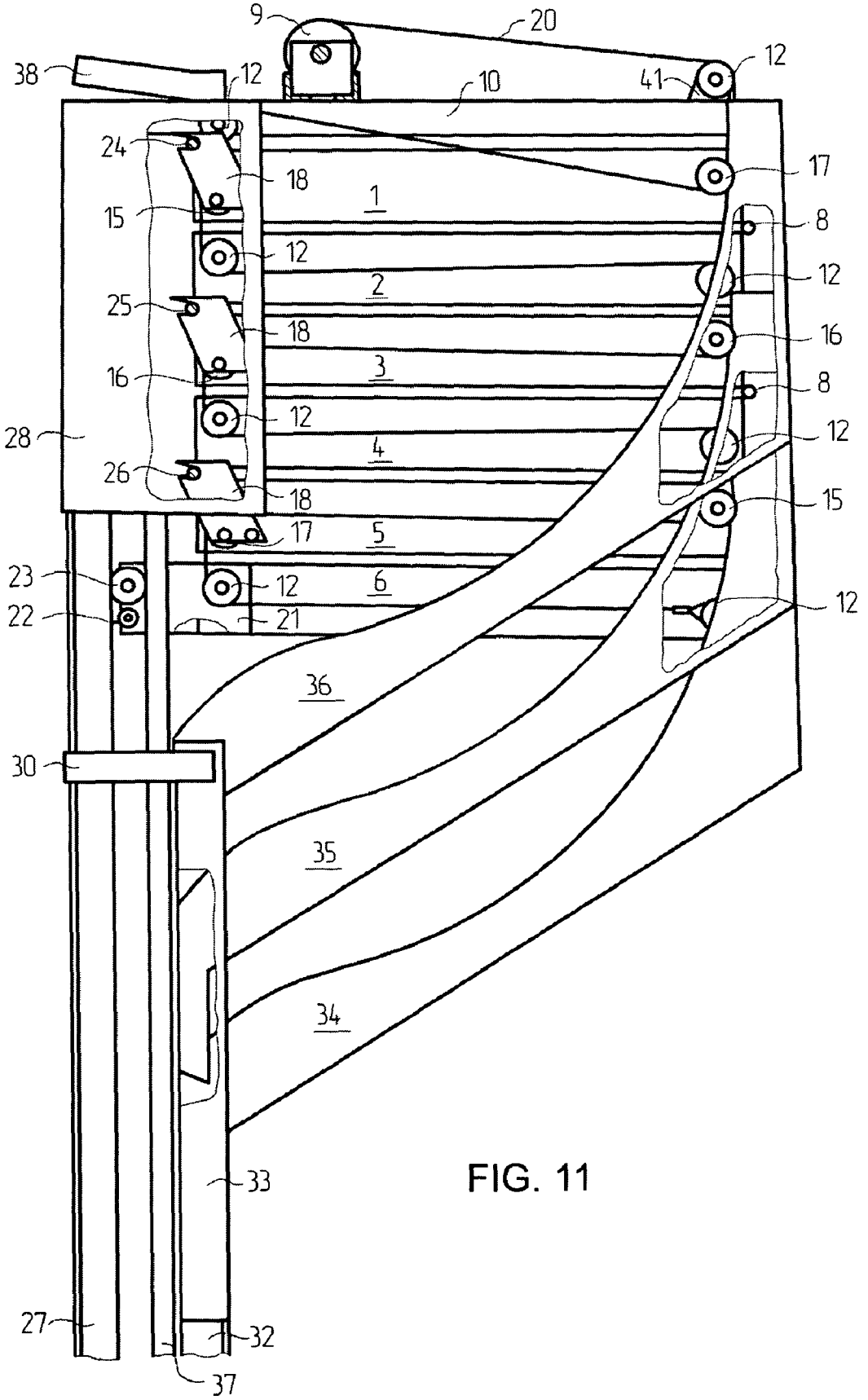
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FIG. 11

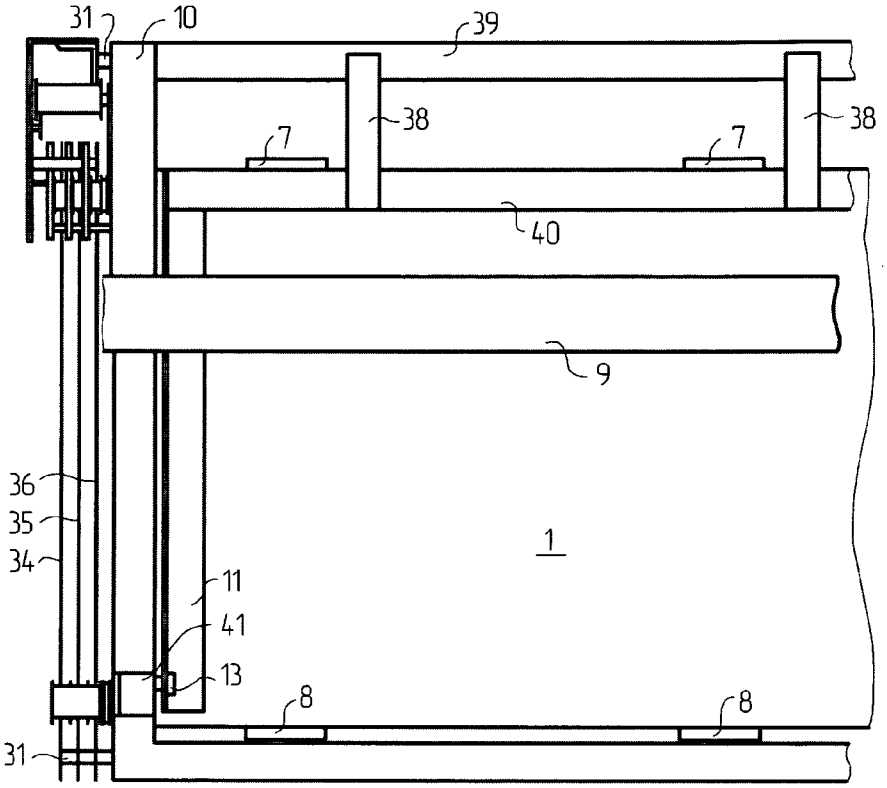

FIG. 12

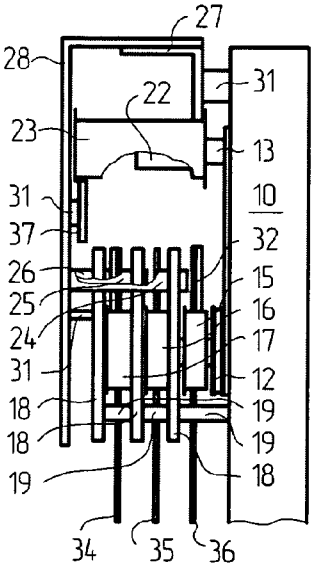

FIG. 13

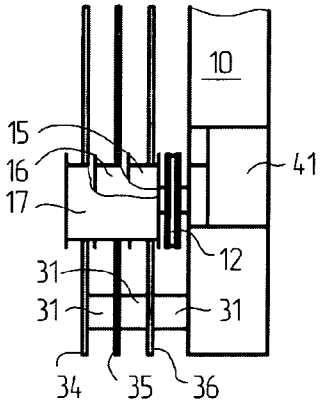

FIG. 14

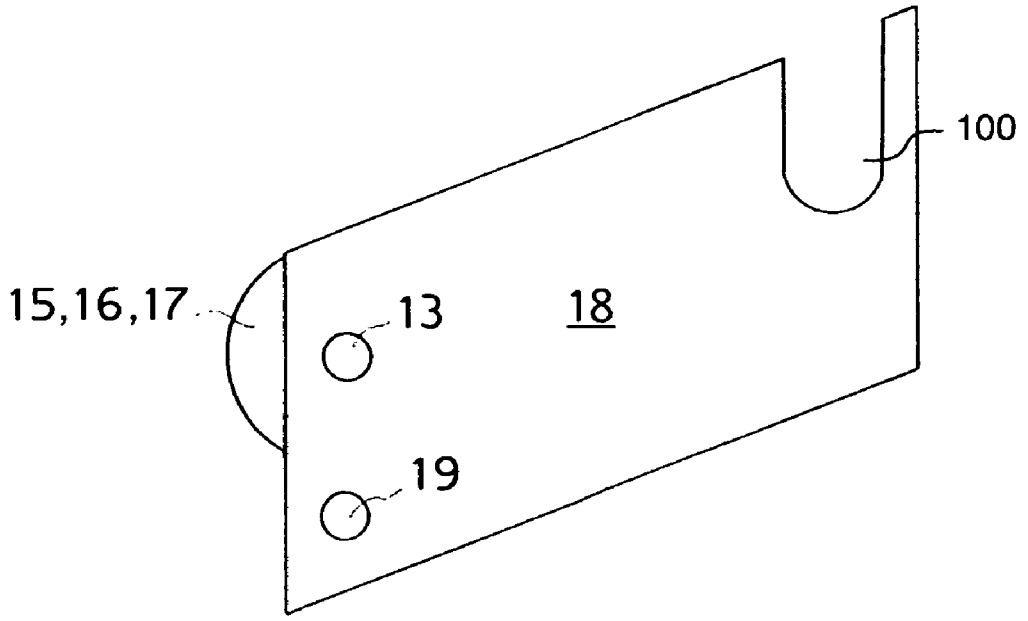

FIG. 15

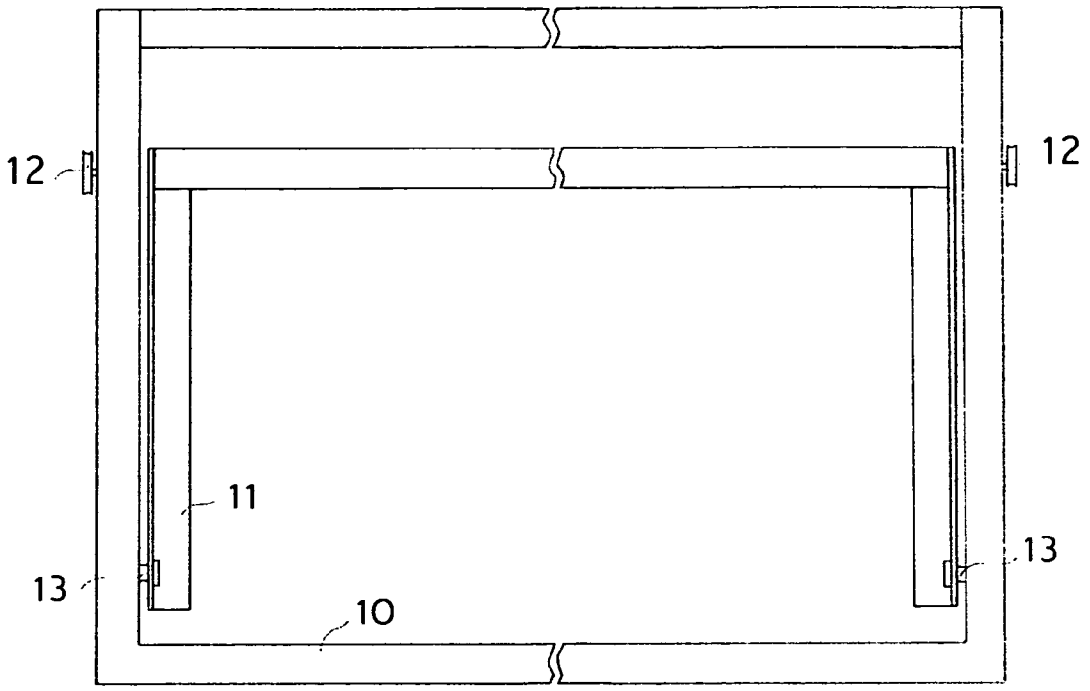

FIG. 16

SECTIONAL FOLDING UP GARAGE DOOR

CROSS-REFERENCE TO RELATED APPLICATION

This U.S. patent application claims priority under 35 U.S.C. 119 (a) through (d) from Ukrainian patent application No. UA200904758 filed May 15, 2009 (now Ukrainian Patent No. 45054 issued Oct. 26, 2009), which application is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to overhead sectional doors of the type used to close large openings in garages and commercial buildings.

BACKGROUND OF THE INVENTION

Sectional folding doors are well known in the art and are widely used all over the world. Typically, such a sectional door comprises a plurality of rectangular panel sections, the total area of which is equal to the area of the aperture that needs to be closed, and the width of which is close to the width of the aperture that needs to be closed. The panel sections are joined to each other at their longitudinal edges with hinges that can be flexed in only one direction with a maximum angle of no more than 90°. The average thickness of such sections is typically about 40 mm, and they are made of lightweight aluminum or plastic. The door moves on two lateral rails by means of rollers. The rails have three sections—vertical, transitional/bending, and horizontal. When the door is vertical, the sections make a solid panel, closing the aperture. When the door is opening, the sections move up, pass the transitional/bending section, and move into the top horizontal surface. When the door is in the horizontal position, it is situated under the ceiling and above the user. The door area remains invariable—the sections of the garage door occupy the same amount of space both in the open and closed positions. Because of this property, the prior art door occupies a lot of space when the aperture is open, which may not be practical in every application.

SUMMARY OF THE INVENTION

The object of the present invention is to reduce the area occupied by the garage door when the door is open while preserving the vertical plane of motion while the door is opening or closing and requiring no free space in front of or behind the door while it is opening or closing.

The preferred embodiment of the invention comprises a sectional door comprising a plurality of panels, a frame, and a power mechanism. This embodiment of the invention allows the door to assume two static conditions—the closed door where all the panels are unfolded, and the open door where the panels are folded into a configuration that has the width and length of the biggest panel and the thickness approximately equal to the sum of the thicknesses of the panels. Also, as the panels move from the open to the closed condition, or vice versa, they move in the vertical plane. As the door opens, the panels fold one section at a time and move upwards, resting one below the other.

The sectional door comprises an even number of panels of similar width, connected sequentially at the top and bottom sides by means of alternating internal and external hinges. This enables the door to fold like an accordion. Roller mechanisms are placed on the lateral sides of the panels in reverse diagonal order with respect to the position of the hinges, to make it possible to fold the door compactly. On the lateral side of the door panels, there is an external and internal row of roller mechanisms. The top external roller mechanism on the first panel (topmost panel) comprises a cable roller, an external rail roller, and a lateral fork hinge placed coaxially; the bottom internal roller mechanism on the first panel comprises a cable roller and an internal rail roller, also placed coaxially. On the second panel, one cable roller is placed in the top internal position and one cable roller is placed in the bottom external position. This prevents interference when the second panel is folded up, and provides the roller mechanisms with up to three connection means. Each panel's roller mechanism comprises a cable roller. The topmost panel's roller mechanisms (both internal and external) also comprise internal and external rail rollers, enabling the motion of the panel along the rails; and a lateral fork hinge that is placed only behind the external rail roller, which comprises a U-slot on is surface, where the semicircular part of the U-slot is concentric with the internal hinge line, and where the lateral fork hinge rotates around the axial branch that is placed on the frame's external rail. This lateral fork hinge can connect and disconnect to the axial branch, and therefore, the topmost panel can rotate around the axial branch as it moves inside the premises. This arrangement of rollers repeats on other pairs of panels throughout the door; the only difference is the length of the internal and external rail rollers; for each pair of panels, going from top to bottom, the external rail roller length increases proportionally. For the internal rail rollers, the shortest roller is on the bottom-most pair of sections, and the roller length increases for each pair of panels going from bottom to top. On the bottom-most panel, two supplementary end rollers are used, situated on the same horizontal line—an end roller and a retaining roller. Both the end roller and the retaining roller are longer than the external rail roller's maximal length, and there is a minimal clearance between the roller's front side and the external rail, which prevents any blockage of the roller during its movement. The retaining roller's diameter is smaller than the rail roller's diameter. The function of the retaining roller is to prevent the bottom-most section from turning inwards.

The frame of the garage door of the present invention comprises vertical and horizontal sectors. The vertical sector comprises an external rail, with axial branches, and an internal rail, with curved sectors. The external rail rollers roll along the external rail with axial branches, where the increased length of the rollers correspondingly increases the distance of the lateral fork hinge from the external rail. The axial branches are placed in the top sector of the external rail. The axial branches are placed vertically, one above the other, at a distance that is the same as the distance between neighboring external rail rollers when the panels are folded. These axial branches serve as axes of rotation for the lateral fork hinges. Their position is such that each lateral fork hinge can only couple with its own corresponding axial branch, when its corresponding pair of sections starts to rotate inside and then fold. When the door is folded, all the lateral fork hinges are coupled with the relevant axial branches, and when the section is horizontal, the lateral fork hinge performs a locking function as it turns 90°. The axial branch is always higher than the vertical segment of the top curved sector of the internal rail, to prevent any interference with the internal roller along its motion path. This property necessarily limits the maximal quantity of the panel sections; the total thickness of all the panel sections cannot exceed the width of a section.

The internal rail comprises a straight vertical sector and curved sectors, whose quantity is the same as the quantity of

the internal rail rollers. Each curved sector comprises three segments—a vertical segment, a reverse concave segment, and a circular segment whose radius of curvature is the same as the section width, and which is equal to the distance from the lateral fork hinge semicircle axis to the rotation axis of the panel's internal rail roller, plus the roller's radius. The curved sector of the internal rail is there to perform a retaining function; it is shaped so that the roller, when moving along the curved section, presses the lateral fork hinge against the axial branch. Each pair of panels has its own unique location for the curved sector, which depends on the internal rail roller length and the height of the axial branch for that pair of panels. The shortest internal rail roller is placed on the bottom-most pair of panels of the door, and rolls up on the internal rail's vertical sector, continuing onto the curved sector. The next pair of panels utilize a different curved sector, which does not coincide with the internal rail's vertical sector; it is displaced laterally to meet the other internal rail roller. The bottom of the curved sector has a reverse concavity segment of the same radius, to provide free motion of the internal rail roller when the door is closing. The length and inclination angle of that reverse concavity segment are what defines the U-slot length and the inclination angle of the internal edge of the lateral fork hinge slot. The end roller rail, situated between the internal and external rails, tracks the motion of the end roller of the bottom-most panel. The end roller rail has a length equal to twice the width of the panel.

The horizontal sector of the frame is as wide as the width of one panel, and it is connected to the external rail on its front side and to the curved sectors of the internal rail on the rear side. A rotary support is placed inside said frame to support the U-slots as they rotate; it is axially fixed inside the frame's horizontal sector through the rear ends of the lateral sides, and connected to the panel's top sections via the internal hinge line. The rotary support rotates within the horizontal coupling, and the lateral fork hinge of the first pair of panels is connected with the axial branch of the first pair of panels at the beginning of the folding process, and rotates downwards until the internal rail roller of the first pair of panels is placed on the vertical segment of the internal rail's curved sector. This prevents any inward bending of the first pair of panels, and enables the door to lock in place. The traction rollers are placed on the horizontal sector of the frame above the internal rail rollers when the door is folded. The lifting rollers are placed on the lateral sides of the frame above the external rail rollers when the door is closed. The lifting rollers, together with the rotary support, implement the door locking mechanism. The winding drum is placed on the horizontal sector of the frame behind the traction rollers. In another embodiment of the invention, it can also replace the traction rollers and execute both their function and the cable winding function simultaneously. The power mechanism comprises the following elements: the cable winding drum, two lifting rollers, and two traction rollers, all situated on the horizontal sector of the frame; cable rollers placed on the panels; and two cables. The cable winding sequence starts with the first pair of panels as follows: winding drum—traction rollers—bottom internal roller of the first panel—lifting roller—bottom external roller of the second panel—top internal roller of the second panel. The cables are fixed at that point if this is the last pair of panels, or go on to the next pair of panels—bottom internal roller of the first panel—top external roller of the first panel—bottom external roller of the second panel—and so on. The diagonal position of the cable rollers prevents their touching the cable. The advantages of this design are increased hoisting capacity as a result of the use of two cables, which enables a sturdier design for the door panels and extends the maximum allowable aperture area to be closed; and the fact that the design uses the weight of the door panels during the opening and closing process, rather than the prior art spring mechanisms, which improves reliability and safety. Further advantages are faster opening and closing due to the reduction of the guide rail length and noise reduction during opening and closing as a result of the absence of horizontal motion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the invention.

FIG. **2** shows the cable winding and the hinge connection of the panels.

FIG. **3** is a lateral view of the first pair of panels.

FIG. **4** is a view of the external roller mechanism.

FIG. **5** is a view of the internal roller mechanism.

FIG. **6** is a view of the cable roller mechanism.

FIG. **7** shows the position of the external roller mechanisms and the end roller n the external rail at a random point within their range of motion.

FIG. **8** shows the position of the internal roller mechanisms of the internal rail at a random point within their range of motion.

FIG. **9** is a lateral view of the door in the closed position.

FIG. **10** is another view of FIG. **9**.

FIG. **11** is a lateral view of the door in the open position.

FIG. **12** is a top view of the door in the open position.

FIG. **13** is a scaled-up view of the external roller mechanisms shown in FIG. **12**.

FIG. **14** is a scaled-up view of the internal roller mechanisms shown in FIG. **12**.

FIG. **15** is a view of the lateral fork hinge with the U-slot.

FIG. **16** is a view of the U-shaped rotary section.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The foregoing description is that of the preferred embodiment of the present invention, and not meant to be limiting. Other embodiments of the invention exist and are apparent to a person of ordinary skill in the art.

FIG. **1** shows the garage door of the present invention. The aperture of the garage is closed by panels **1**, **2**, **3**, **4**, **5**, and **6** (note that the number of panels does not have to be 6, and can be any number). The frame comprises an external rail **27** with axial branches that are placed on platform **28**, and internal rail **32** with curved sectors **34**, **35**, and **36** and the end roller rail **37**. All the rails are connected with clamps **30**. Horizontal sector **10** has a front bar **39** and a rotational support **11**. The power mechanism is placed on horizontal sector **10**, and comprises winding drum **9**, reducer **43**, electric motor **42**, and cable rollers **12**—lifting rollers on the lateral sides of horizontal sector **10** and traction rollers on support **41**.

FIG. **2** shows the manner of cable winding and the interconnection of panels with internal hinges **7** and external hinges **8**. The door is connected to the horizontal sector **10** via rotary frame **11** with internal line hinges **7**.

FIG. **3** shows the top pair of panels—panel **1** and panel **2**—showing the order of roller placement on those panels. The lateral fork hinge **18** is shown at the top of the figure, fixed on axle **13** and anchor jack **19**. The cable is wound from the top of the panel through cable rollers **12** and rollers **17**.

FIG. **4** shows a side view of the rollers at the top of the first panel. Axle **13** is mounted on the lateral side **14** of the panel. On that axle **13**, the following are placed in consecutive order: cable roller **12**; roller **15** (for panel **1**); and the lateral fork hinge **18** that is fixed on axle **13** and anchor jack **19**. FIG. **15**

shows an isolated view of the lateral fork hinge **18**, which shows the axle **13**, anchor jack **19**, rollers **15**, **16**, and **17** (coaxial to axle **13**), and the U-slot **100**.

FIG. **5** shows the internal roller mechanism, which is located in the bottom part of panels **1**, **3**, and **5**. On that axle **13**, the following are placed in consecutive order: cable roller **12**; roller **17** (for panel **1**).

FIG. **6** shows the cable roller mechanisms placed on panels **2**, **4**, and **6**, comprising one cable roller **12** on axle **13**.

FIG. **7** shows the vertical correspondence between lateral fork hinges **18** of panels **1**, **3**, and **5** to axial branches **24**, **25**, and **26**, fixed on platform **28**. It also shows the position of end roller **23** and retaining roller **22**, mounted on plate **21** to interact with external rail **27** and end roller rail **29**, connected via joining element **31** with clamp **30**.

FIG. **8** shows the relationship of the lengths of rollers **15**, **16**, and **17** with the circular sectors **34**, **35**, and **36** and their positions on step bar **33** vis-à-vis internal rail **32**.

FIG. **9** shows the location of the segments on curved sector **36** as follows; AB is the vertical segment, BC is the reverse concavity/inclined segment, and CD is the circular segment. When the door is closed, rotary frame **11** is turned downwards until the limiting elements **38** butt against front bar **39** of horizontal sector **10**. At that point, roller **17** of the internal roller mechanism remains on the vertical sector of circular rail **36**, preventing the first pair of panels from bending inwards. For other pairs of panels, this function is performed by lateral fork hinges **18**, which are thrust against internal rail **32**; and for the last panel, this function is performed by the end roller **23** and retaining roller **22**. Furthermore, because of gravitational force on the open door and because of the door's structure, each rail roller is strongly pressed against its rail, stabilizing the structure. The edges of the rollers prevent the panels from lateral displacement. While the top panel is slightly turned inward, this does not disturb the panel exterior, as over ⅔ of the panel remains above the aperture.

FIG. **10** is a continuation of FIG. **9**, and is a sectional view of the step bar **33**, axial branch platform **28**, internal rail **27**, end roller rail **37**, the first and fourth clamp **30** and plate **21**.

FIG. **11** shows the door in its open condition. The U-slots of lateral fork hinges **18** of panels **1**, **3**, and **5** are connected to axial branches **24**, **25**, and **26**. The hinges are turned, and as a result, the folded panels are hanging on axial branches **24**, **25**, and **26**, and cable **20** is holding panels **5** and **6** in a horizontal position. Rollers **17**, **16**, and **15** of the interal rail roller mechanisms stay on the curved sectors **36**, **35**, **34**, and prevent displacement of the corresponding lateral fork hinge from the axial branch.

FIG. **12** shows a sectional view of the left part of the invention in the door folded position. The lateral side of rotary frame **11** is connected to horizontal sector **10** by axis **13**, and the front side **40** is connected to panel **1** by a line of internal hinges **7**, with limiting elements **38** placed on it. FIG. **12** also shows two sides of the winding drum **9**.

FIG. **13** shows the positional relationship between lateral fork hinges **18** and curved sectors **34**, **35**, and **36** in the horizontal plane aligned with the section's lateral side, which excludes their mutual touching during the motion of the external roller mechanisms. The Figure shows sectional views of axial branches **24**, **25**, and **26**, and a view of the end roller **23**, which is located between end rail roller **37** and external rail **27**, and connected to horizontal sector **10** with joining element **31**.

FIG. **14** shows rollers **15**, **16**, and **17** of the internal roller mechanisms positioned on curved rails **34**, **35**, and **36**, respectively. Those curved rails are interconnected and connected with horizontal sector **10** via joining elements **31**. Cable roller **12**, which performs a traction function, is mounted on horizontal sector **10** with support **41**.

FIG. **16** shows a view of the rotary frame **11**, two traction rollers **12**, horizontal sector **10**, and axles **13**, in isolation from the other elements for greater clarity.

FIG. **9** shows the door in the completely closed position, and FIG. **11** shows it in the completely open position. To go from closed to open position, electric motor **42** rotates the winding drum **9** via a reducer **43** counterclockwise, which winds cable **20** on winding drum **9**. This applies two forces to the first pair of panels—a lateral force, whose vector coincides with cable **20**, and which is directed from roller **12** of the first panel's internal roller mechanism to traction cable roller **12**; and a vertical force, whose vector coincides with cable **20** and is directed from roller **12** of the external roller mechanism of section **2** to the lifting cable roller **12**. The total sum of these two forces exceeds the gravitational force, and the first pair of panels is lifted, rotated, and folded. The process of folding involves three stages. First, the first pair of panels and the whole door starts lifting. At that stage, rotary frame **11** rotates upwards, and roller **17** of the internal roller mechanism of the first panel moves from the vertical segment of curved **36** into the inclination segment. Then, the second stage of the process starts. At that stage, the U-slot of the lateral fork hinge **18** of the first panel engages with the axial branch **24**, and roller **17** moves on the inclined segment of the curved sector **36**. Finally, during the third stage, roller **17** of the first panel's internal roller mechanism passes the inclined segment and moves on to the circular segment of curved sector **36**, the U-slot of the lateral fork hinge **18** becomes completely coaxial with the axial branch **24**, and panel **1** rotates around the axial branch **24** until the first pair of panels is completely folded. The other pairs of panels are lifted when the first two panels fold. Panels **3** and **4** fold similarly to panels **1** and **2**, except that the lateral force vector is now directed from the roller **12** of the internal roller mechanism of panel **3** to the roller **12** of the internal roller mechanism of panel **2**, and the vertical force vector is now directed from roller **12** of the external roller mechanism of panel **4** to roller **12** of the external roller mechanism of panel **3**. Panels **5** and **6** fold similarly to panels **3** and **4**. Panel **6** is the final panel; as such, it has an end roller **23** and retaining roller **22**, placed on plate **21** as shown on FIG. **11**. The length of end roller rail **37** is dependent on the linear motion of end roller **23** on external roller **27**, when panels **5** and **6** are not coplanar. At the time, retaining roller **22** thrusts against the internal rail **32**.

When the door is closing, winding drum **9** rotates clockwise and the cable **20** unwinds. Gravity provides the main force in the process; the force vector is directed straight down from roller **12** of the external roller mechanism of panel **6**, as shown in FIG. **11**. The bottom edge of panel **6** goes down, end roller **23** moves between external rail **27** and end roller rail **37**, and roller **15** of the internal roller mechanism of section **5** goes down along the curved sector **34**. Lateral fork hinge **18** of the external roller mechanism of panel **5** rotates on axial branch **26** while this roller passes through the circular segment of curved sector **34**. Then, as roller **15** of the internal roller mechanism of panel **5** moves along the inclined segment of curved sector **34**, the lateral fork hinge **18** of the external roller mechanism of section **5** starts disengaging from axial branch **26**. Then, at the final stage of the process, roller **15** of the internal roller mechanism of panel **5** goes to the vertical segment of curved sector **34** and the internal rail **32**, and roller **17** of the external roller mechanism of panel **5** engages with external rail **27**. Finally, panels **6** and **5** are completely coplanar and hang downwards. The process is similar for panels **4** and **3** and for panels **2** and **1**. At the end of

the process, rotary frame **11** is turned until limiting elements **38** butt against front bar **39**, and the door closing process is finished.

The invention claimed is:

1. A sectional folding garage door comprising:

an even number of panels connected by hinges;

a plurality of external roller mechanisms, each external roller mechanism placed on the top lateral side of each odd-numbered panel, each comprising an external cable roller, an external rail roller, and a lateral fork hinge, mounted coaxially to each other along a horizontal axis;

a frame comprising two vertical guides and a horizontal sector, said vertical guides comprising an external rail and a plurality of axial branches protruding horizontally from the vertical guides, the number of said axial branches equal to the number of panels, the topmost axial branch being the longest and each successive axial branch being shorter, and an internal rail, said internal rail comprising at least one curved sector with a radius of curvature equal to the vertical dimension of a panel, and said horizontal sector comprising a rotary frame;

a plurality of lateral fork hinges, each lateral fork hinge corresponding to an axial branch, wherein each lateral fork hinge revolves around its corresponding axial branch during folding;

a power mechanism comprising at least one cable, a cable winding drum, and a plurality of rollers situated on at least one of the panels.

2. A sectional folding garage door according to claim **1**, wherein said external rail rollers are the shortest for the top-most pair of panels and increase in length for each successive pair of panels.

3. A sectional folding garage door according to claim **1**, wherein said curved sectors correspond to internal rail rollers.

4. A sectional folding garage door according to claim **1**, wherein said curved sectors include a vertical segment, a reverse concave segment, and a circular arc segment.

5. A sectional folding garage door according to claim **1**, wherein the bottommost panel further comprises a retaining roller and an end roller, wherein said end roller is longer than the external rail roller of the same panel.

6. A sectional folding garage door according to claim **1**, further comprising a plurality of internal roller mechanisms, one for each pair of panels, each comprising an internal cable roller and an internal rail roller, wherein said internal rail rollers are the longest for the top-most pair of panels and shorter for each successive pair of panels.

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