Feb. 18, 1936. D. C. HUNGERFORD 2,030,873

SPRING BALANCED DOOR

Filed Nov. 5, 1931 3 Sheets-Sheet 1

Fig. 2.

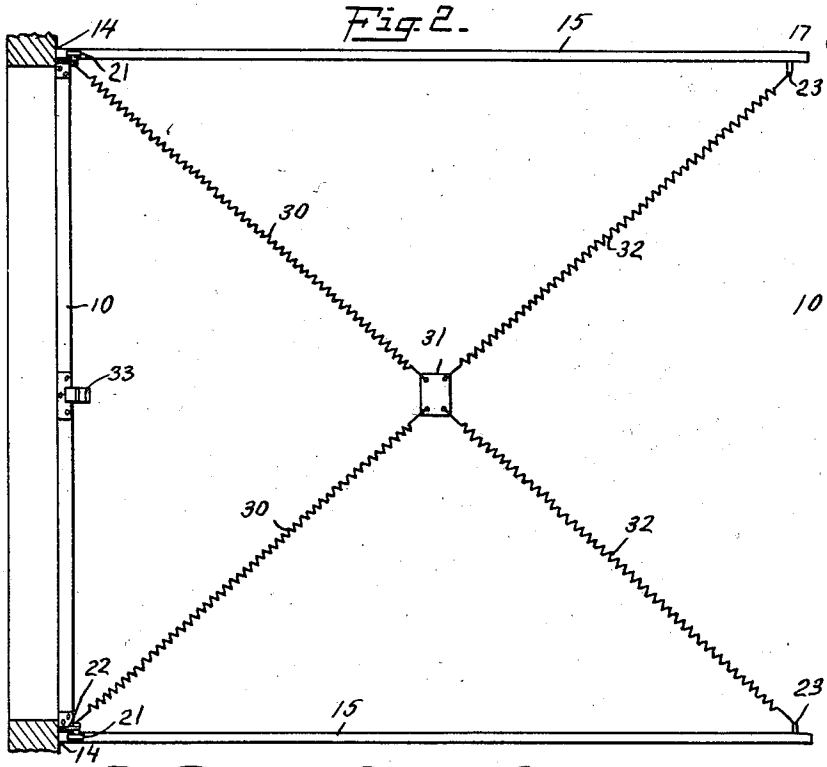
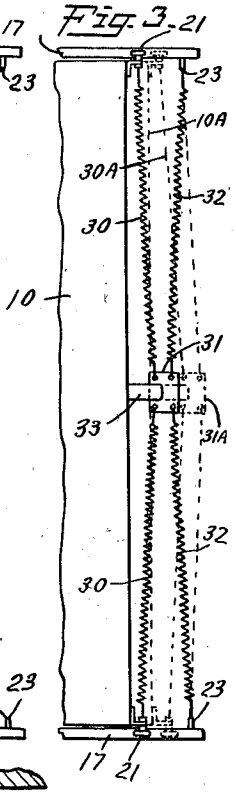


Fig. 3.



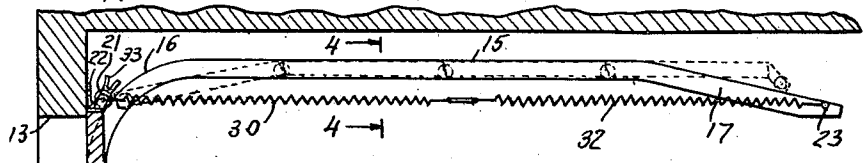


Fig. 1.

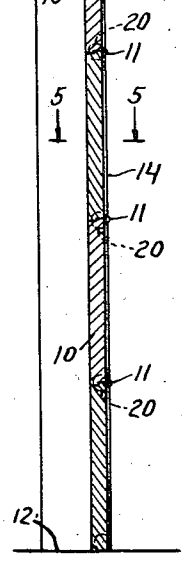


Fig. 6.

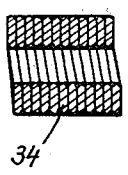


Fig. 4.

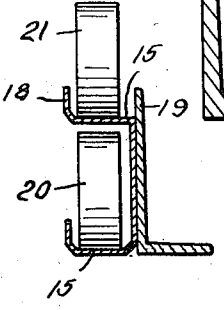
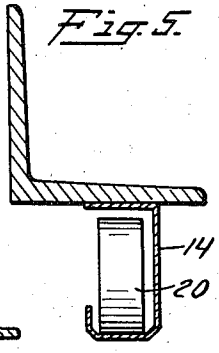


Fig. 5.



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Feb. 18, 1936. D. C. HUNGERFORD 2,030,873

SPRING BALANCED DOOR

Filed Nov. 5, 1931 3 Sheets-Sheet 2

Fig. 9.

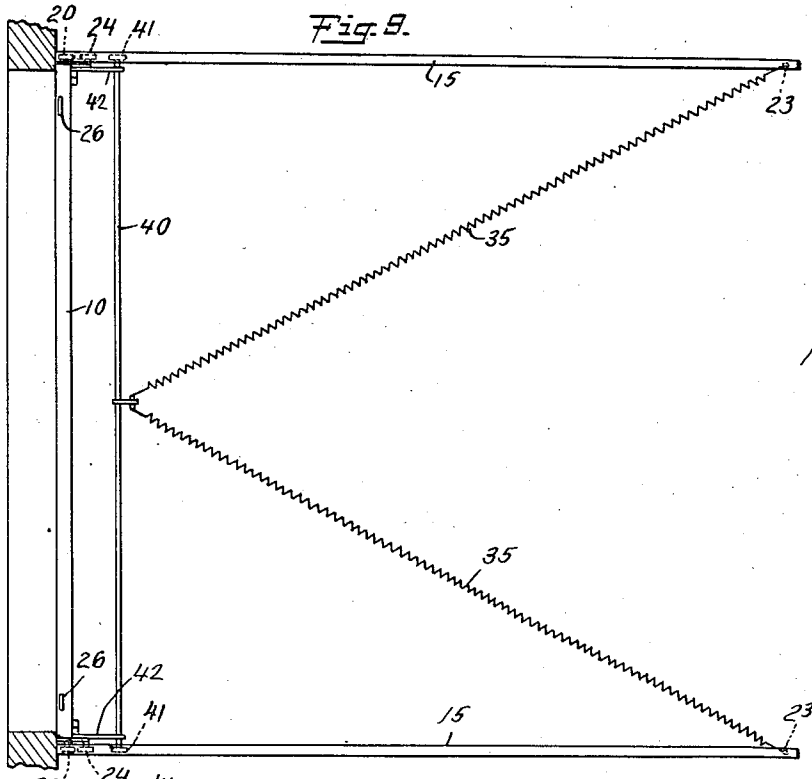
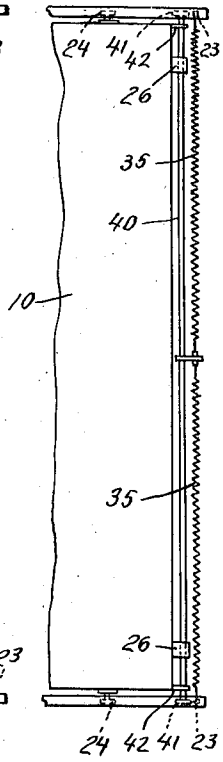


Fig. 10.



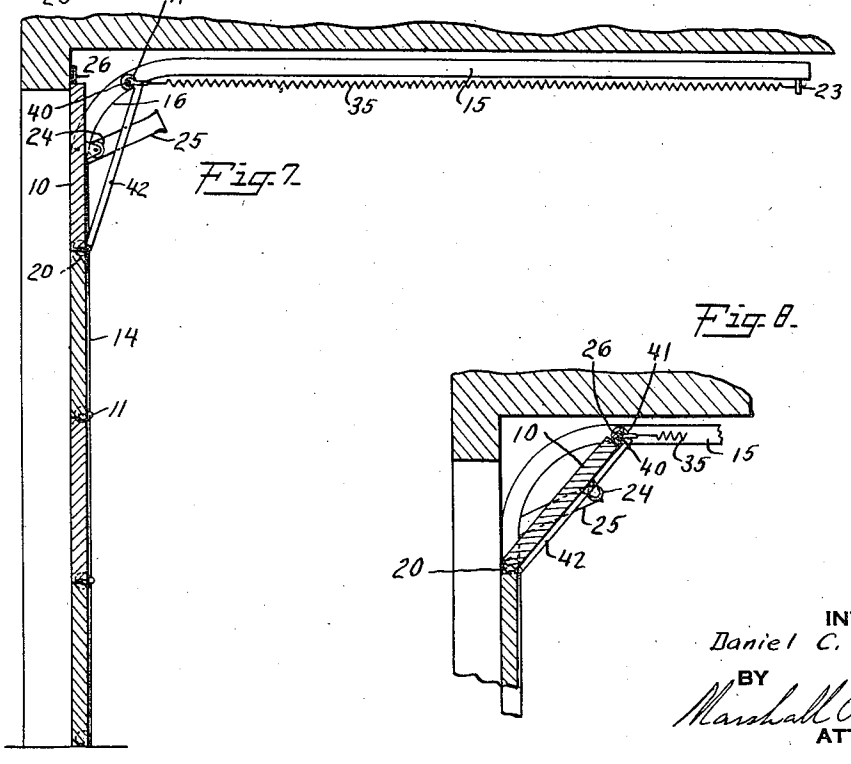


Fig. 7.

Fig. 8.

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SPRING BALANCED DOOR

Filed Nov. 5, 1931 3 Sheets-Sheet 3

Fig. 12.

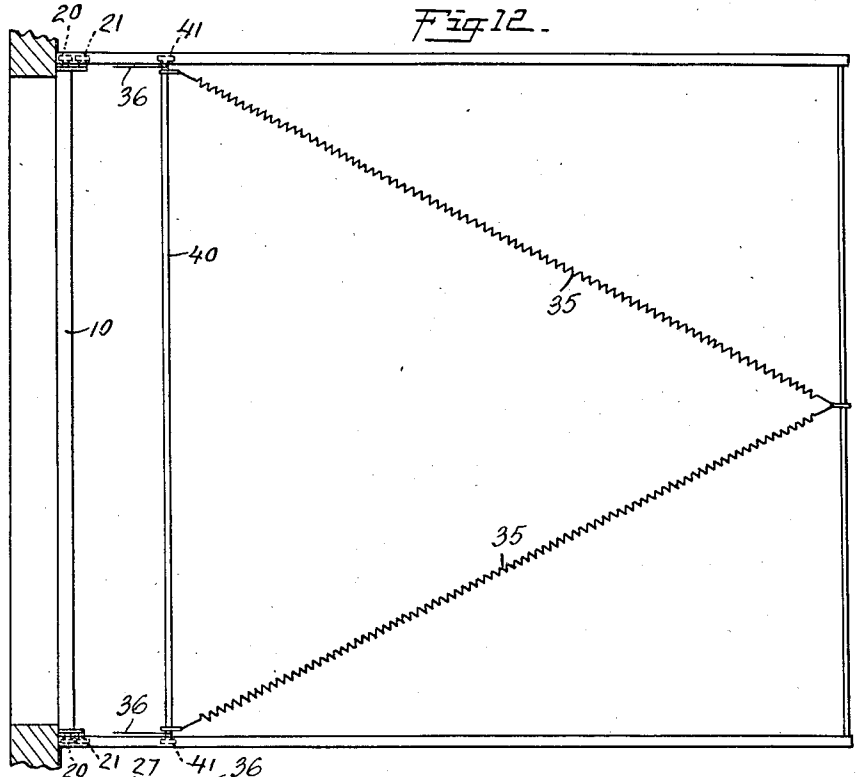


Fig. 11.

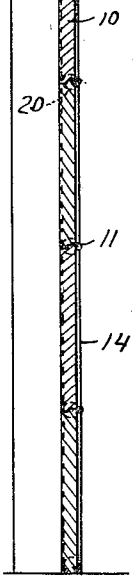


Fig. 14.

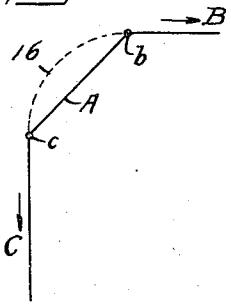
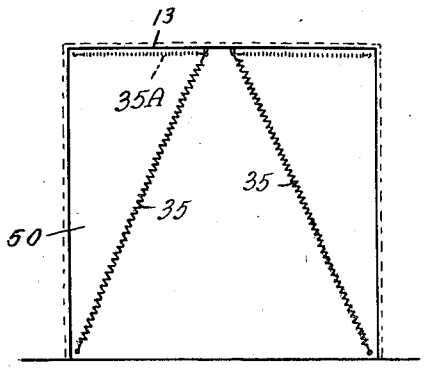


Fig. 13.



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UNITED STATES PATENT OFFICE

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SPRING BALANCED DOOR

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Application November 5, 1931, Serial No. 573,094

26 Claims. (Cl. 20—20)

This invention relates to improvements in spring counterbalancing mechanisms.

Its object is to provide a simple arrangement whereby closures which are movable from vertical to horizontal positions are effectively balanced in various positions which they assume, by helical springs disposed diagonally to the path of movement of their points of attachment to the closures.

Another object is to provide an arrangement with track guided closures in which the balancing springs occupy no space outside of or beyond the tracks.

A still further object is to conserve headroom by so arranging the parts that the horizontal portions of the guiding tracks may be near the top of the doorway and close to the ceiling.

These and other objects will appear from the following specification in which I will describe the invention, the specific features of which will be pointed out in appended claims.

Referring to the drawings,

Fig. 1 is a sectional side elevation of a door which is made according to and embodies this invention, showing the door in closed position in full lines and in its open position in dotted lines;

Fig. 2 is a top plan view of the structure shown in Fig. 1 with the door closed;

Fig. 3 is a top plan view of a part of the door in its open position. Its extreme limit of opening movement is indicated in broken lines to illustrate the cushioning effect of the springs;

Fig. 4 is a sectional elevation of one of the tracks, the section being taken on the line 4—4 of Fig. 1;

Fig. 5 is a similar view of one of the tracks, the section being taken on the line 5—5 of Fig. 1;

Fig. 6 is a cross section on an enlarged scale, a portion of one of the springs shown in its closed position;

Fig. 7 is a sectional elevation of a modified construction which embodies this invention;

Fig. 8 is a similar view of some of the parts showing positions they assume during the operation;

Fig. 9 is a plan view of the structure shown in Fig. 7;

Fig. 10 is a plan view of some of the parts in the positions they assume when the door is fully open;

Fig. 11 is a sectional elevation of another modification which embodies this invention;

Fig. 12 is a plan view of the parts shown in Fig. 11;

Fig. 13 is a diagrammatic front elevation of another embodiment of the invention; and

Fig. 14 is a diagrammatic illustration of a feature of the invention showing how the door sections are biased to stand in intermediate positions.

Referring first to Figs. 1–6, 10 designates a plurality of door sections hinged together as at 11 and together forming a closure for the doorway between the threshold 12, the header 13 and the vertical portions 14 of the spaced tracks. The tracks comprise these vertical portions 14 shown in section in Fig. 5 and horizontal portions 15 shown in section in Fig. 4 with intermediate curved portions 16 near the door header. The inner ends 17 of the tracks are depressed, as shown in Fig. 1. The vertical, curved and horizontal portions of the tracks form channels in which run rollers 20 which project from the lower edges of each of the door sections. Rollers 21 in brackets 22 at the upper corners of the upper door section rest on the outer web of the curved portion of the tracks when the door is closed and run onto the upper web of the horizontal portion of the track as the door is opened and are retained by a flange 18 formed as a part of the track and a flange 19 of an angle iron which supports the horizontal part of the track.

A pair of helical springs 30, 30 run diagonally from the roller brackets 22, to a plate 31 and another pair of similar springs 32, 32 run from the plate 31 to points 23 near the inner ends of the tracks. A forked member 33 is affixed to the upper edge of the upper door section in such a position as to engage the plate 31 when the doors are open.

When the door sections are in the closed position shown in full lines in Fig. 1, the springs 30, and 32, are fully extended and exert a horizontal pull on the bracket 22 and through rollers 21 against the lower portion of the curved tracks 16, where the vertical component of its force is small and the door has a bias to close, providing positive closure of the door at this point. As the door is opened, and the rollers 21 traverse the curved track 16, the horizontal component increases until rollers 21 reach the horizontal section 15 of the track at which point and thereafter the door is increasingly supported by the horizontal track. Concurrently the angularity of the springs increases and their tension decreases as they contract. These two functions of the springs are proportioned to equal the decrease in the unsupported weight of the door sections, so that an approximate balance is effected at all

positions of the doors when the rollers **21** are on the horizontal tracks. Obviously this same balance is maintained during the operation of closing the door.

When the door is opened quickly, there is a tendency, due to the momentum of the moving parts, for it to overrun its fully open position. Its movement is arrested by the engagement of the forked member **33** with plate **31**, as illustrated in Fig. 3. The upper door section is shown in its overrun position in dotted lines at **10A** in the latter figure, with the plate forced to the position shown at **31A** by the member **33**. When in this position the spring **30** moves to the position in which it is shown by dotted lines at **30A** where it has an angularity which causes it to exert a horizontal pressure on the door sections to cushion and arrest their movement and to produce a tendency to move them back slightly to a position of rest in perfect balance, with the upper section in the position in which it is shown in full lines in Fig. 3, when the springs are closed.

At this time the rollers **20** which project from the lower corners of the lower door section will be in the upper part of the curved portion **16** of the tracks. Consequently, the weight of this lower section will produce a horizontal component of force tending to move the door sections to the left as viewed in Fig. 1 (dotted lines). This is overcome by the angularity of the depressed portions **17** of the tracks upon which the rollers **21** rest at this time. This produces a horizontal component of force equal and opposite to that which has been pointed out, thus leaving the door in perfect balance.

The springs are preferably made with an initial set, that is, they are designed to be closed coil to coil when the door is fully opened, as in the full line position of Fig. 3, but to be under tension as soon as they are opened even slightly. Therefore, when spring **30** is moved to the position shown by dotted lines at **30A** in Fig. 3, it is under a tension which has a horizontal component which resists movement of the door to the right. At the beginning of a movement of the door to the left (Fig. 3), the spring **32** will immediately provide a horizontal force to oppose this movement to balance the horizontal component set up by the rollers **20** projecting from the lower corners of the lower door section **10**, running onto a more nearly vertical part of the curved portions **16** of the tracks, than they occupy when the door is fully opened.

This initial set of the springs is more readily obtained and to a greater extent when the wires of the spring are of an oblong cross-section, as shown at **34** in Fig. 6.

At this time the rollers **20** which project from the lower corners of the lower door section will be in the upper part of the curved portion **16** of the tracks. Consequently, the weight of this lower section will produce a horizontal component of force tending to move the door sections to the left as viewed in Fig. 1 (dotted lines). This is overcome by the angularity of the depressed portions **17** of the tracks upon which the rollers **21** rest at this time. This produces a horizontal component of force equal and opposite to that which has been pointed out, thus leaving the door in perfect balance.

The springs are preferably made with an initial set, that is, they are designed to be closed coil to coil when the door is fully opened, as in the full line position of Fig. 3, but to be under tension as soon as they are opened even slightly. Therefore, when spring **30** is moved toward the position shown by dotted lines at **30A** in Fig. 3, it is under a tension which has a horizontal component which resists movement of the door to the right. At the beginning of a movement of the door to the left (Fig. 3), the spring **32** will immediately provide a horizontal force to oppose this movement to balance the horizontal component set up by the rollers **20** projecting from the lower corners of the lower door section **10**, running onto a more nearly vertical part of the curved portions **16** of the tracks, than they occupy when the door is fully opened.

This initial set of the springs is more readily obtained and to a greater extent when the wires of the spring are of an oblong cross-section, as shown at **34** in Fig. 6.

When the head-room between the door header and the ceiling is limited, an arrangement with a traveler is used. One such arrangement is shown in Figs. 7–10 and another in Figs. 11 and 12.

Referring now to Figs. 7–10, a traveler **40** is shown on the ends of which are rollers **41** which run in the horizontal portions **15** of the tracks which, as may be seen from Fig. 7, are but slightly above the door header. Links **42** connect the ends of the traveler with the lower corners of the upper door section near its rollers **20**. A pair of helical springs **35** are connected between the center of the traveler and the fixed points **23**.

Rollers **24** project from the upper door section **10** between its upper and lower edges into inclined stub tracks **25**. Fingers **26** extend from the upper edge of the upper door section in position to rest upon and engage the traveler when the parts, in opening the door, assume the positions in which they are shown in Fig. 8 in which the rollers **24** are about to leave the stub tracks **25**. From that point on to the position shown in Fig. 10, the upper part of the upper door section is supported by the traveler. In closing the door, when the parts move from the positions shown in Fig. 8 to those shown in Fig. 7, the rollers **24** and stub tracks **25** cooperate to force the upper part of the upper door section against the sides of the door frame.

The balance in this case is effected in the manner previously described, by the tension and angularity of the springs.

In the arrangement shown in Figs. 11 and 12, the tracks, the door sections and their rollers are the same as shown in Fig. 1, except the track is somewhat lower and the rollers **21** project from the upper corners of the upper door section. In this case, as in Fig. 7, a traveler **40** is provided which has rollers **41** which run in the horizontal portions **15** of the tracks. Cables or chains **36** extend from the ends of the traveler, over sheaves **27** to the lower corners of the lower door section. With this arrangement as with the others, the tension and angularity of the springs balance the door sections in every position which they can assume.

Fig. 13 shows a door **50** in verical position. A pair of springs **35** are connected between the lower corners of the door and points near the center of the header **13**. When the door is open the springs will assume the positions in which they are shown in dotted lines at **35A** and will be closed.

Several modifications have been illustrated and described for the purpose of showing that the invention is not limited to any specific form or construction. In each case the springs, because

of their angularity, have a greater amount of extension than in former constructions, although they occupy less room and need be of less strength. The springs and the door sections occupy substantially the same space. Speed increasing pulley arrangements are not needed as with former arrangements.

In every case, whenever any door section reaches a position midway between its vertical and horizontal positions, as shown at A in Fig. 14, the spring force, represented by the arrow B, tends to move the point *b* to the right and the point *c* up over the curved portion 16 of the track. At this time the gravity force, represented by the arrow C, which is equal to the force B, tends to move the point *c* downwardly and the point *b* around the curve 16. While these forces are equal, opposite and balanced there is a tendency of the door when moving to come to rest whenever one of its sections reaches the position A, because in opening, the point *c* has to be forced around the curve 16 and in closing the point *b* has to be forced around this curve. The momentum of the moving parts is sufficient to overcome this tendency, but it is useful to insure the door standing in several positions intermediate its closed and open positions.

What I claim is:

1. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, and projections from the closure near the corners thereof engaging said tracks, the projections near the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the projections near the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position.

2. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, rollers projecting from the lower corners of the closure engaging said tracks and arranged to engage the curved portions thereof when the closure is in a horizontal position, and rollers projecting inwardly from the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the rollers projecting from the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position.

3. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, rollers projecting from the lower corners of the closure engaging said tracks and arranged to engage the curved portions thereof when the closure is in a horizontal position, and rollers projecting inwardly from the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the rollers projecting from the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position.

4. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, projections from the closure near the corners thereof engaging said tracks, the projections near the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the projections near the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position, and helical springs connected to the closure near the projections from its upper corners disposed at opposite oblique angles to the path of movement of their connection with the closure.

5. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the closure engaging said tracks, rollers projecting inwardly from the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position, and helical springs connected to the closure near the projections from its upper corners disposed at opposite oblique angles to the path of movement of their connection with the closure.

6. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, rollers projecting from the lower corners of the closure engaging said tracks and arranged to engage the curved portions thereof when the closure is in a horizontal position, rollers projecting inwardly from the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the rollers projecting from the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position, and helical springs connected to the closure near the projections from its upper corners disposed at opposite oblique angles to the path of movement of their connections with the closure.

7. A counterbalancing mechanism comprising a closure, tracks therefor arranged to guide the closure between a vertical position and a horizontal position, a pair of helical springs connected to the closure disposed at opposite oblique angles to the path of movement of their connection with the closure and in the path of movement of the closure, and means on the closure to engage the springs when the closure is in its horizontal position.

8. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, rollers projecting from the lower corners of the closure engaging said tracks and arranged to engage the curved portions thereof when the closure is in a horizontal position, rollers projecting inwardly from the upper corners of the closure engaging the curved portions of the tracks when the closure is in a vertical position and engaging the depressed ends of the tracks when the closure is in a horizontal position, the rollers

projecting from the lower corners of the closure engaging the intermediate curved portions of the tracks when the closure is in a horizontal position, helical springs connected to the closure disposed at opposite oblique angles to the path of movement of their connection with the closure near the rollers projecting from its upper corners and in the path of movement of the closure, and means on the closure to engage the springs when the closure is in its horizontal position.

9. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor arranged to guide the sections between vertical positions and horizontal positions, and helical springs operatively connected to the upper corners of the upper section and connected to diagonally opposite points near the inner ends of the tracks.

10. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor arranged to guide the sections between vertical positions and horizontal positions, and a pair of helical springs operatively connected to the upper section and extending from a point between the upper corners of the upper section to the inner ends of the tracks.

11. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the closure adapted to run on the vertical and curved portions of the tracks, other rollers near the top of the closure adapted to impart a lateral movement to the top of the closure, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, a connection between the traveler and the closure, and helical springs connected to the traveler disposed at an oblique angle to the path of travel of their connection with the traveler.

12. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the closure adapted to run on the vertical and curved portions of the tracks, other rollers near the top of the closure, inclined stub tracks for said other rollers, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, a connection between the traveler and the closure, and helical springs connected to the traveler disposed at an oblique angle to the path of travel of their connection with the traveler.

13. A counterbalancing mechanism comprising a closure, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the closure adapted to run on the vertical and curved portions of the tracks, other rollers near the top of the closure, inclined stub tracks for said other rollers, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, links connecting the traveler and the closure, members projecting from the top of the closure adapted to engage the traveler, and helical springs connected to the traveler disposed at an oblique angle to the path of travel of their connection with the traveler.

14. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of said sections adapted to run on said tracks, other rollers projecting from the upper section adapted to impart a lateral movement thereto, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, a connection between the traveler and said sections, and helical springs connected to the traveler disposed at an oblique angle to the path of movement of their connection with the traveler.

15. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the sections adapted to run on said tracks, other rollers projecting from the upper section, inclined stub tracks for said other rollers, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, a connection between the traveler and the hinge connection between two of said sections, and helical springs connected to the traveler disposed at an oblique angle to the path of movement of their connection with the traveler.

16. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, rollers projecting from the lower corners of the sections adapted to run on said tracks, other rollers projecting from the upper section, inclined stub tracks for said other rollers, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, links connecting the traveler with the hinge connection between two of said sections, members projecting from the top of the upper section adapted to engage the traveler, and helical springs connected to the traveler disposed at an oblique angle to the path of movement of their connection with the traveler.

17. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor comprising vertical portions, horizontal portions and intermediate curved portions, the inner ends of the tracks being depressed, rollers projecting from the lower corners of the sections adapted to run on said tracks, other rollers projecting from the upper section, inclined stub tracks for said other rollers, a transverse traveler having rollers adapted to run on the horizontal portions of the tracks, links connecting the traveler with the hinge connection between two of said sections, members projecting from the top of the upper section adapted to engage the traveler, and helical springs connected to the traveler disposed at an oblique angle to the path of movement of their connection with the traveler, the rollers projecting from the lower section being adapted to rest on the curved portions of the tracks when the rollers projecting from the lower corners of the other sections are on the horizontal portions of the tracks and the rollers on the traveler being then adapted to rest on the depressed portions of the tracks.

18. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions, and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension exerts a horizontal component of force on the connecting track portions in vary-

ing relation as the closure traverses the said connecting portions of said tracks.

19. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions, and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension exerts a vertical component of force on the connecting track portions in varying relation as the closure traverses the said connecting portions of said tracks.

20. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions, and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension is resolved into horizontal and vertical components in varying relation as the closure traverses the connecting portions of said tracks, the connections at one end of the springs being disposed at a point intermediate the tracks.

21. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension is resolved into horizontal and vertical components in varying relation as the closure traverses the connecting portions of said tracks, said springs being disposed oblique to the horizontal track portions when the door is closed.

22. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension is resolved into horizontal and vertical components in varying relation as the closure traverses the connecting portions of said tracks, said springs being disposed oblique to the horizontal track portions when the door is closed and tending to assume positions at right angles to the said track portions as the door is opened.

23. A counterbalancing system comprising a plurality of hinge connected rigid sections, tracks therefor arranged to guide the sections between vertical positions and horizontal positions, and helical springs operatively connected to the upper corners of the upper section and to fixed points adjacent the inner ends of the tracks.

24. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, the vertical component of the spring force on the said connecting track portion being substantially equal to the weight of the door below the said track portions.

25. A counterbalancing system for door closures, comprising a plurality of hinge connected rigid sections, tracks comprising vertical sections, horizontal sections and inclined connected sections, springs fixed at one end and operatively connected at their other ends to the upper portion of the closure, the springs and closure being so proportioned as to force and weight that the vertical component on the inclined connecting sections of the tracks will be at all times substantially equal to the weight of the closure below the said inclined track sections.

26. A counterbalancing system for door closures, comprising a closure, tracks for said closure having horizontal portions, vertical portions and intermediate portions connecting said vertical and horizontal portions, springs operatively connected at one end to and exerting an upward pull on the upper portion of the closure and fixed at the other end, the force of said springs being operative against said intermediate, connecting, track portions, whereby the spring tension is resolved into horizontal and vertical components in varying relation as the closure traverses the said connecting portions of said tracks.

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