C. D. SEEBERGER.

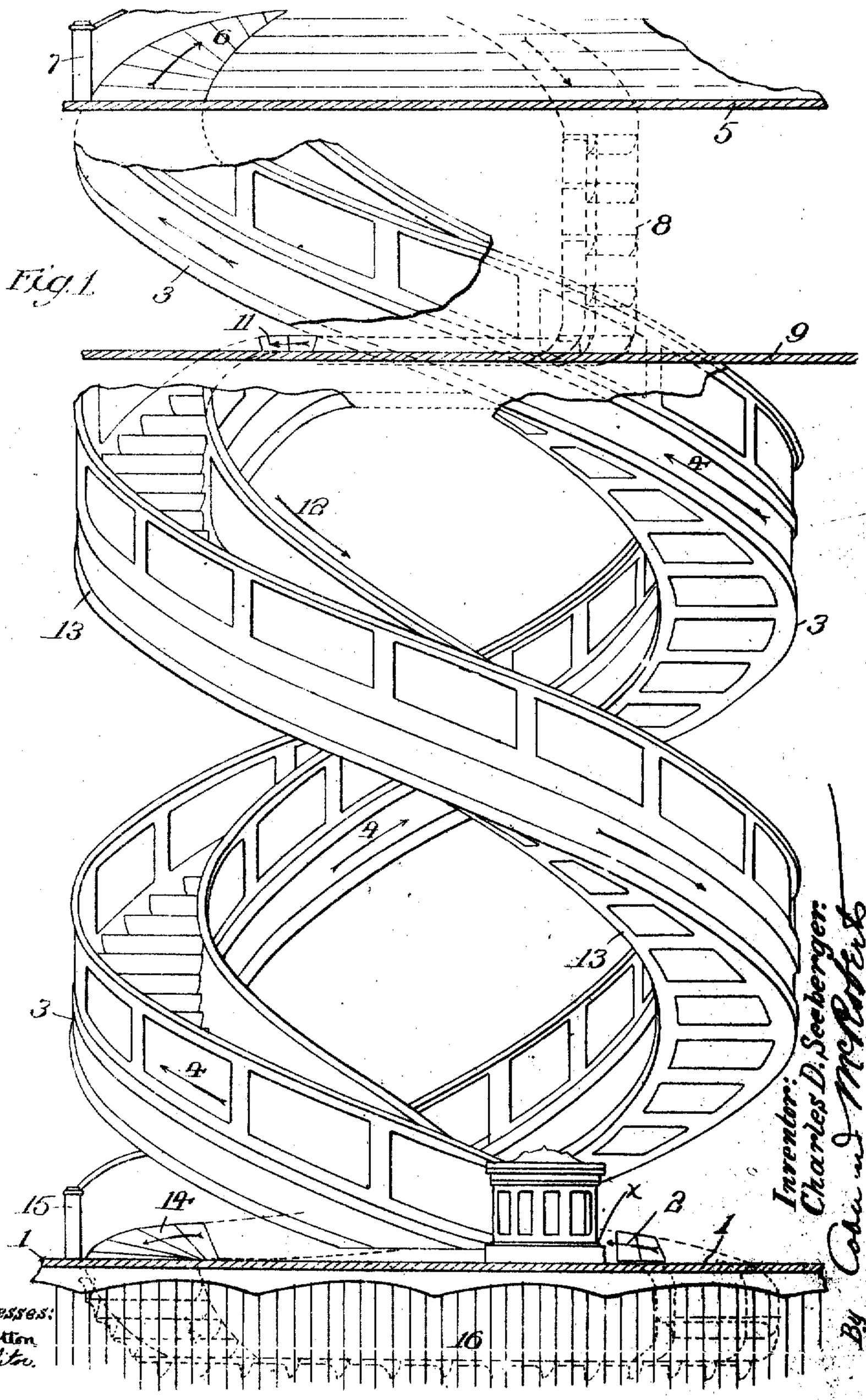
ELEVATOR.

APPLICATION FILED OCT. 21, 1903. RENEWED DEC. 2, 1909.

999,885. **Patented Aug. 8, 1911.**

11 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
W. H. Cotton
E. Molitor.

Inventor:
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11 SHEETS—SHEET 2.

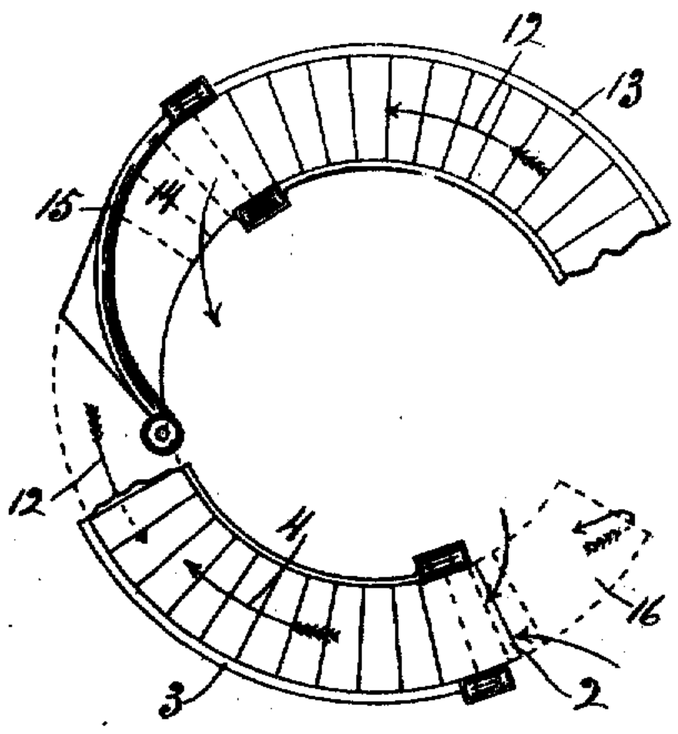

Fig. 2.

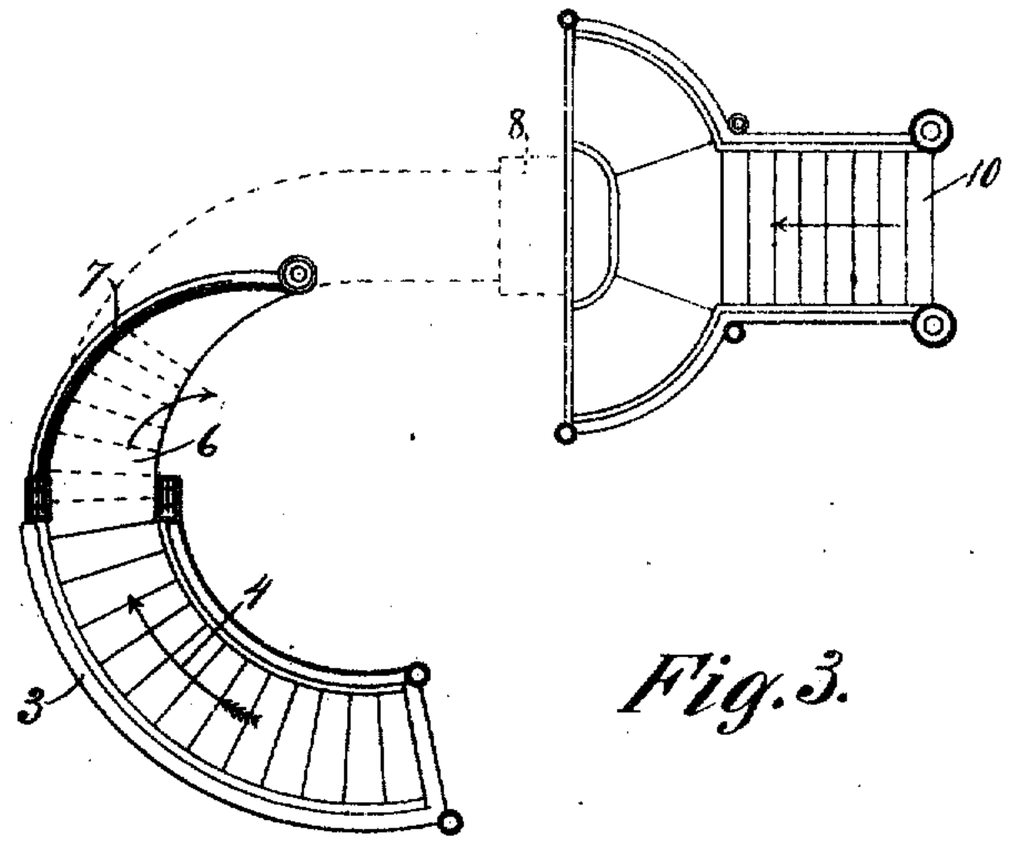

Fig. 3.

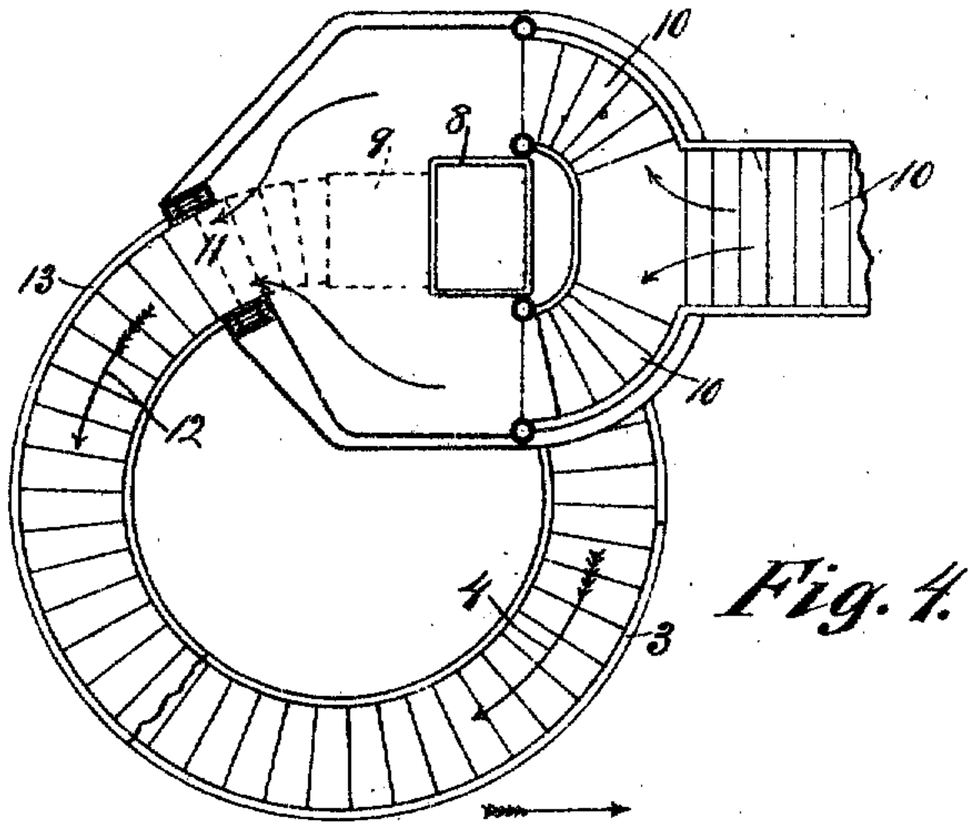

Fig. 4.

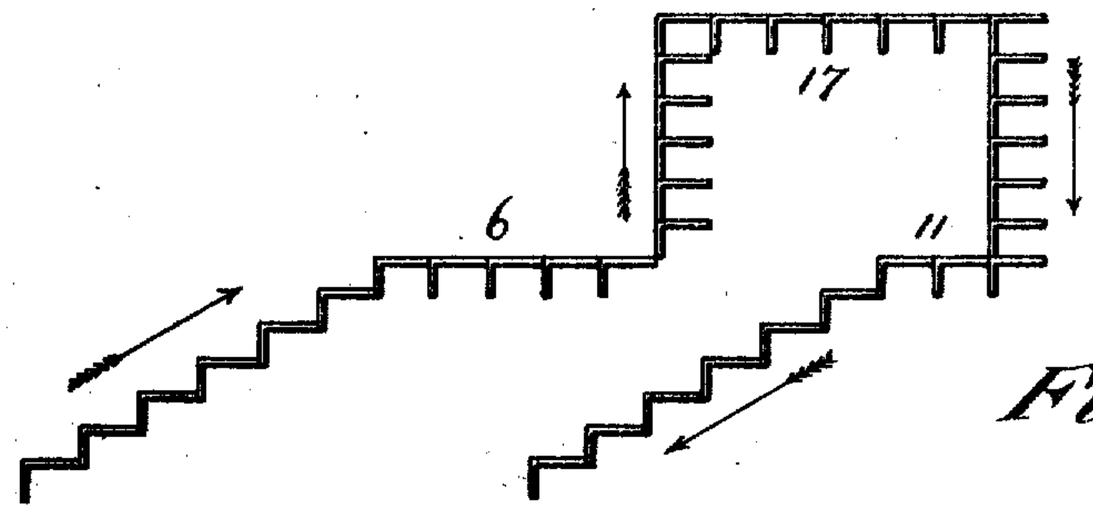

Fig. 5.

Witnesses:
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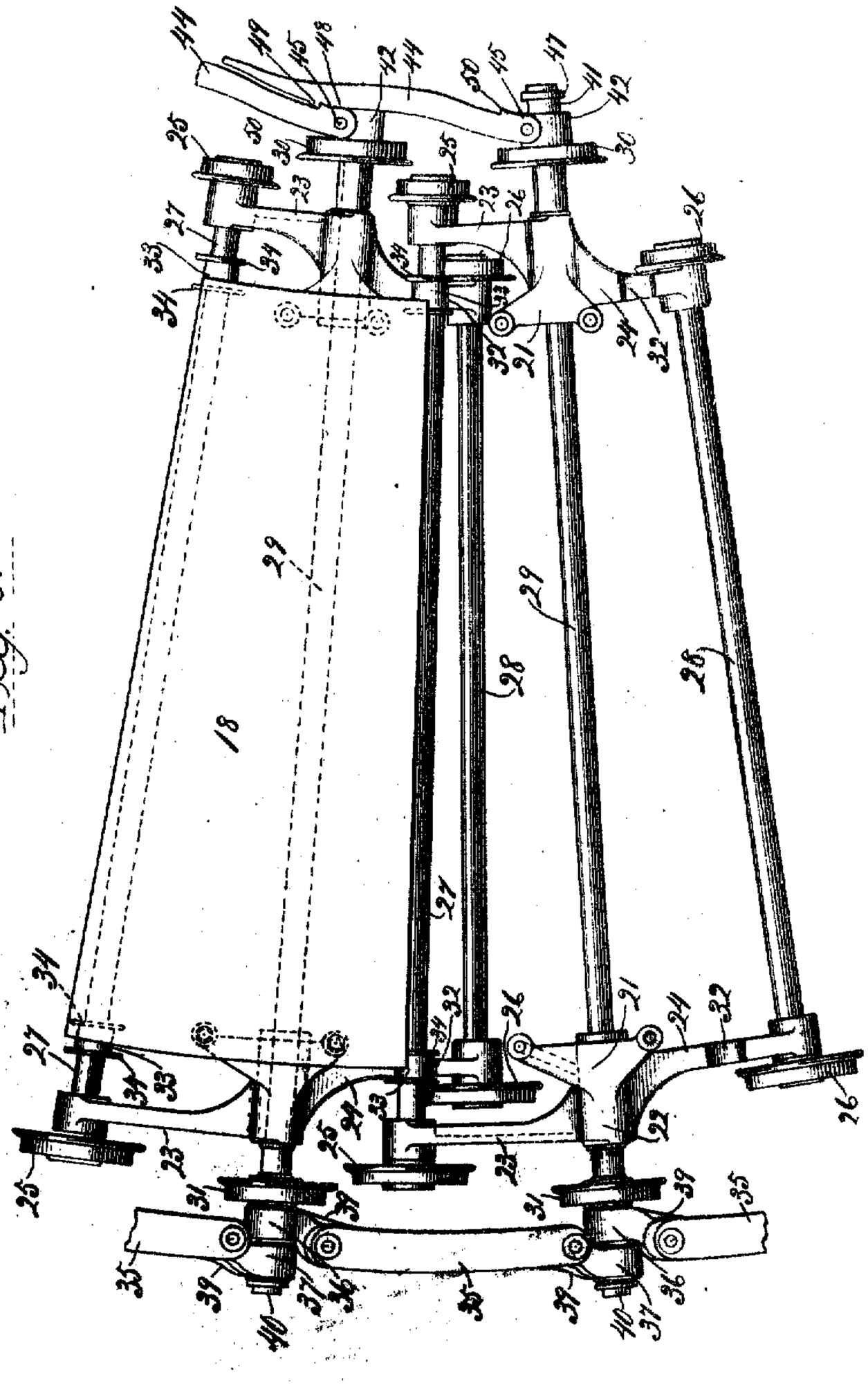
11 SHEETS—SHEET 3.

Fig. 6.



Witnesses:

Edith L. Allen.

E. Walton

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11 SHEETS—SHEET 4.

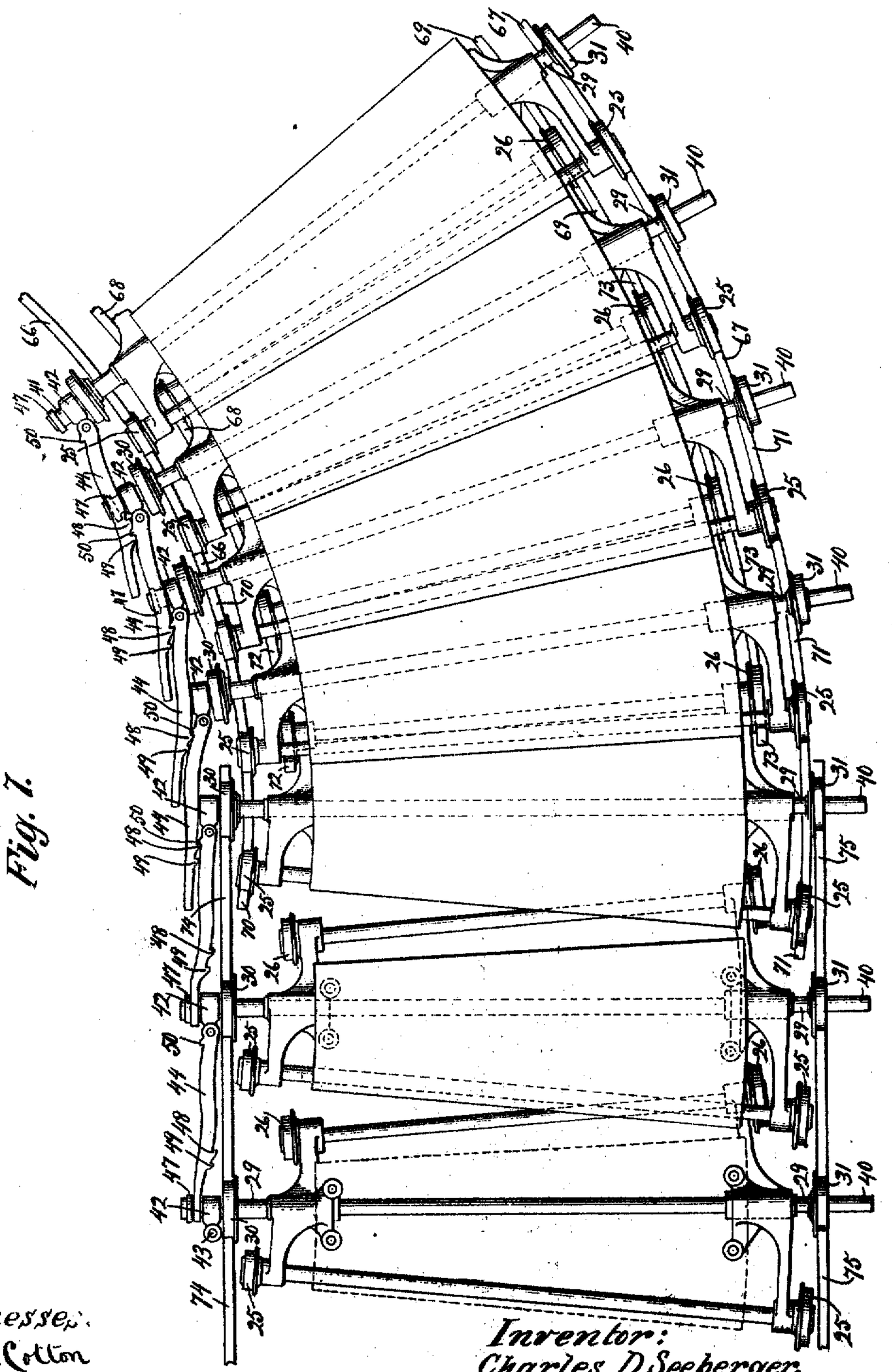

Fig. 7.

Witnesses:
W. H. Cotton
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11 SHEETS—SHEET 5.

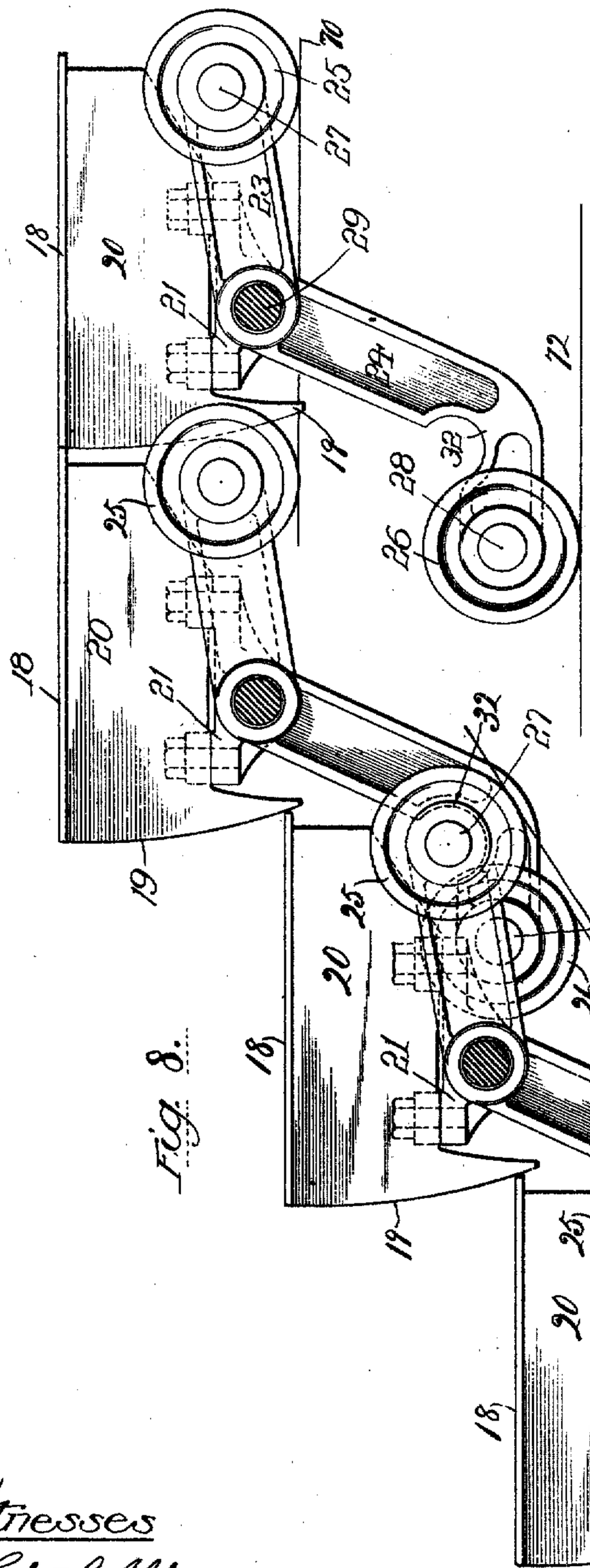

Fig. 8.

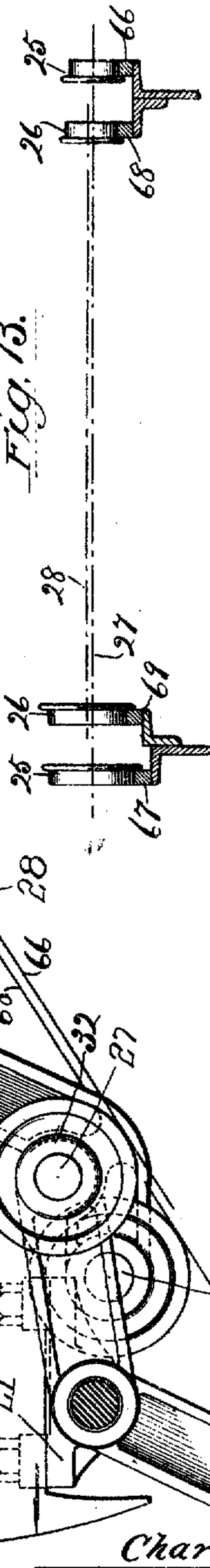

Fig. 13.

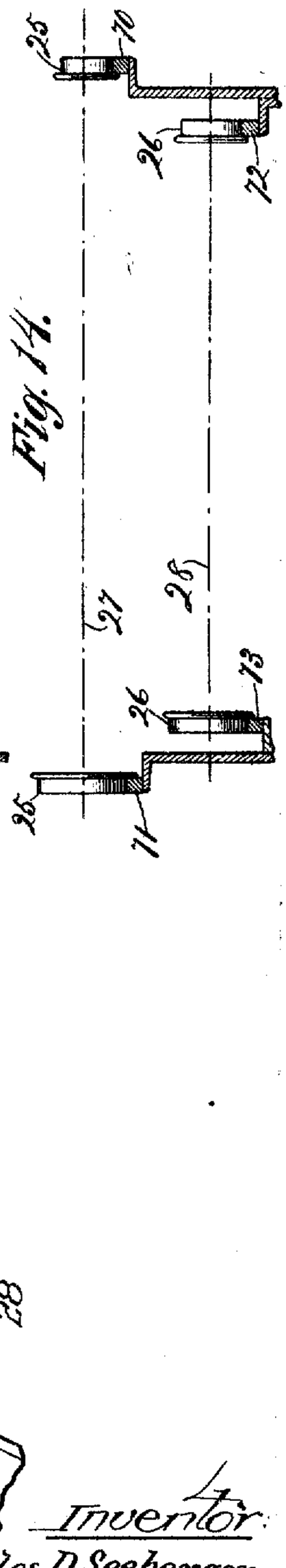

Fig. 14.

Witnesses

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999,885

Patented Aug. 8, 1911.

11 SHEETS—SHEET 6.

Fig. 2.

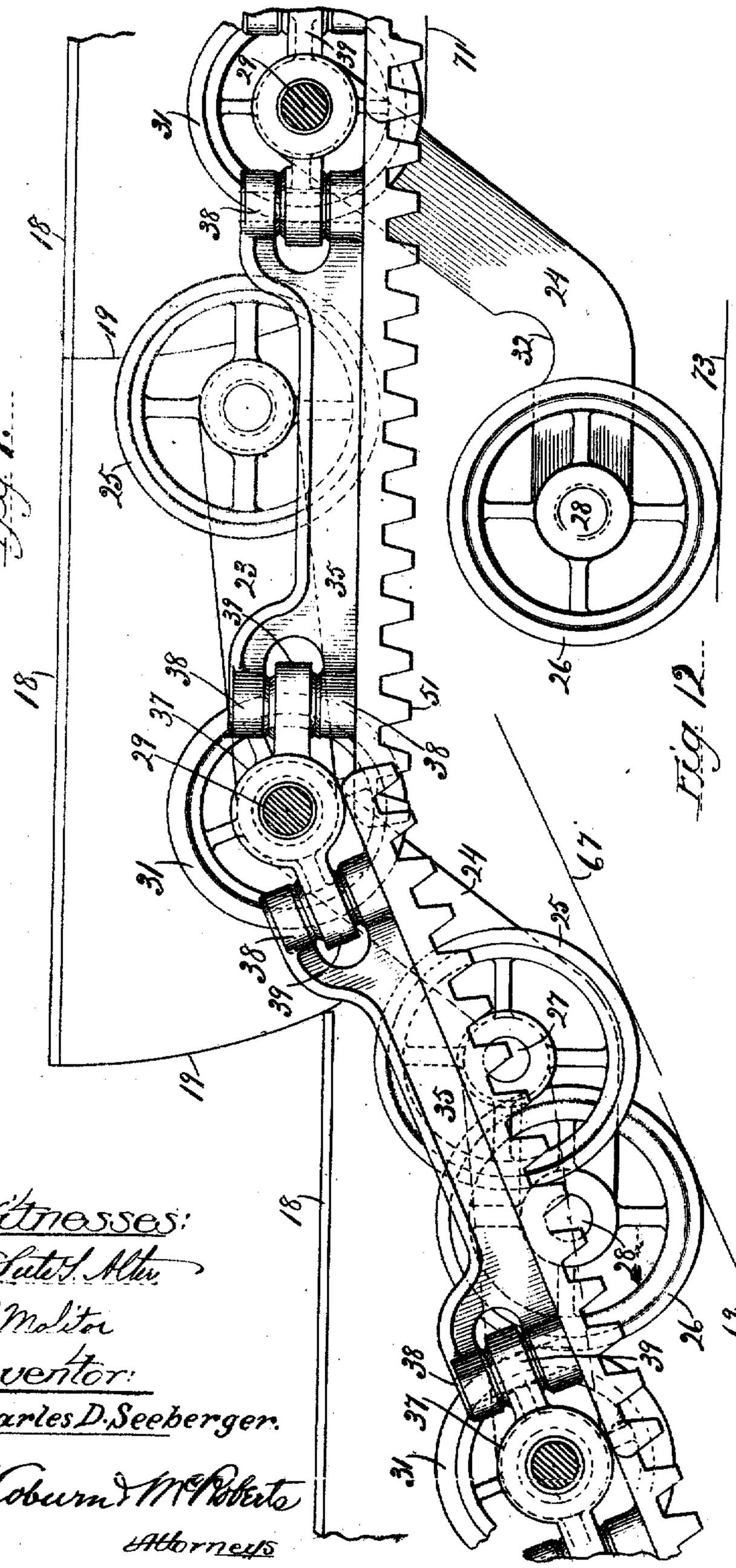
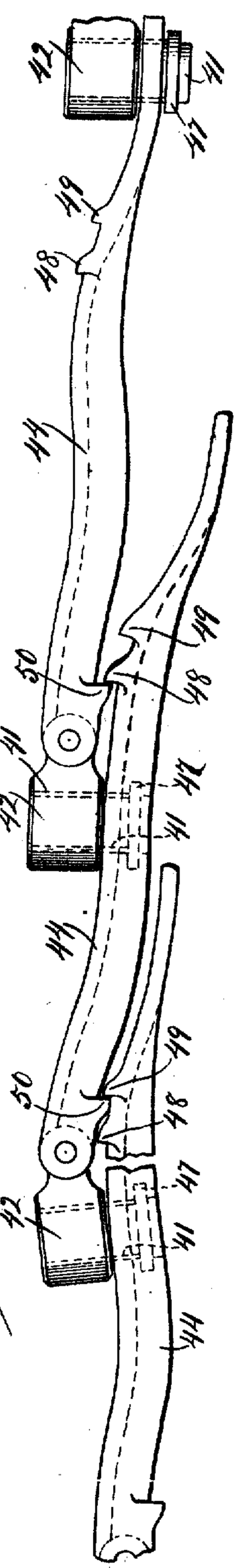


Fig. 12.



Witnesses:

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11 SHEETS—SHEET 7.

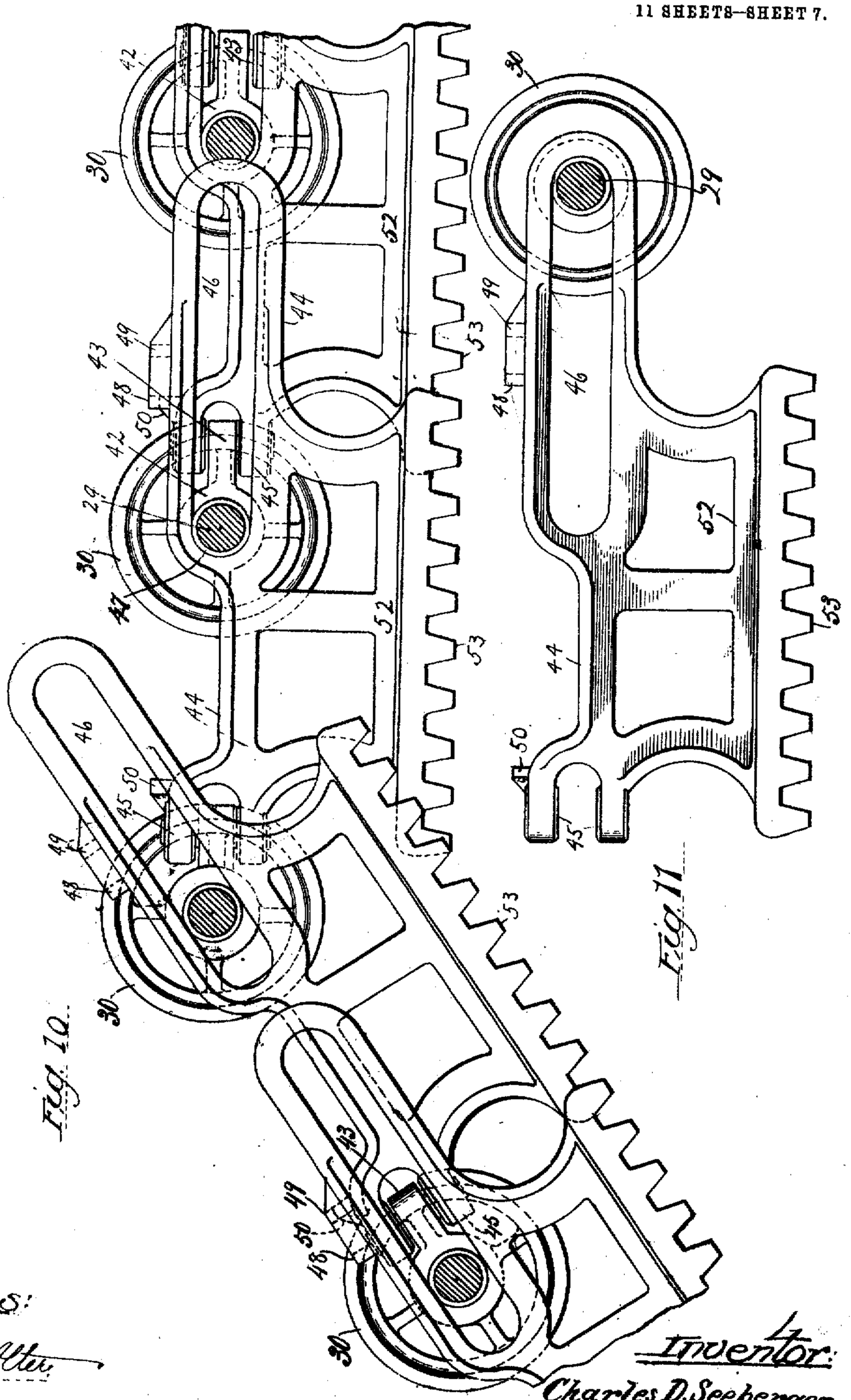

Fig. 10.

Fig. 11.

Witnesses:

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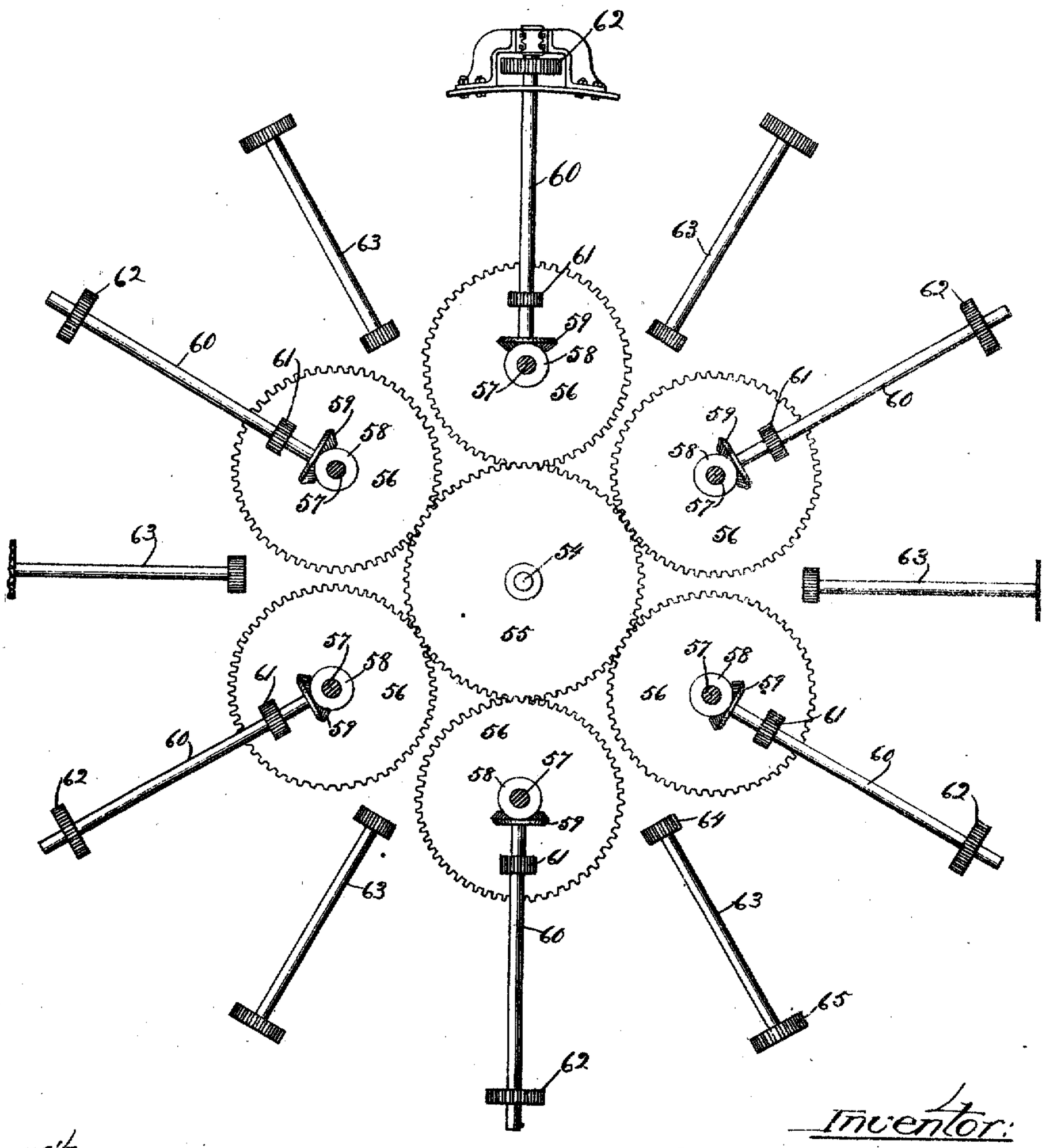
999,885. **Patented Aug. 8, 1911.**

11 SHEETS—SHEET 8.

Fig. 15.



Witnesses:

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999,885.

Patented Aug. 8, 1911.

11 SHEETS—SHEET 9.

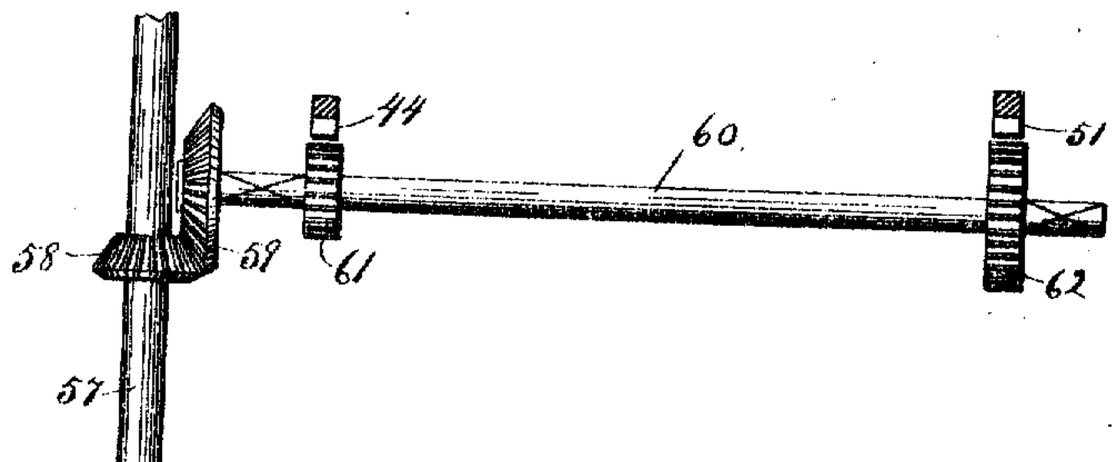


Fig. 16.

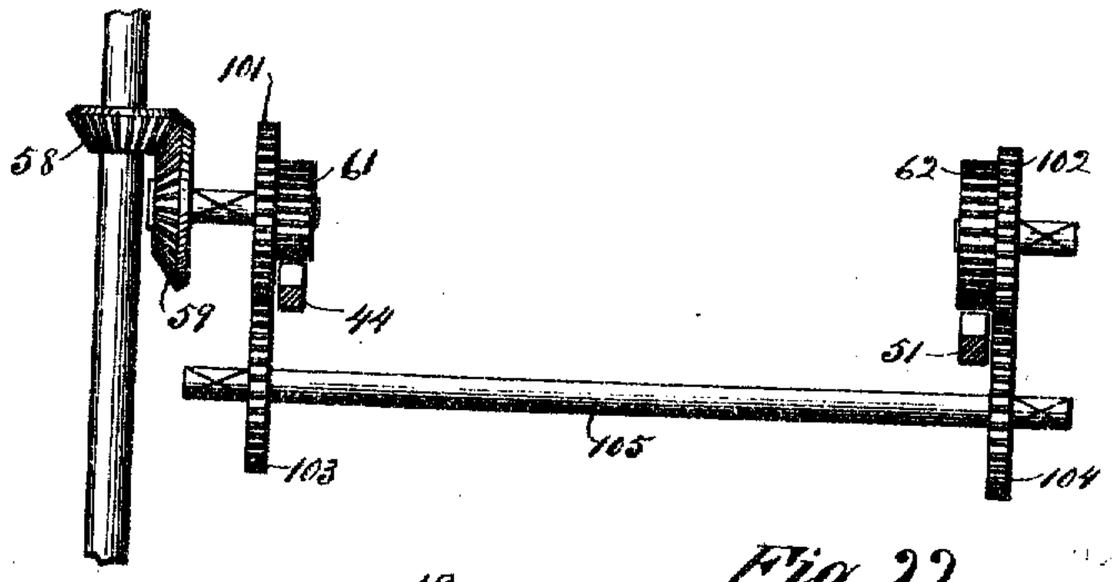


Fig. 22.

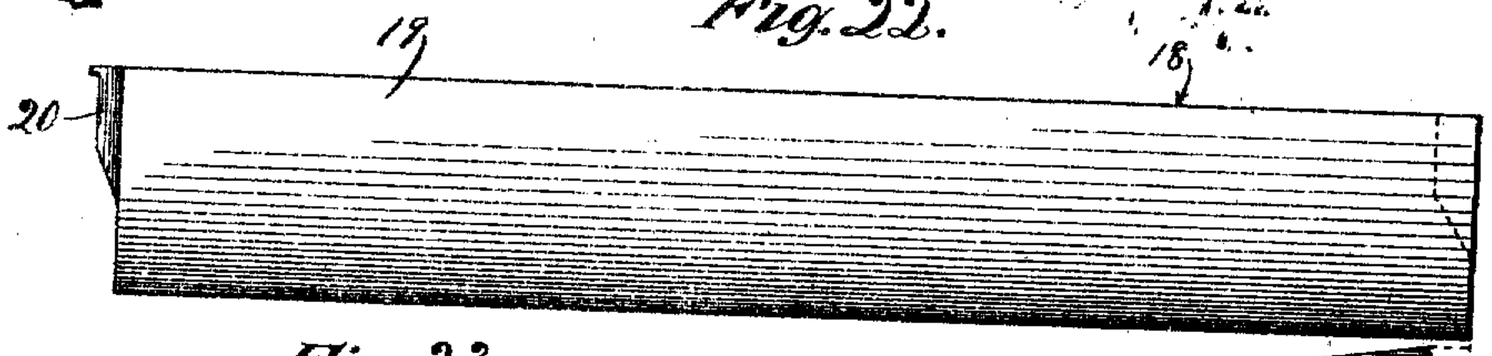
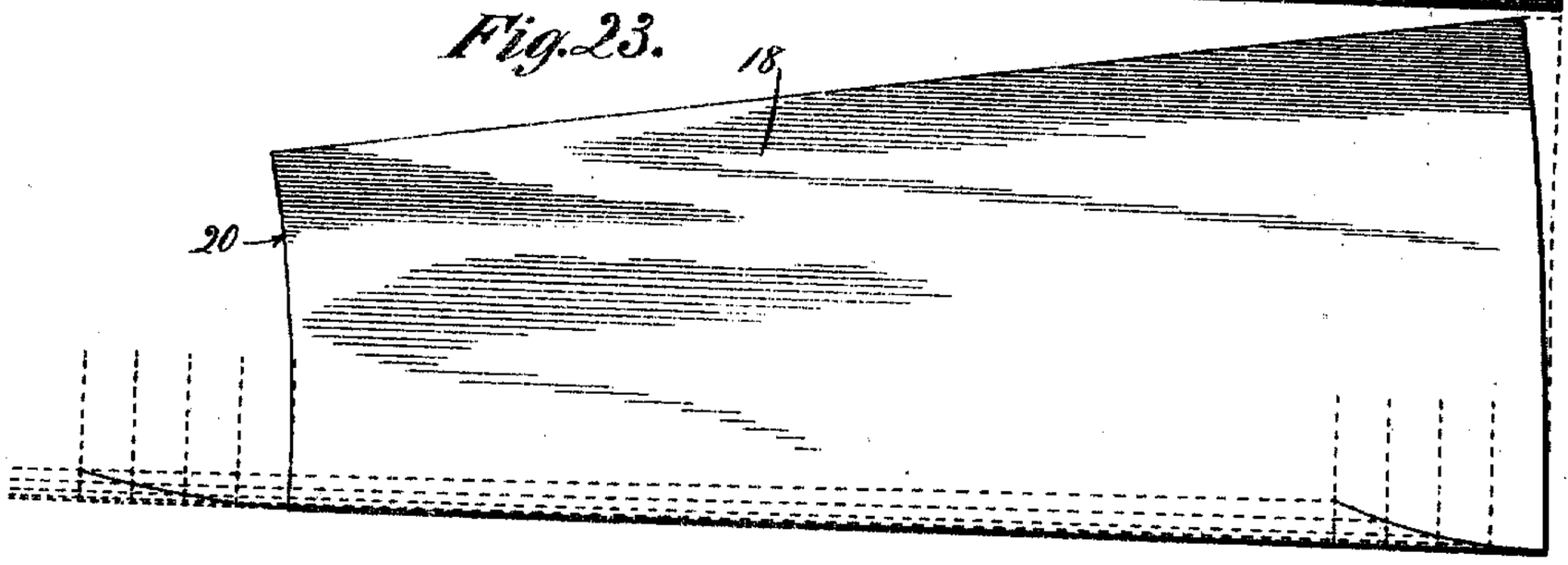


Fig. 23.



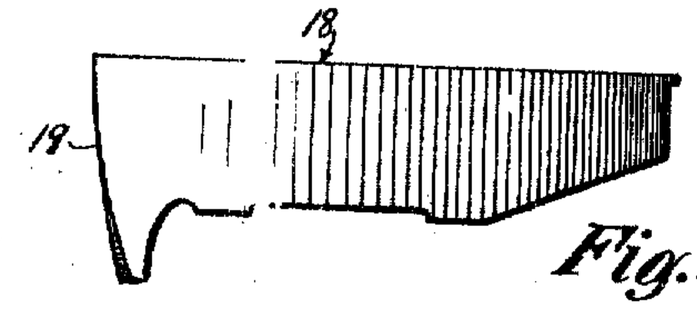


Fig. 24.

Witnesses:
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APPLICATION FILED OCT. 21, 1903. RENEWED DEC. 2, 1909.

999,885.

Patented Aug. 8, 1911.

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Fig. 17.

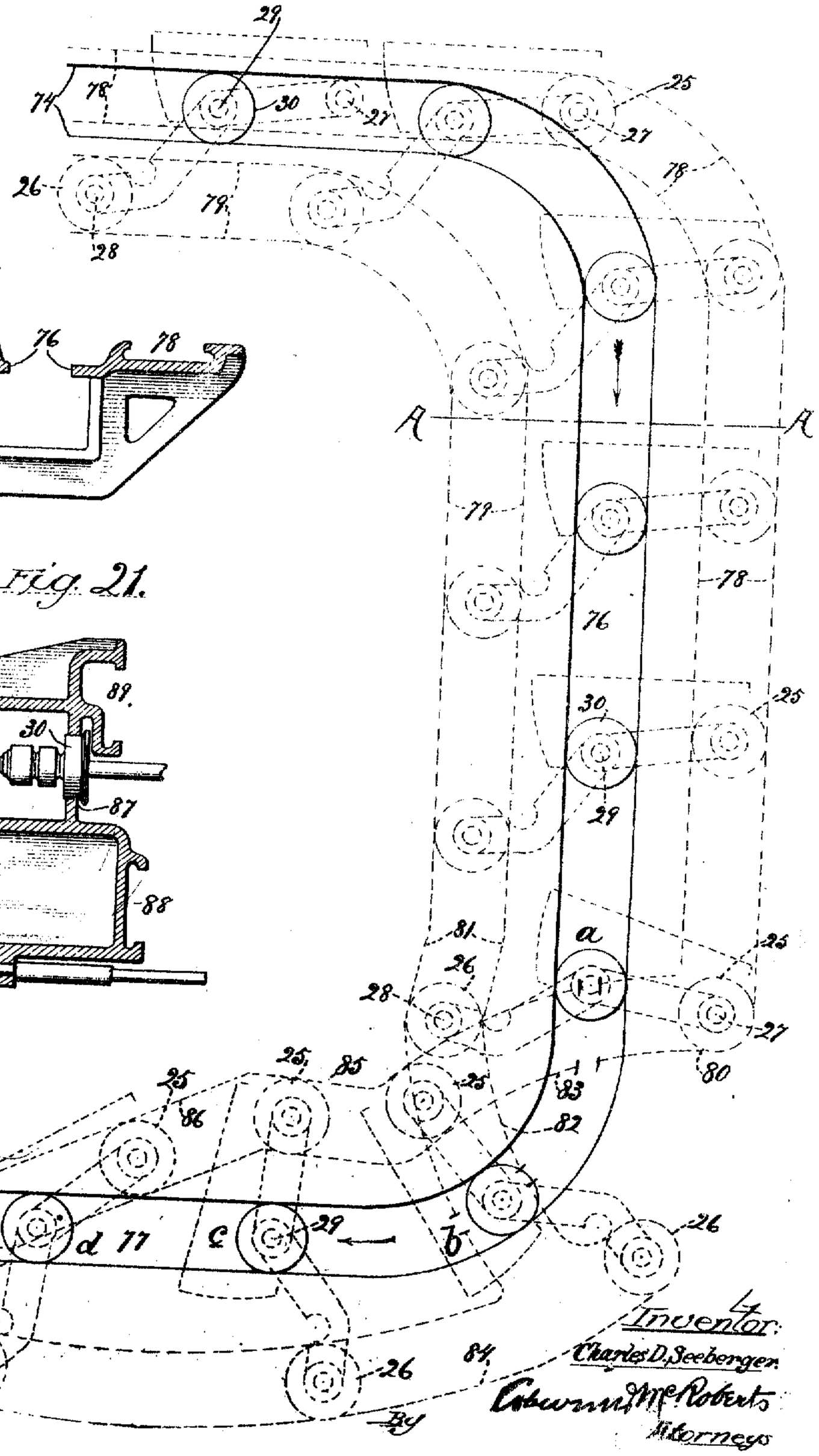

Fig. 18.

Fig. 21.

C. D. SEEBERGER.

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APPLICATION FILED OCT. 21, 1903. RENEWED DEC. 2, 1909.

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Patented Aug. 8, 1911.

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Fig. 20.

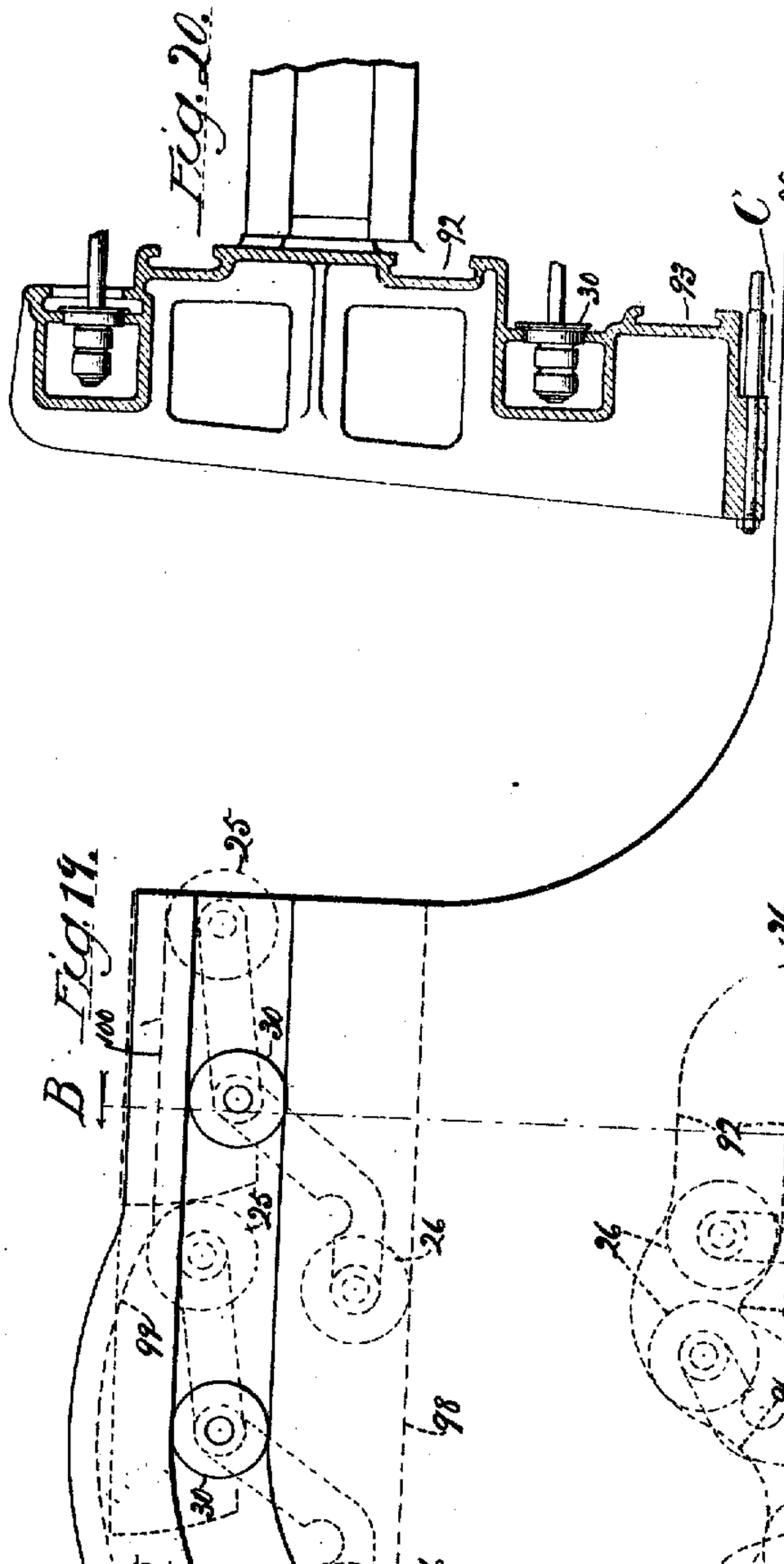

Fig. 19.

Witnesses:

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UNITED STATES PATENT OFFICE.

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ELEVATOR.

999,885. Specification of Letters Patent. Patented Aug. 8, 1911.

Application filed October 21, 1903, Serial No. 177,878. Renewed December 2, 1909. Serial No. 531,070.

To all whom it may concern:

Be it known that I, CHARLES D. SEEBERGER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Elevators, of which the following is a specification.

My invention relates to elevators, and is concerned with various features of improvement for an elevator in which a single endless series of steps running in duplex spirals about a common well or center of curvature is employed for conveying purposes on both the ascending and descending spiral runs or right and left threads.

The invention consists in the matters hereinafter disclosed and pointed out in the appended claims.

The principles of my invention may be embodied in practice in various forms and exemplifications, and the accompanying drawings show preferred arrangements and organizations in which its various features may be realized.

In these drawings—Figure 1 is a perspective view of a design for a duplex spiral elevator embodying the features of my present invention, and showing the same extending between a lower and an upper level, and also illustrating one arrangement for the upper level that may be employed, the drive mechanism being omitted for greater clearness of illustration; Fig. 2 is a diagrammatic view of the floor plan at the lower level, indicating the first floor or landing, and showing in plan view the beginning of the ascending run and the end of the descending run; Fig. 3 is a diagrammatic view of the floor plan at the upper level of Fig. 1, and shows in plan view the upper end of the ascending run and the stairs leading down to the gallery for the descending landing of Fig. 1; Fig. 4 is a diagrammatic view of the arrangement of the gallery for the descending landing of the upper level when the arrangement at the upper level illustrated in Fig. 1 is employed, and also showing in plan view the beginning of the descending run and an intermediate portion of the ascending run; Fig. 5 is a diagrammatic view showing the arrangement and organization at the upper level when the getting-off and getting-on landings are on the same floor or level, whereby the gallery arrangement of Fig. 1 is not employed; Fig. 6 is a plan view of two of the steps when they are on the ascending run, the tread of one of the steps being omitted to show the construction of the carriage; Fig. 7 is a plan view of a series of steps of which the two at the right are shown running by their truck-wheels on inclined curved tracks of the ascending run, the middle three running by their truck-wheels on curved horizontal tracks of the landings, and the two at the left running by their axle-wheels on horizontal straight tracks at a tangent to the curved tracks, the outer linkage being omitted for simplicity of illustration; Fig. 8 is a view showing a series of steps in side elevation of which the two at the left are in the positions and relations occupied by steps on the inclined curved tracks, and the two at the right are on curved horizontal tracks of the landings; in this view the axles are in section, the axle-rollers being omitted for better illustration of the other parts; Fig. 9 is a view similar to Fig. 8 and showing the arrangement of linkage employed at the outer convex ends of the steps, the ends of the axles being in section; Fig. 10 is a detail view showing in side elevation the arrangement of linkage employed at the inner concave ends of the steps, the ends of the axles being in section; Fig. 11 is a side view of one of the links of Fig. 10 detached, with the axle of the next step in section; Fig. 12 is a top plan view of the inner linkage illustrating the three positions which adjacent axles assume at different points in the course or cycle of the steps; Fig. 13 is a partly cross-sectional view on the spiral runs showing the arrangement of tracks for the truck-wheels on the inclines; Fig. 14 is a similar view showing the arrangement of the tracks for the truck-wheels on the curved level landings; Fig. 15 is a diagrammatic view showing the arrangement of the drive mechanism; Fig. 16 is a detail view of one of the vertical drive shafts with its associated sprockets, illustrating the connections to the ascending and descending runs; Fig. 17 is a diagrammatic view showing the arrangement of parts and illustrating the movements of the steps in the upper carriage or loop; Fig. 18 is a sectional view on the line A—A of Fig. 17; Fig. 19 is a view similar to Fig. 17 and showing the movements of the steps in the lower loop or carriage; Fig.

20 is a sectional view on the line B—B of Fig. 19; Fig. 21 is a sectional view on the line C—C of Fig. 19; Fig. 22 is a front view of one of the steps showing the riser; Fig. 23 is a diagrammatic view illustrating the method of plotting the lines of the riser; and Fig. 24 is a diagrammatic view illustrating the curves at the outer and inner ends of the riser.

In the embodiment of my present invention I employ a carrier or the footway consisting of a single series of steps, preferably connected together as hereinafter described, which ascend from a lower to an upper level or levels in a spiral path or course, and descend from the upper to the lower level in a second spiral path or course, the descending run being below or under the ascending run or vice versa in the same circular area and preferably having the same center of curvature. It is obvious that the steps may be continued and carried between as many levels or floors as is desired, and the exemplification here given of an organization running between only two levels or floors is merely illustrative of the general scheme of arrangement, which of course may be developed by duplication for additional levels. On the inclines between the floors or levels they run on curved horizontal or level tracks, while at the terminal levels they run around loops in which portions of the tracks are preferably straight and at tangents to the curved tracks, although the carriage approach may be designed without the introduction of tangents. As I employ but a single series of steps for the entire cycle including the reversely directed spiral runs, I provide a construction and organization in which the tread surfaces of the steps or carriages remain horizontal and uppermost on both the ascending and descending runs. At the terminal levels the steps are inclosed in any suitable casings which conceal and protect the parts where they are not used for conveying purposes, and between the various levels spiral structures are provided in which the steps move and are supported on suitable tracks. The spiral framework is constructed of any suitable material, and the sides are preferably provided with guard-rails or balustrades which may be surmounted by traveling handrails if desired. The general scheme of the spiral framework and its associated parts will be readily understood from Fig. 1, and does not require any particular description.

Referring now to the views shown in Figs. 1, 2, 3, 4, and 5, which illustrate the path or course of the steps, I will first describe the general design of the elevator shown in Figs. 1 to 4. In these figures the directions of movement of the steps are indicated by arrows, and the directions of movement of the passengers at the landings are indicated by featherless arrows. Also, the steps on the inclines are indicated in full lines and those on the landings by dotted lines for convenience of illustration. It may be assumed that the passenger boards the steps of the elevator at the lower landing of Fig. 2, where the steps emerge from below the floor 1 of the lower level to form the lower getting-on landing 2. At this landing the steps run in a horizontal curved path with their treads or upper surfaces in horizontal alinement, and then immediately ascend upon the inclined curved or spiral path provided by curved tracks or ways on the spiral structure 3, as hereinafter described, and the passenger is carried along the ascending curve indicated by the arrows 4, until he reaches the upper level or second story 5, where the steps again run in a horizontal curved path with their treads in horizontal alinement to form the getting-off landing 6, and where a shunt 7 may be employed to assist the passenger in alighting, as shown in Fig. 3. After providing the landing 6, the steps may pass beneath the floor of the upper level 5, and are preferably led in a horizontal straight run at a tangent to the ascending incline to a point where they pass down in a casing 8 to a gallery 9, to which suitable stairs 10 lead from the upper floor or level. When they reach the gallery they are preferably led below the floor in a reverse straight horizontal run at a tangent to the descending run or incline, emerging from below the floor of the gallery 9 and then running in a curved horizontal path with their treads in alinement to form the upper getting-on landing 11, from where they begin their descent in the descending spiral path represented by the arrows 12 provided by curved tracks on the spiral structure 13. The passenger having boarded the descending run at the gallery 9 is conveyed to the lower level or story, where the steps run in a horizontal path with their treads in alinement to form a getting-off landing 14, and where a suitable shunt 15 may be employed to assist in alighting. The steps may pass below the floor at the landing 14, and continue in the curved path until they pass to a point approximately under the getting-on landing 2 where they go into a straight or level run 16 tangent to the inclines and thence through the lower loop or carriage, hereinafter described, to a straight or level run tangent to the landing 2 where they emerge from below the floor and pass in a curved horizontal run to form this landing. It will thus appear that the steps pass around top and bottom loops or carriages, and travel in a double spiral path in making a complete cycle of the machine, the ascending and descending runs on the inclines being preferably in the same vertical planes

at various points and traveling about a common central well of which the center is the center of curvature of the spirals; for example, it will be apparent from Figs. 1, 3 and 4 that the initial steps of the descending run are below and in the same vertical plane as the final steps of the ascending run, and that the path of the descending run follows below or underneath the path of the ascending run for its entire length, the terminal of the descending run being below the initial steps of the ascending run. The latter is apparent from an inspection of Figs. 1 and 2.

In the form just described the descending run is below the ascending run, but it is obvious that either run may be above the other as the ascending run may be below the descending run. Also, in the form shown the center of curvature of the two runs or paths is the same, and it is obvious that the runs may be on compound curves.

The arrangement and organization at the upper terminal level may be varied so as to do away with the gallery and to have the upper getting-on and getting-off landings 6 and 11 upon the same floor or level. For example, in Fig. 5, I show a design where the getting-off and getting-on landings 6 and 11 of the upper floor are upon the same level. In this form the ascending run beyond the getting-off landing 6 is carried around a loop 17 above the floor of the upper level and is returned to a point beneath the floor of the upper level from which it emerges at the getting-on landing 11.

In the present application I make no claim to this latter construction or arrangement as the same forms part of the subject matter of my companion application, filed Feb. 26, 1906, Serial No. 302,760, renewed Mar. 26, 1910, Serial No. 551,774, in which it is claimed.

The above description applies specifically to the forms shown in which the steps are utilized between two levels, and it will be understood that where they are continued to other higher landings or levels, the spiral structure will be duplicated between the added floors and the steps will be led around a suitable loop at the uppermost or terminal level. It will also be understood that landings may be provided between the levels as occasion may require, and that each may be constituted by a single step or by several steps traveling horizontally according to the interval of time desired in which the passenger may act.

The steps remain with their tread surfaces uppermost and horizontal upon the curved horizontal landings, at each of which they lie in the same horizontal plane to form a level platform, and upon the curved inclines of the ascending and descending runs where they lie in different horizontal planes in the form of steps, as clearly shown in Figs. 8 and 9. I shall now describe their construction, interconnection and method of operation, referring more particularly to Figs. 6 to 12.

Each step comprises a horizontal portion or tread 18 provided with a suitable riser 19 and end pieces 20, which are suitably secured to the brackets 21 of the trucks 22. The shape of the steps will depend on the radius of the curve in which they run, the horizontal tread being segmental in its general outline, its sides converging toward the center of curvature of the spiral run and its inner concave end being slightly shorter than its outer convex end, as clearly shown in Figs. 6 and 7. In the particular form of elevator shown, each tread is provided with a single riser of suitable contour to maintain contact with the adjacent step and which performs its function on both the ascending and descending runs, as hereinafter described.

Each truck is provided with arms 23 and 24 constituting yokes in which the shafts of the truck-wheels 25 and 26 rotate in bearings, the pairs of wheels on each step being keyed to their respective shafts 27 and 28 to produce uniform movement of the wheels. The trucks of each step are further provided with bearings for a step-axle 29 to which inner and outer wheels 30 and 31 respectively are suitably keyed. The truck-wheels 25 and 26 of each step are adapted to run on inclined curved tracks 66, 67, and 68, 69, respectively, when on the inclines, and on curved horizontal tracks 70, 71, and 72, 73, respectively, which are extensions of the curved tracks when at the landings, and the wheels 30 and 31 are adapted to run on straight or tangent tracks 74 and 75, respectively, beyond the landings at the terminal levels, the arrangement being such that the steps are carried or supported by the truck-wheels while on the curved tracks and by the axle-wheels while on the tangent or straight tracks. For this purpose the treads of the axle-wheels 30 and 31 are of the same size or diameter, while the diameter of the tread surface of each inner truck-wheel is enough smaller than the diameter of the tread of its associated outer wheel so that the tread of the inner wheel will pass over enough less actual length of track than the associated outer wheel to keep the shafts 27 and 28 directed to the center of curvature of the curved tracks upon which these wheels run, or in other words the diameters of the truck-wheels are proportionate to the radius of their associated tracks. The axles 29 are longer than the shafts 27 and 28, and the wheels 30 and 31 therefore are beyond or outside the wheels of these shafts, while the shafts 27

of the wheels 25 are in turn longer than the shafts 28 of the wheels 26, as will appear from Figs. 6 and 7. By this arrangement the wheels 26 of the shafts 28 run on inner or narrow gage tracks, while the wheels 25 of the shafts 27 run on outer or wider gage tracks, as clearly shown in Figs. 13 and 14. The tread surface of the inner wheel 25 is therefore the smallest in diameter, that of the inner wheel 26 being next larger, that of the outer wheel 26 being next larger, and that of the outer wheel 25 being largest, as also appears from Fig. 13. The inner track for the inner wheel 25 is raised above the outer track for the outer wheel 25 at any cross-sectional point on the inclines a distance equal to the difference between the lengths of the radii of the two wheels, and the same relation is observed with respect to the tracks for the inner and outer wheels 26. The tracks for the inner truck-wheels and the tracks for the outer wheels are respectively separated in elevation a distance equal to the difference in the lengths of the radii of their respective tread surfaces. This organization is clearly shown in Fig. 13.

As the truck wheels 25 and 26 run on inclined tracks, the yokes are made angular in side elevation. The arms 24 of the yokes are of such length that the shafts 28 are out from under the body of the associated step, the objects being to have the wheel base broader than the tread of the step to insure stability and as the arms 24 of the yokes of each step project downwardly and laterally beyond and under the shaft 27 of the next step, they provide for interlocking adjacent steps, for which purpose they are provided with recesses 32 in their upper surfaces to form seats for the shaft 27 of the next step when the steps are on the incline. Each shaft 27 is preferably provided with fixed collars 33 having flanges 34 which embrace the sides of the arms when the collars seat in the recesses to prevent any lateral displacement. The angularity and shape of the yokes are such that when adjacent steps are on either the ascending or descending incline, the collars of each shaft 27 are seated in the recesses of the yoke of the next step, whereby the steps on the incline are locked together to make a rigid unitary series. This construction is shown in Figs. 6, 7 and at the left of Figs. 8 and 9. When the steps are off the inclines and upon the curved level runs, the tracks for the wheels 25 and 26 are placed at different levels, those for the wheels 26 being below those for the wheels 25, as shown in Fig. 14, in order that the treads will aline in a horizontal plane to make an unbroken landing. The effect of this arrangement is to drop the arms 24 away from and below the shafts 27, whereby the collars 33 are disconnected from their seats, as shown at the right of Figs. 8 and 9. By the organization here disclosed the steps are caused to automatically interlock on the inclines and unlock on the levels, so that they are added one by one on both the ascending and descending incline to form a rigid unitary structure, and are broken off one by one at the levels. The interlocking of the steps maintains the equilibrium of the steps, prevents any independent or separate movement of any individual step, and causes the entire series on the incline to move as a unit. This is an important consideration as in a spiral elevator all thrusts are toward the center, and the interlocking of the steps resists all lateral thrusts by holding the steps in their radial relation; also, in devices of this character where the steps must change on the levels from their relative positions on the inclines, it is necessary to provide their permanent connections with more or less adjustment, and by causing the steps to interlock on the inclines the permanent connections may be made adjustable to accommodate the different positions on the levels and inclines while a rigid connection is assured throughout the range of their use on the inclines. Moreover, when power is applied to this unitary series of steps, at any point, it is in effect positively distributed throughout the interconnected series; by reason of their connections the steps are in effect one piece. Also, when the step-frames or yokes interlock, it is obvious that the tracks for the truck-wheels of the axles 27 may be omitted on the inclines, so that the steps may run on the inclines as two-wheel steps and are interlocked to make a rigid unitary structure supported only by the wheels 26 if desired. It is apparent that this greatly reduces the friction of the machine.

The steps are connected at their outer and inner ends by suitable linkage, the connection between the steps at one end being constant and at the other end being variable or adjustable. In the system here shown the constant connection is on the outer linkage. In Figs. 6 and 9, the outer linkage is shown as consisting of a series of curved links 35, which are pivotally connected to adjacent axles 29. Each link is pivoted at its opposite ends to collars 36 and 37 on adjacent axles by means of vertical pins passing through yokes 38 on the links and intermediate ears 39 on the associated inner and outer collars. Each axle 29 is provided with a wrist 40 which loosely receives the collars and upon which they are suitably held. Each link connects with an inner collar at one end and an outer collar at its opposite end, the ears of the inner and outer collars being respectively outturned and inturned. The inner linkage is shown in detail in Figs. 6, 7, 10, 11, and 12.

The inner end of each axle 29 is provided

with a wrist 41 which freely rotates in a sleeve 42 located outside the axle-wheel 30 and having a lateral projection or ear 43 to which a link 44 is pivoted by a vertical pin passing through its yoked end 45. Each link 44 is provided near its free end with an elongated horizontal slot 46 which receives the wrist on the axle 29 of an adjacent step as clearly shown in Figs. 10 and 11. Each wrist is provided with an annular retaining fin 47, and the body of the link of the next step lies between this fin and the associated collar 42 as shown in Fig. 10, to prevent the displacement of the link, the arrangement being such that the wrist may move from end to end of the slot but the link and wrist are not disconnected. The links are slightly offset or curved away from the steps at their outer or free ends, as shown in Figs. 6 and 12, whereby when the steps are on the curved tracks the links will not interfere with each other. In practice the links are thicker near their pivotal ends by reason of suitable strengthening webs which overhang the fins 47 except when the latter are near the free ends of the links, this construction causing the ribs to appear in dotted lines in some instances, as in Fig. 6 and at the left in Fig. 12. At a point approximately at the center of the slot 46, each link is provided on its upper surface with a pair of inwardly facing hooks 48 and 49, and near its pivoted end with an oppositely or outwardly facing hook 50, these hooks being all arranged in the same line. When the steps are on the incline the axles are alined as shown by the two axles at the left of Fig. 10, and the inner links of adjacent steps are connected by the engagement of the hooks 49 with the hooks 50, or on the longest hooked length as shown in Fig. 6 and at the left of Figs. 10 and 12. Assuming that the parts in Fig. 10 are moving from left to right up the incline, when the axle 29 of a leading step reaches a horizontal or level run it drops in relation to the following step, as clearly shown by the two intermediate axles in Fig. 10, and the hooks 49 and 50 are disconnected. When the succeeding or second link passes to the horizontal run it again falls into line with the first or leading link, as shown by the two links at the right of Fig. 10, and in this alined position the hooks on the links are again brought into operative relation and the hook 50 of the second link automatically engages the short hook 48 of the first link, or the links are connected for the curved horizontal landing run on the shortest hooked length, in which relation the steps travel over the curved landing. This position is shown at the middle axle of Fig. 12 and at the right of Fig. 10. When the leading step passes under the floor at the end of the curved landing it is slightly depressed as by a drop in the track, and the hooks are again disconnected by reason of the angle made by the links, whereby the link of the leading step is freed from the hook 48 of the second step and its axle passes to the outer end of the slot of the link of the second step, as shown in Fig. 11 and at the right of Fig. 12, when the steps draw out to bring the axles into parallelism on the straight runs. On the reverse run, the axle of each succeeding step is in the position of Fig. 11 as the steps move over the tangent tracks, and when they strike the curved horizontal tracks at the getting-on landing 11 they again interlock on the hooks 48 and 50. When the leading step passes to the descending incline, these hooks are disconnected by the angular relation of the links, and when the following step is upon the incline the links are again alined and the hooks 49 and 50 interlock in which position they travel over the descending incline. When the steps reach the lower level the hooks 49 and 50 are disconnected by the angular relation of the links when the leading and second steps are respectively upon the curved horizontal and curved inclined tracks; when the leading and second steps are both on the getting-off landing run the hooks 48 and 50 engage by reason of the alinement of the links while their steps are on that run; when the leading step passes from the curved horizontal run of this landing down through the floor it is slightly depressed by a drop in the track and the hooks 48 and 50 are disengaged so that the following axle again assumes the position of Fig. 11, in which relation it remains until the steps return to the getting-on landing 1. Upon the curved horizontal tracks of this landing the links again aline to reëngage on the hooks 48 and 50 which co-act during the run over the tracks of this landing; when the leading step strikes the incline the angular relation of the links causes these hooks to disconnect, and when the succeeding step also comes upon the incline the links again aline to reëngage on the hooks 49 and 50 as before. It is obvious that when the steps are on the inclines the distance from any hook 50 to the next following axles will be greater than the distance between the same points when the steps are on the curved horizontal runs, by reason of the differences in elevation caused by the gradient of the inclines. This difference is equal to the distance between the hooks 48 and 49, so that the linkage automatically adjusts itself to connect the axles in either relation. On the inclines the inner linkage is about an inch and a quarter longer than on the horizontal curved runs, while it is about ten inches longer when the steps run on the tangent tracks at the carriages.

The relation of each hook 50 with reference to the axle 29 of its associated sleeve,

and the relation of the hook 48 with reference to the inner end of the slot of its associated link are such that when the hooks 48 and 50 are engaged the axle is at the inner end of its associated slot so that there is a positive and fixed connection at that point between the associated adjacent axles. When the links are unhooked the engagement is at the outer end of the slot, as in Fig. 12, and when the hooks 50 and 49 engage the engagement is formed between them. These parts provide means to allow proper and necessary adjustment of the connections between the steps on the ends where the relations of the step axles vary, and also provide for the automatic engagement and disengagement of these adjustable connections.

The outer and inner links are preferably in the form of rack bars in order to apply power for moving the steps. The lower edges of the outer links are provided with teeth 51, and their lower portions extend somewhat beyond the yoked ends 38, as shown in Fig. 9, and overlap in all positions so that the teeth form continuous rack bars. Each inner link 44 is provided with a depending web 52 which extends from below the yoke 45 to a point below the hooks 49, so that while the steps are running on the curved portions of track on the inclines and on the curved landings the webs form a practically continuous length as they will lap, as clearly shown in Fig. 10. The lower edges of the webs are provided with teeth 53, whose pitch is so arranged that the teeth on adjacent links are in line radially or transversely on either length of the linkage on the hooks 48 or 49. The links 35 and 44 being pivoted to their associated collars in one plane, and the collars being in turn journaled on the axles in another plane, the connections are those of a universal joint, and the racks are curved approximately on the arcs of circles of which the center is the center of curvature of the curved tracks.

Power to drive the steps may be applied in any suitable manner, and as the steps run in a double spiral path around the axis of the central well, I preferably employ suitable drive shafts grouped in the central well to distribute and apply power to the steps at various points on the inclines. In order to synchronize the movements of the drive shafts, I prefer to drive them all from the same central shaft to which a suitable motor is connected. The driving mechanism may be located at any level, and preferably is in the basement. In the form shown it consists of a suitably driven short central shaft 54, having a gear wheel 55 which is adapted to mesh with a series of gear wheels 56 on vertical drive shafts 57, arranged at suitable intervals about the power shaft 54. In Fig. 15 I have shown six drive shafts arranged in the well, although any suitable number may be employed. These vertical drive shafts extend upward alongside the spiral runs in proximity to the path or course of the steps and are adapted to impart motion thereto. Each drive shaft is provided with a bevel gear pinion 58 which meshes with a corresponding bevel gear pinion 59 on a radial sprocket shaft 60. The radial sprocket shafts are suitably journaled in the frame of the spiral structure or casing, and each such shaft is provided with driving sprockets 61 and 62 arranged respectively near its inner and outer end in the paths of the teeth of the inner and outer links respectively, the diameter of the inner sprocket being proportionately less than the diameter of the outer sprocket according to the relative speeds of the inner and outer ends of the steps, and the width of the sprockets being sufficient to engage the teeth on the links. The gear connections between the shafts 57 and the sprocket shafts 60 are such that their rotation drives the steps in the proper direction. Each drive shaft 57 extends upwardly alongside the spirals; if the steps run between two levels they will extend between the floors of these levels, and they will be extended according to the number of levels reached by the steps. By reason of this fact each drive shaft will be adjacent to or intersect each of the ascending and descending runs at one point at least between each two levels. Where each drive shaft intersects a spiral it gears with a sprocket shaft 60, and by reason of the intersection of each drive shaft with both the ascending and descending runs or spirals it follows that each such shaft will gear with both the ascending and descending lines of stairs. For this purpose each drive shaft is reversely geared with the radial shafts associated with and driving the reversely directed runs, as shown in Fig. 16. The employment of this organization serves to balance the load of the ascending and descending lines of steps, and reduces and equalizes the torsional strains on the drive shafts.

I prefer to employ radial idle shafts 63 which are suitably journaled in the casing or frame of the spiral structure intermediate the shafts 60, and are provided with inner and outer sprocket wheels 64 and 65 respectively, which mesh with the links. These idlers serve to synchronize the elevator, insure the radial positions of the step axles, prevent one end of the step axle from getting ahead of the other, and equalize the strains due to the lateral thrusts of the parts. These idlers are disposed at suitable intervals in the path of the steps. As the ascending and descending runs are curved on the same center in the design here shown,

it follows that all the radial shafts 60 and 63 are on radii of the same circle, as illustrated diagrammatically in Fig. 15.

The tracks upon which the steps run are supported by any suitable means, such as plate girders, carried by the stationary structure. The relatively wide gage tracks 66, 67, for the inner and outer truck wheels 25 respectively, and the narrow gage tracks 68 and 69 for the inner and outer truck-wheels 26 respectively, are supported on the spiral structures and extend in inclined spirals or curves from level to level. The arrangement of these tracks on the inclines is clearly shown in Fig. 13, and the steps travel thereon in step-like form, it being apparent, however, that but a single track is necessary on the inclines when the trucks or steps interlock as before described. At the levels the tracks are projected in curved horizontal paths as at 70, 71, 72 and 73 to form level runs so that the threads of the steps on the getting-on and getting-off landings will have their upper surfaces in alinement to form landing surfaces of unbroken continuity, as shown in Fig. 7. On the curved horizontal paths at the landings where the treads are in the same horizontal plane, the narrow gage tracks 72 and 73 are below the tracks 70 and 71 a distance sufficient to accommodate for the angularity of the trucks, as clearly shown in Figs. 8, 9 and 14.

When the steps run on the tracks on the inclines and landings, the wheels 30 and 31 of the axle-roller are inoperative. At the landings and extending away from the inclines, I provide straight horizontal tracks 74 and 75, which are tangential to the curved tracks and support and carry the axle-rollers 30 and 31, respectively, upon which the steps run as they leave and approach the curved horizontal runs of the landings, as shown in Fig. 7. The curved tracks do not support the steps when the rollers 30 and 31 are upon the tangent tracks, the adjacent ends of the curved and tangent tracks being preferably arranged in suitable manner, however, to provide continuous supports for the steps, and the curved horizontal tracks leading beneath the floors of the levels to the tangent tracks. The tangent tracks preferably develop into channel tracks which extend around the upper and lower loops or carriages at the upper and lower terminal levels in suitable portions of the casing or frame. When the steps pass the getting-off landing 6 at the upper terminal level, the wheels 30 and 31 engage their respective tangent tracks 74 and 75, as shown in Fig. 7, where the steps move on an ascending incline from right to left and illustrate the arrangement of parts at the top of the getting-off landing. The tracks 74 and 75 develop into channel tracks which extend from thence around the upper loop or carriage 8 as shown at 74, 76, 77, in Fig. 17. At the lower end of the loop 8 the channel tracks 77 merge again with the straight horizontal tracks 74 and 75 tangent to the upper getting-on landing 11.

If the parts of Fig. 7 be now assumed to move on a descending incline from left to right, the arrangement of the tracks at the lower end of the upper loop 8 and at the upper getting-on landing 11 will be clear from an inspection of this figure and Fig. 17. When the steps pass beyond the lower getting-off landing 14 the axle-wheels pass to and are carried upon tangent or straight horizontal tracks 74 and 75. If the parts of Fig. 7 be now assumed to move from right to left on a descending incline, the tracks 74 and 75 will illustrate the tangent tracks at the lower getting-off landing. These tangent tracks develop into channel tracks 87 around the lower loop or carriage, as shown in Fig. 19, and at the upper portion of this loop the tracks 87 again merge into straight horizontal tracks 74 and 75 leading to and tangent to the getting-on landing 1.

In the form of step here shown each tread is provided with a single riser, which is adapted to perform its function on both the ascending and descending runs. For this purpose it is necessary to reverse the step so that the riser shall be in service on either run.

Referring now to Fig. 17 which is a diagrammatic view of the step movements in the upper carriage 8, the stationary structure of the upper loop or carriage is provided with oppositely disposed guides for the truck wheels 25 and 26, which preferably are in the form of channel guides or ways 78 and 79, respectively, and which are so located in the paths of travel of the truck-wheels that the latter will pass into these guides when the axle wheels pass into the channel extensions of the tracks 74 and 75. It is of course understood that the channel tracks and guides are provided for each end of the steps, although for clearness of illustration, I show the track and guides on but one side of the structure, as for axle-wheel 30 and the truck-wheels on the same side of the structure, the relation of the track and guides on the line A—A of Fig. 17 being shown in cross-section in Fig. 18. The guides 78 and 79 follow the course of the tracks 74, and when the latter develop into the vertical run 76 the guides 78 and 79 project on either side in such relation as to maintain the horizontal position of the tread, as shown in Fig. 17. When the steps reach the lower portion of the vertical runs of the track 76 and guides 78 and 79, the descent of the truck-wheels 25 of the now leading shaft 27 is momentarily stopped by

the shoulders 80, formed by deflecting the guides 78 inwardly toward the tracks 76, the truck-wheels 26 of the now rear shaft 28 having been shifted by the outwardly directed section 81 of the guide 79, so that the parts occupy the relative positions shown at *a* in Fig. 17. The guide 79 connects with an inwardly directed guide section 82 and the guide 78 with an inwardly directed guide section 83, these sections crossing to opposite sides of the tracks 76. The walls of the channel guides 79 are suitably recessed or cut-away where these sections cross to allow the passage of the relatively wide truck-wheels 25. The guide section 83 is at an acute angle to the guide 78, and the guide section 82 is at an obtuse angle to the guide 79, and as the axle 29 moves along in its tracks 76, which at or about where the sections 82 and 83 cross begin to curve toward the horizontal tracks 74 and 75 which are tangent to the upper getting-on landing 11, the wheels 25 are dragged over the angular section 83 while the wheels 26 pass down through the reverse or crossing section 82, when the parts assume the positions indicated at *b*. In this position the wheels 25 and 26 have crossed to opposite sides of the track 76, the structure being provided with suitable gaps where the channels 82 and 83 cross the channel 76 to accommodate the axles of the steps, as shown in Fig. 17. The wheels 26 now travel along lower curved guide-sections 84 which extend forwardly and approach the plane of the channel tracks 74 and 75. The wheels 25 travel through an upwardly directed section 85 which effects a drag on the wheels so that the parts assume the positions shown at *c*, and thence the wheels 25 travel in downwardly directed sections 86 which serve to depress the wheels 25 toward and in rear of the wheels 30 and 31, as indicated at position *d*. When the wheels 25 and 26 reach the ends of the sections 84 and 86 the tread surface of the step assumes the position at *e*, with its horizontal portion uppermost and its riser in the lead. Also, the positions of the wheel-shafts are reversed, as the shaft 27, which on the ascending run was the leading shaft now becomes the follower, and the shaft 28 becomes the leading shaft on the descending run. The steps enter and leave the loop in horizontal position, and it is understood that suitable guides may be provided for the truck-wheels between the ends of the tracks 70, 71, 72, 73, at the upper getting-off landing and the guides 78, 79, and also between the ends of the guides 84, 85, and the tracks 70, 71, 72, 73, at the upper getting-on landing preferably located a little below normal level, in order that the steps may be steadied. It is obvious, however, that this is provided by extending the tracks to the guides.

From a consideration of the foregoing it will be apparent that as the steps pass over the tangent straight or level runs, the truck wheels 25 and 26 enter the channel guides 78 and 79, respectively, and the axle rollers 30 and 31 enter the channel tracks 74; as the steps proceed around the loop they are carried and supported by the axle rollers 30 and 31 while the truck wheels and their cooperating channel guides serve primarily at these points as shunts or guides to control the step-unit and reverse and change the direction of the leading edges of the steps. As the steps proceed down the vertical run the treads are maintained in substantially horizontal position until the truck-wheels have moved through the remaining sections to the point *e*, the treads are in reversed position, being turned practically end to end so that the risers are on the leading edges and the truck-wheels 26 have become the leading wheels and the truck-wheels 25 have become the rear wheels of each respective step. In this position the steps pass over the straight horizontal run leading to the getting-on landing 11 and to the descent upon the incline from the upper level or story, and when the steps pass upon the curved horizontal run the truck-wheels are brought into coöperative relation with their respective tracks 70, 71, 72, 73, to sustain and support the steps, the axle-wheels again becoming inoperative. When the steps go upon the descending incline, they are supported by the tracks 66, 67, 68, 69, in step-form and in this relative position and arrangement are carried throughout the descending incline.

When the steps reach the straight horizontal run of the lower level the axle wheels 30 and 31 coöperate with lower channel tracks 87 arranged upon opposite sides of the frame and extending around the lower loop in the manner shown in Fig. 19, the axle wheels serving to support and carry the steps during the course of their travel around this loop. The truck wheels pass into channel guides 88 and 89 which receive the wheels 26 and 25 respectively. The arrangement of parts is illustrated in Fig. 21, which is a section through one side of the lower carriage on the line C—C of Fig. 19, it of course being understood that similar provision is made for the other end of the steps on the opposite side of the structure. The lower channel guide 88 connects with an upwardly extending section 90 and the upper channel guide 89 with a downwardly extending section 91, the arrangement and disposition of these sections being such that they cross each other and lead to opposite sides of the tracks 87, the guides 88 having their walls recessed or cut-away to allow the wider shaft 27 to pass. The wheels 26 are carried upwardly in the sections 90 at the time the wheels 25 are carried downwardly

in the sections 91, as shown at *v* in Fig. 19, so that the wheels 26 are above and the wheels 25 below the track 87, and they then pass into parallel sections 92 and 93 which maintain the steps in approximate vertical position with the wheels 26 above and in the lead of the wheels 25 as shown at *w*. Each of the upper parallel sections 92 is provided with a jog or stop 94 by which the wheels 26 are momentarily arrested so as to cause the steps to turn upon their axles 29 as centers and to throw the lower wheels 25 forward and in the lead of the wheels 26, as shown at *x*, the sections 93 extending in a curve 95 slightly toward the tracks 87. In this position of the parts the steps are again reversed edge for edge and also turned over or lowermost in the unit. The channel track guides 95 are curved to gradually approach the channel tracks 87, while the guides for the wheels 26 beyond the stops 94 take a sudden dip as at 96 toward the channel tracks 87, this dip serving to form a drag for the wheels 26, while the wheels 25 being free to move forward and to be turned upon the axle 29 as a center by reason of the detention of the wheels 26 travel around in their curved guides 95 and assume the lead, whereby the steps are restored to their original positions with the raisers upon the rear edges and with the upper faces of the treads coming into alinement as shown at *y*. As the steps pass forward around the end of the loop the front wheels 25 pass upon their guides 95 and the rear wheels 26 pass along guides 97 curved to conform to the curvature of the tracks 87; the guides 97 terminate in the horizontal tracks 98, and the guides 95 are provided at their ends with downwardly directed portions 99 which deflect the wheels 25 to the horizontal ends 100, so as to bring the treads horizontal or uppermost in the unit.

It is of course understood that the guides 88 and 89 may connect with the tracks 70, 71, 72, 73, of the curved horizontal getting-off landing 14, and that the guides 99 and 100 may connect with similar tracks of the getting-on landing 2 in order to steady the steps. Where the steps emerge from below the floors at the getting-on landings the supporting tracks of the truck-wheels are suitably elevated, and where they pass below the floors at the getting-off landings these tracks are suitably depressed.

In the design of elevator here shown, when the steps are carried around the terminal loops or carriages, the toothed edges of the links 44 and 51 are turned over so that the teeth face upwardly upon the return run or descending spiral or tread and engage with the under sides of the driving sprockets, as shown in the lower half of Fig. 16. As the steps are uppermost in the carriage it is necessary to remove the shafts of the driving sprockets from their path in the return run. For this purpose the driving sprockets 61 and 62 of the return run are mounted in the framework upon stub-axles, as shown at the lower portion of Fig. 16, and are also provided with gear-wheels 101 and 102, respectively, with which a second pair of gears 103 and 104 mesh. The gears 103 and 104 are keyed upon a common shaft 105 which is journaled in the framework below the stub-axles a sufficient distance to allow for the clearance of the steps. By this means the shaft for transmitting power to the outer driving sprocket of any pair is placed out of the way of the step on the return run where the teeth of the links face upwardly and engage the driving sprockets as shown in Fig. 16. It is also understood that the idler wheels 64 and 65 on the return run may be similarly mounted on stub-axles and provided with similar auxiliary shafts and gears.

As the inner linkage automatically adjusts its length to meet the requirements of the positions of the steps on the inclines and on the landings, the risers of the steps must be of such contour and configuration as to maintain contact with the adjacent treads in both positions of the links. For this purpose I provide a warped riser, which as it approaches the axis of the machine becomes more nearly straight in elevation. In plotting the curve of the riser, an arc of a circle is struck at the outer end of the tread with a radius equal to the greatest width of the segmental tread and this arc is continued to correspond with the height of the riser, as shown in Fig. 23. This arc is intersected into any number of equal divisions, and from each of such intersections a radial line is drawn to the axis of the spiral or center of curvature. At any suitable points along the length of the tread and at a point corresponding to its inner or narrow end the radial lines are intersected by dividing lines spaced to correspond with the spacing of the divisions of the outer arc, and the intersections of the radial and dividing lines mark the paths of arcs which indicate the curvature of the riser at the points where these arcs are located. It is obvious that the radial lines are parallel in elevation as shown in Fig. 23 and tend to approach the same vertical axis, and that the inner end of the riser therefore tends to become straight in elevation as it approaches the center of the machine. The arcs of the inner and outer ends of a riser that is attached to a tread respectively 14 and 21 inches wide at the ends is shown in Fig. 24.

It is apparent that the loops or carriages impart different rotations to the steps to permit the axles of adjacent steps to pass or clear.

It is obvious that the double spiral form

of elevator allows all landings to be placed on the inside so that the portions having the minimum speed are utilized for taking on and discharging passengers. By rating the speed of the inside ends of the steps at 100 feet per minute, a vertical rise of two-thirds of a foot per second is insured, which provides adequate speed, whereas if the outside ran only 100 feet per minute, as it would if utilized for landing purposes, the passenger would move much slower, as the vertical rise would be less per second. The seats in each yoke for each succeeding shaft 27 guide the steps in radial positions during the act of setting or positioning the steps on the curves, and the seats and collars assure the coöperation of the hooks of the adjustable linkage as they prevent any dis-alinement thereof.

It is apparent that the direction of movement of the elevator is clockwise and contra-clockwise.

It is apparent that while my present device is primarily designed to carry passengers, it is in fact a conveyer which may be used for any kind of freight, as each section though shown in the form of a step may be of any suitable form or design. It is further apparent that the driving mechanism need connect with the conveyer only on the inclines and that it will not be necessary to provide driving mechanism on the horizontal portions as the steps or sections on the horizontal will be pushed forward. In this action the links are under compression, and the slotted connection of each of the inner links with the next step or section provides a suitable means for accomplishing this function.

Having described my invention, what I claim is—

1. A conveyer transporting between different levels in which the direction of movement is clockwise and contra-clockwise.

2. A moving stairway in which the direction of movement is clockwise and contra-clockwise.

3. A duplex spiral elevator in which the ascending and descending runs travel in opposite directions about a common well.

4. An elevator in which the ascending and descending series of steps travel in spiral paths in opposite directions about a common center of curvature.

5. An elevator in which a single series of steps travels in reverse spiral paths.

6. In a device of the class described, a series of steps arranged in ascending and decending spiral paths about a common center of curvature, and driving mechanism common to the steps of both paths.

7. In a device of the class described, a series of steps traveling in reverse spiral paths, and driving mechanism engaging the steps in each path.

8. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in reverse spiral paths, of driving mechanism engaging with the ascending and descending runs of said steps.

9. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in ascending and descending spiral paths one below the other, of driving mechanism engaging said steps on both runs.

10. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in ascending and descending spiral paths one below the other, of a drive shaft adjacent the spiral paths, and means for connecting said shaft with the steps on the respective runs.

11. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in ascending and descending spiral paths having a common center, of driving wheels mounted on the ways and engaging the steps on both runs, and a driving shaft connected with said wheels.

12. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in ascending and descending spiral paths, of driving wheels mounted on the ways, and respectively engaging said steps on the ascending and descending run in substantially the same vertical plane, a drive shaft adjacent the wheels, and means to connect said shaft with the wheels of the opposite runs.

13. In a device of the class described, the combination with a series of connected steps, ways in which said steps travel in ascending and descending spiral paths, of driving wheels mounted on the ways, and respectively engaging said steps on the ascending and descending run in substantially the same vertical plane, a vertical drive shaft adjacent the wheels, and means to reversely connect said shaft with the wheels of the opposite runs.

14. In a device of the class described, the combination with a double spiral structure, a series of connected steps running in reverse directions on said structure, and a series of drive wheels on the structure engaging said steps on the ascending and descending runs, a series of drive shafts adjacent the structure, and means to reversely connect each shaft with a drive wheel on each run.

15. In a device of the class described, the combination with a series of steps, and spiral ways in which said steps travel, of a rack connecting said steps, driving sprockets on both the ascending and descending ways and meshing with said rack, and means for applying power to said sprocket wheels to drive the steps from a common source.

16. In a device of the class described, the combination with the moving steps adapted to transport on their ascending and descending runs, guides on which said steps are arranged to travel in reverse spiral paths, of driving mechanism engaging the steps on both runs.

17. In a device of the class described, a series of moving steps arranged to carry on ascending and descending spiral paths one under the other, and driving mechanism for the steps.

18. In a device of the class described, the combination with an endless carrier adapted to transport on its ascending and descending runs, of guiding and supporting ways for said carriers arranged in double spiral paths having a common center of curvature, and driving mechanism engaging with both the ascending and descending portions of said carrier.

19. The combination in a moving stairway, of two spiral runs, each having an inner and an outer track, horizontal tracks at top and bottom connecting the tracks of the two spirals, the inner track of the ascending spiral joining the outer track of the descending spiral and the other track of the ascending spiral joining the inner track of the descending spiral, step sections arranged to travel on the said endless track, and means for driving the said step sections.

20. In a device of the class described, the combination with a supporting structure arranged in double spiral paths about a common well, a series of steps adapted to run on said structure, and racks connecting the steps, of a series of radial sprockets on the structure and adapted to engage the racks, a series of vertical drive shafts adjacent the structure, and means to connect each drive shaft with sprockets engaging both runs.

21. In a device of the class described, a conveyer arranged to travel in reverse ascending and descending paths, and a driving shaft or shafts in which the direction of torsional strain is reversed by alternate connection with the ascending and descending lines of the conveyer.

22. In a device of the class described, a conveyer arranged to carry in reverse ascending and descending paths, and a driving shaft or shafts having alternate connection with the ascending and descending runs of the conveyer to reverse the direction of torsional strain on the said shaft or shafts.

23. In a device of the class described, idlers to synchronize the speed of the two ends of the steps or sections.

24. In a device of the class described, the combination with a series of steps adapted to travel in ascending and descending paths about a common well, of a series of radially disposed idlers engaging said steps, and means to drive the steps.

25. In a device of the class described, the combination with a series of steps adapted to travel in ascending and descending paths about a common well, of a series of radially disposed idlers engaging said steps at both ends, and means to drive the steps.

26. In a device of the class described, the combination with a series of steps adapted to travel in ascending and descending paths about a common well, of a series of driving devices located at intervals in said paths, and idlers engaging the steps between the driving devices.

27. In a device of the class described, the combination with a series of steps adapted to travel in ascending and descending curved paths about a common well, of a series of radially disposed driving devices engaging said steps at both ends at intervals in said path, and a series of radially disposed idlers engaging said steps at both ends and located between the driving devices in said path.

28. In a device of the class described, the combination with a spiral structure having curved horizontal and inclined ways, of a series of steps adapted to run on said ways, and means to adjustably connect the inner ends of said steps together on different portions of the ways.

29. In a conveyer, interlocked sections forming a unitary structure upon spiral ways.

30. In a spiral conveyer, interlocked tread surfaces forming a unitary device on the incline.

31. In a spiral conveyer running on inclined and horizontal ways, a series of sections adapted to interlock upon the inclined way to form a unit and to unlock upon the horizontal way.

32. In a spiral elevator, interlocked steps on the inclined ways forming a practically rigid unit to resist lateral strains.

33. In a spiral elevator, interlocked steps on the inclined ways forming a practically rigid unit to which power is applied for driving the same.

34. In a spiral elevator, interlocked steps on the inclined ways forming a practically rigid unit, sprockets and idlers engaging the steps, and means to drive the sprockets.

35. In a device of the class described, a spiral unit composed of interlocked steps on the incline.

36. In a device of the class described, a spiral unit composed of interlocked steps on the incline, and means for driving the steps as a unit.

37. In a device of the class described, the combination with a structure having curved inclined and horizontal ways, of a series of steps adapted to run on said ways, and means to automatically connect and disconnect the steps on the respective portions of the ways.

38. In a device of the class described, the combination with a structure having inclined ways, of a series of steps having yokes adapted to travel on said ways, and means to connect the yokes when on the ways.

39. In a device of the class described, the combination with a structure having inclined ways, of a series of steps, each step having end yokes, a shaft carried in one end of each of said yokes and having wheels adapted to the ways, the opposite end of said yoke projecting into the vertical plane of the shaft of the adjacent yoke and adapted to seat the same when the steps are on the ways.

40. In a device of the class described, the combination with a structure having inclined and horizontal ways, of a series of steps, each step having end yokes composed of angularly disposed upper and lower arms, a shaft in the upper arms of each yoke having wheels adapted to said ways, the lower arms projecting into the vertical plane of the shaft of the next step and provided with seats to receive the same when the steps are on the inclined ways.

41. In a device of the class described, the combination with a structure having inclined and horizontal ways, of a series of steps, each step having end yokes composed of angularly disposed upper and lower arms, a shaft in the upper arms of each yoke having wheels adapted to said ways, flanged collars on said shaft, the lower arms of the yokes projecting under the next step and provided with seats to receive the collars when the steps are on the inclined ways.

42. In a device of the class described, a series of sections running on spiral ascending and descending ways, and engaging means on the rear of each section to guide the next section into radial position.

43. In a device of the class described, a series of steps running on spiral inclined ways, engaging means on the front and rear portions of adjacent steps to guide the succeeding step into radial position, and means to lock adjacent steps against lateral movement.

44. In a device of the class described, a step having a portion which projects under the tread of and coöperates with the next lower step when the steps are on an incline.

45. In a device of the class described, a step having a portion which projects under the tread of and coöperates with the next lower step when the steps are on an incline, and means to reverse the steps at the end of the incline.

46. In a device of the class described, a step having a yoke which projects under the tread of and coöperates with the next lower step when the steps are on an incline.

47. In a device of the class described, a step having a portion which projects under the adjacent part of the tread of and coöperates with the next step to provide a wheel base on an inclined way.

48. In a device of the class described, a step having a portion which projects under the next step to interlock therewith.

49. In a device of the class described, a step having a portion which interlocks with an adjacent step on an incline, and means to reverse the steps after leaving the incline.

50. In a device of the class described, a series of steps adapted to run on horizontal and inclined ways, each step having end yokes composed of angularly disposed upper and lower arms, a shaft in the lower arms having wheels, a shaft in the upper arms having wheels, the lower arms projecting under the shaft in the upper arms of the next step and adapted to engage therewith when the steps are on the inclined ways and to disengage therefrom when the steps are on the horizontal ways, whereby the steps are supported by the wheels of both shafts on the horizontal way and on the wheels of the shaft of the lower arms on the inclined way.

51. A step for spiral elevators having wheels adapted to straight tracks and wheels adapted to curved tracks.

52. In a device of the class described, a series of moving steps, each having a wheel-base broader than the tread thereof, tracks on which said steps travel in reverse ascending and descending paths, and means to reverse the steps whereby they are adapted to carry on both paths.

53. A step for an elevator having a wheel-base broader than the tread, and an axle journaled in the base and provided with wheels outside the wheel-base.

54. A step for an elevator having a wheel-base comprising end-yokes, an axle journaled in the base and provided with wheels outside the wheel-base, shafts journaled in the ends of the yokes, and wheels keyed to the axle and shafts.

55. A step for a spiral elevator having an axle provided with wheels of equal diameter, yokes rigid with the tread, shafts in the ends of the yokes having wheels proportionate in diameter to the radii of the tracks on which they are designed to run, said yokes being longer than the width of the tread of the step.

56. A step for a spiral elevator having a step-base or frame composed of yokes, an axle journaled in each yoke and having wheels of equal diameter keyed thereto, and shafts journaled in the front and rear ends of the yokes and having wheels keyed thereto, said shaft wheels being proportionate in diameter to the radii of the tracks on which they run.

57. In a device of the class described, the combination with a series of steps, ways in

which said steps run in ascending and descending spiral paths, and means for reversing the steps between the paths.

58. In a device of the class described, the combination with a series of steps, and inclined ways on which the steps are adapted to run in reverse spiral paths, of a loop or carriage adapted to rotate the steps between the runs.

59. In a device of the class described, the combination with a series of steps, an axle journaled in each step, and inclined ways on which the steps run in opposite spiral paths, of a loop or carriage adapted to rotate the steps on their axles between the runs.

60. In an elevator, a series of connected steps having axle bars, wheel-bases on the bars, ascending and descending inclined runs upon which the steps move in opposite direction in transporting position, a carriage between the runs and having a continuous channel guide with which the axle bars cooperate while the steps are passing through the carriage.

61. In an elevator, ascending and descending inclined runs, connected steps reversely moving in transporting position upon the runs, extended axle bars for the steps and provided with guide rollers, and a carriage between the runs and having a continuous channel guide with which the guide rollers coöperate while the steps are passing through the carriage.

62. In an elevator, a continuous series of connected steps each of which is provided with a wheel-base having an axle-bar fixed thereto, inclined upper and lower runs on which the said steps travel with their treads uppermost, a carriage connecting the runs and provided with a continuous channel guide, and guide rollers on the axle-bars cooperating with the channel guide as the steps pass through the carriage.

63. In a conveyer, a way forming upper and lower conveyer runs, a series of wheeled sections each having an axle-bar, means to move the sections in continuous series on the way, a carriage connecting the runs at each end, a continuous guide in the carriages for the axle bars, and tracks in the carriages for the wheels of the sections.

64. In a device of the class described, the combination with a series of steps, each having a base rigid with its tread, an axle journaled in the base and having wheels, truck-wheels on the base, and inclined tracks upon which the truck-wheels run in reverse spiral paths, of a loop or carriage having curved tracks to guide the axle-wheels from one path to the other, and guides for the truck-wheels adapted to turn the step-base on its axle to present the tread in horizontal position in both directions of its run.

65. In a device of the class described, the combination with a series of steps, each having a base rigid with its tread, an axle journaled in the base and having wheels, truck-wheels on the base, and inclined tracks upon which the truck-wheels run in reverse spiral paths, of a loop or carriage having curved tracks to reverse the direction of travel of the step-units, and guides for the truck-wheels to turn the step-bases to present the treads in uppermost position in the step-units on the reversed runs.

66. In a device of the class described, the combination with a series of connected steps, each having a tread provided with a single riser, a step-base rigid with the tread, an axle journaled in each base and provided with wheels, truck-wheels on each base, and inclined tracks upon which the truck-wheels run in reverse spiral paths, of a loop or carriage between the paths, curved tracks on the loop to reverse the direction of travel of the step-units between the spiral paths, and guides on the loop for the truck-wheels to reverse the steps to present the risers in position in the step-units on the reversed runs.

67. In a device of the class described, the combination with a series of connected steps, each having a tread provided with a single riser, a step-base rigid with the tread, an axle journaled in each base and provided with wheels, truck-wheels on each base, and inclined tracks upon which the truck-wheels run in reverse spiral paths, of a loop or carriage between the paths, curved tracks on the loop to reverse the direction of travel of the step-units between the spiral paths, and guides on the loop for the truck-wheels to turn the steps over between the reverse runs, whereby the treads and associated risers are presented in operative position on both runs.

68. In a spiral elevator, a series of steps adapted to transport in reverse ascending and descending spiral paths, each step having a single riser adapted to its leading edge on one run and to its following edge on the other run and means to turn the steps between the runs.

69. In an elevator, a series of steps adapted to transport in ascending and descending spiral paths, each step having a single riser adapted to act on each run, and means to turn the steps between the runs.

70. In a spiral elevator, a series of steps adapted to run in ascending and descending spiral paths, each step having a riser on one edge, and means for reversing the steps to maintain the riser in operative position on both runs.

71. In a spiral elevator, a step having a curved riser making contact with an adjacent step on ascending and descending inclines.

72. A step for a spiral elevator having a

curved riser whose radial lines come more nearly into a vertical plane as they approach the center of the machine.

73. A step for a spiral elevator having a segmental tread and whose riser is struck at its outer end on a radius equal to the width of the tread at that point and whose radial lines passing through the arc so struck approach a vertical plane at the center of the machine.

74. In a device of the class described, a series of steps each having a segmental tread and a curved riser, curved ways providing ascending and descending paths one below the other for said steps, and automatically adjustable linkage connecting one end of the steps.

75. In a device of the class described, a series of steps each having a segmental tread and a warped riser, curved ways for said steps having inclined and horizontal portions, links connecting the inner ends of the steps, and hooks on the links adapted to connect the same on different lengths when the steps are on the inclined and horizontal ways respectively.

76. In a device of the class described, horizontal and inclined curved ways, a series of steps moving on said ways, and rigid links adjustably connecting the steps on different link lengths on the horizontal and inclined ways.

77. In a moving stairway, two similarly turned spiral runs, each having an inner and an outer track, horizontal tracks at top and bottom of the stairway connected to the spiral tracks, step sections having wheels arranged to travel on said tracks, an endless linkage connecting the steps on different link lengths, and means for driving the step sections in an endless path.

78. In a device of the class described, tracks providing ascending and descending spiral paths one below the other, steps adapted to travel on the tracks, and a rigid link associated with each step and having adjustable link-length connection with an adjacent step.

79. In a device of the class described, a way providing ascending and descending spiral paths one below the other, steps adapted to travel on the way and varying in their angular relation on different portions of the way, and rigid links automatically adjustable to connect the steps on different link-lengths in their various relations.

80. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of end linkage having automatically adjustable connection with said steps, and means to move the steps.

81. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of end linkage having automatically adjustable connection with said steps at their inner ends, and means to move the steps.

82. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links on said steps, means on the links adapted to engage when the links are alined and to disengage when the links dis-aline, and means to move the steps.

83. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links on the steps, means on the links adapted to engage on different lengths when the steps are on the horizontal and inclined ways and to disengage when the links are in angular position, and means to move the steps.

84. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links on said steps, means on the links adapted to engage when the steps are horizontal and to disengage when the steps are in angular relation, and means to move the steps.

85. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links on the steps, each link having a pair of inwardly facing hooks and an outwardly facing hook in alinement, the outwardly facing hook of each link adapted to engage one of the inwardly facing hooks of an adjacent link when the steps are on the inclined ways and the other of said hooks when on the horizontal ways and to disengage therefrom when the steps are angularly disposed.

86. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of a link pivotally connected to each step and having a slotted connection to an adjacent step, each pair of adjacent links overlapping, and means on the links to automatically connect on different lengths when the links are alined and disconnect when the links are angularly arranged.

87. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of automatically adjustable linkage connecting said steps, teeth on the links, and drive wheels engaging the teeth.

88. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links connecting their ends, teeth on the links, means to adjustably connect the links at one end of the steps, and sprockets engaging the teeth to move the steps.

89. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of toothed links connecting the ends of the steps, oppositely disposed hooks on the inner links adapted to automatically vary the length of the inner linkage, the teeth on the inner links having such pitch that the teeth of adjacent links are in line radially on either length of linkage, and sprockets engaging the teeth to move the steps.

90. In a device of the class described, the combination with a series of steps adapted to travel on horizontal and inclined curved ways, and automatically adjustable end linkage connecting said steps, of means to adjust the steps in radial position to assist in the cooperation of the links, and means to move the steps.

91. In a device of the class described, the combination with a series of steps adapted to travel upon horizontal and inclined curved ways, of links on the steps, means on the links adapted to engage on different lengths when the steps are on the horizontal and inclined ways, means to adjust the steps in radial position to aline the links, and means to move the steps.

92. In a device of the class described, the combination with a structure having curved inclined and horizontal ways, of a series of steps, each step having end yokes composed of angularly disposed upper and lower arms, a shaft in the upper and lower arms of each yoke having wheels adapted to said ways, the lower arms projecting into the vertical plane of the shaft of the next step and provided with seats to receive the same when the steps are on the inclined ways, links on the steps, means on the links adapted to engage on different lengths when the steps are on the horizontal and inclined ways, and means to move the steps.

93. In a device of the class described, a conveyer having racks with teeth of continuous uniform pitch when on horizontal or inclined paths.

94. In a device of the class described, the combination with a series of steps adapted to travel in reverse directions upon two horizontal and inclined curved ways, of links connecting the steps, teeth on the links, and sprockets engaging the teeth on the ascending and descending lines of steps.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES D. SEEBERGER.

Witnesses:
W. H. STOKES,
W. L. RICKARD.