G. L. BENNETT.

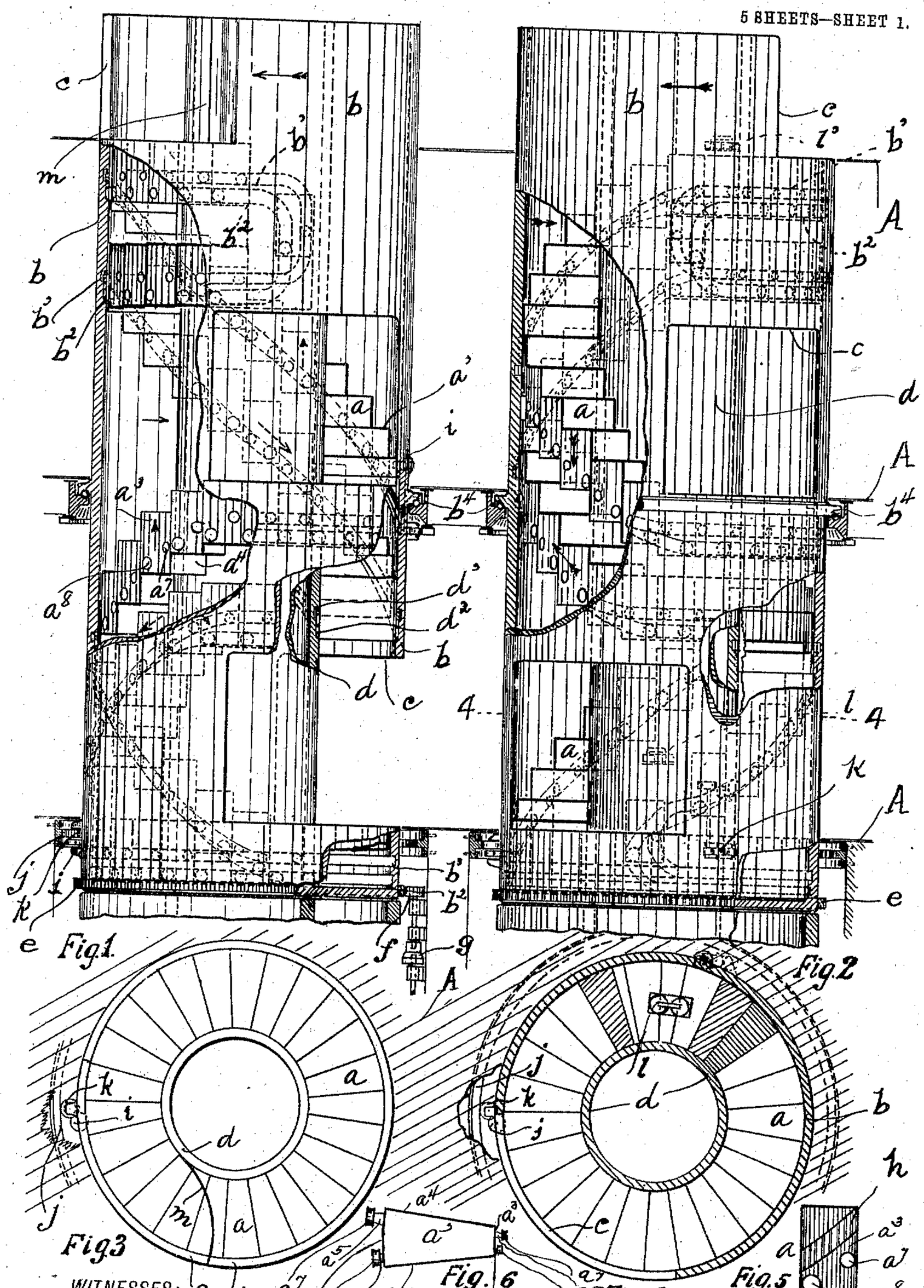
ESCALATOR.

APPLICATION FILED JAN. 27, 1906.

967,710.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 1.



WITNESSES:

Louis F. Goldmann

John J. Grady Jr.

INVENTOR

George L. Bennett

BY

Brothingham & Wentworth

his ATTORNEYS.

G. L. BENNETT.

ESCALATOR.

APPLICATION FILED JAN. 27, 1906.

967,710.

Patented Aug. 16, 1910.

5 SHEETS—SHEET 2.

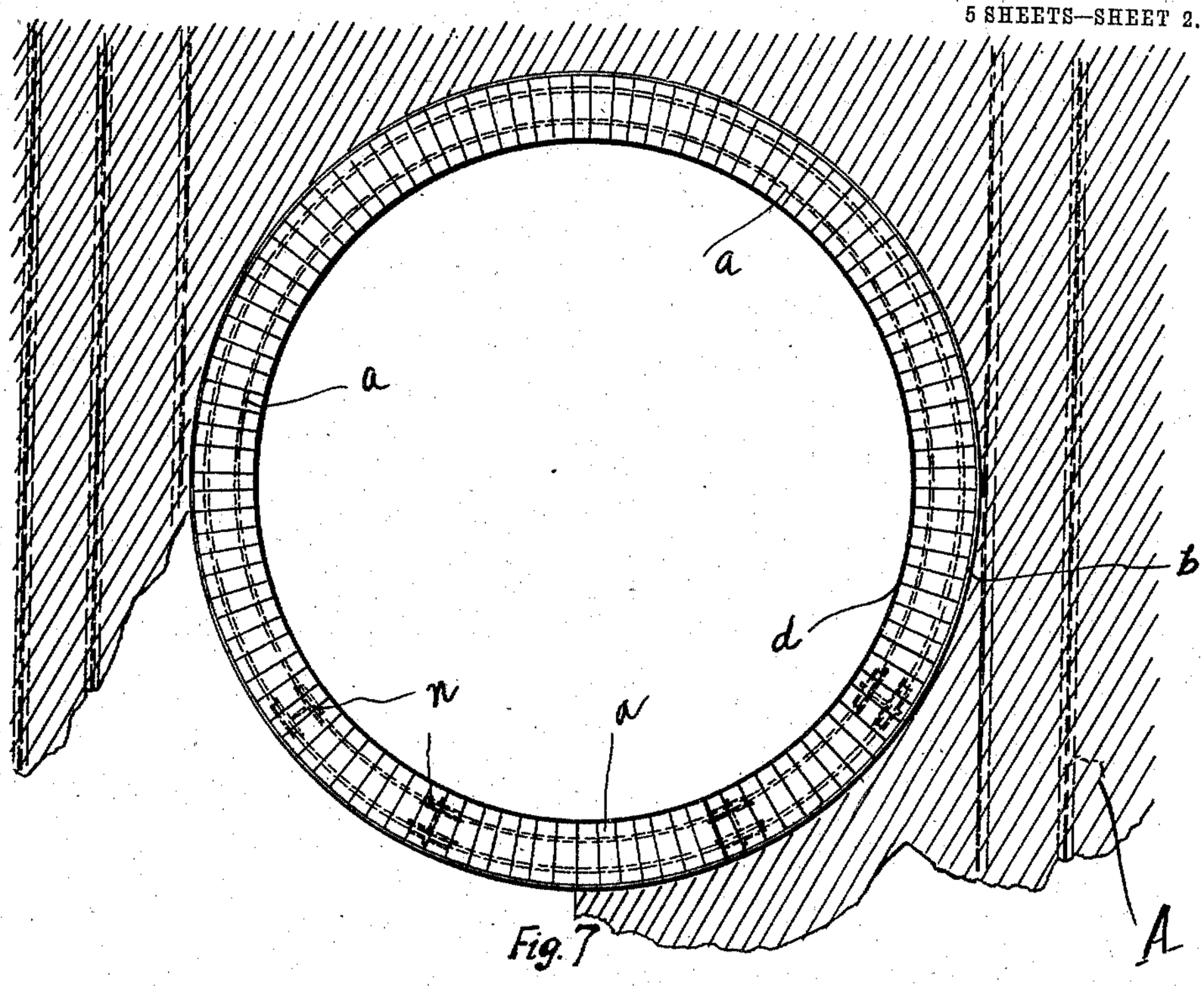


Fig. 7

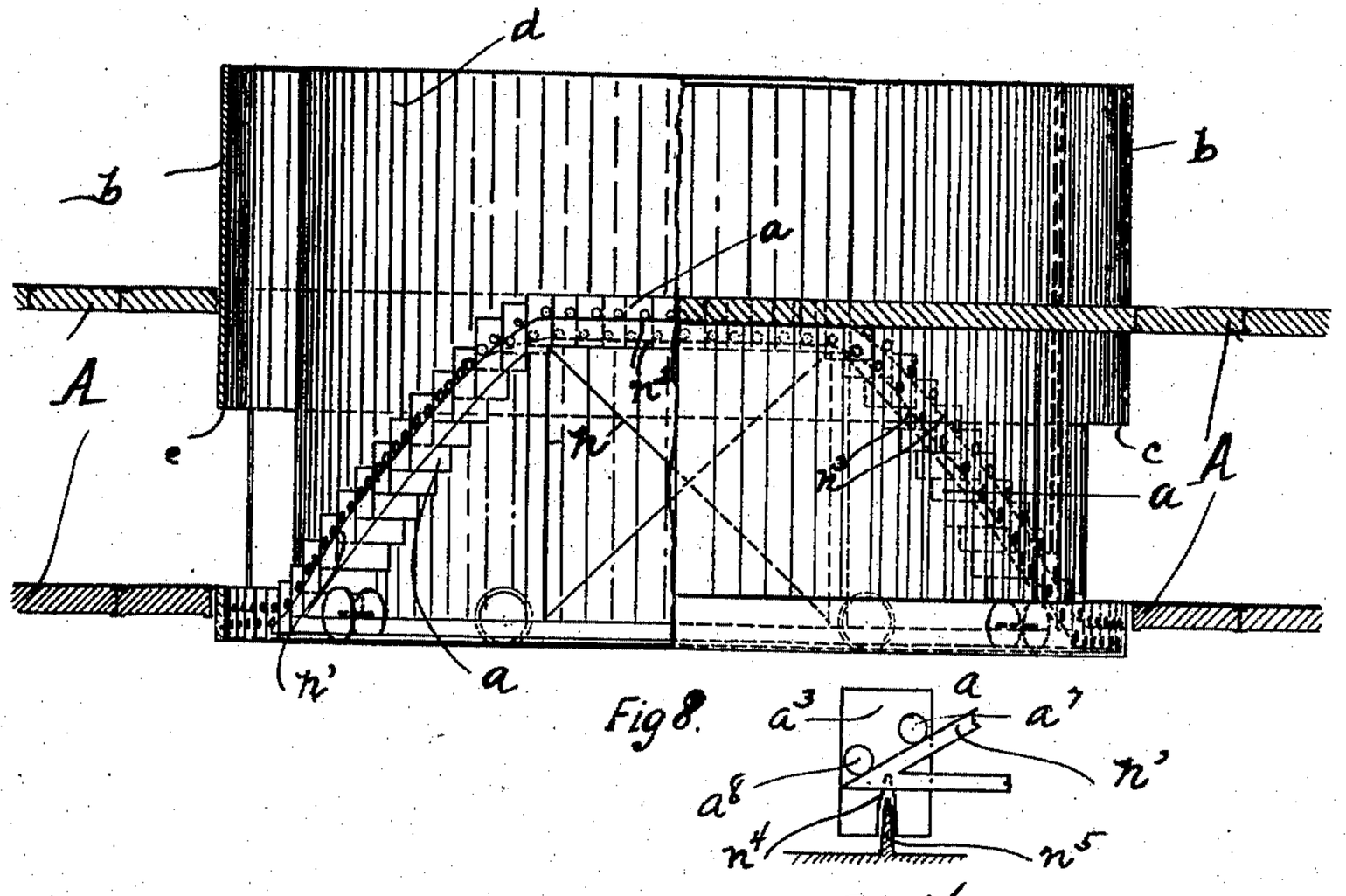


Fig 8.

Fig. 16

WITNESSES:

Louis J. Hellmann

John J. Grady Jr.

INVENTOR—

George L. Bennett

BY

Frothingham & Wentworth

his ATTORNEYS

G. L. BENNETT.

ESCALATOR.

APPLICATION FILED JAN. 27, 1906.

967,710. Patented Aug. 16, 1910.

5 SHEETS—SHEET 3.

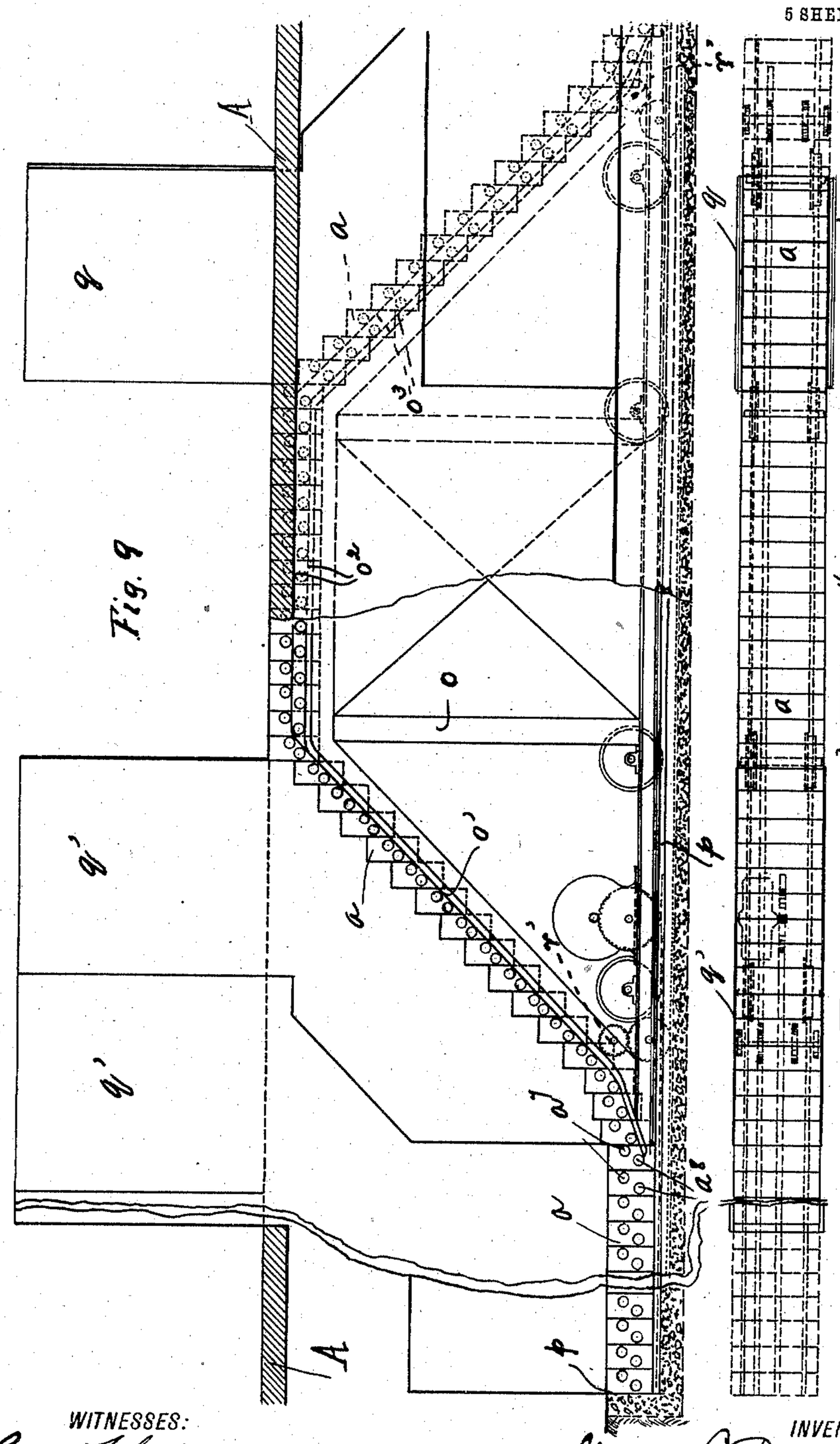


Fig. 9

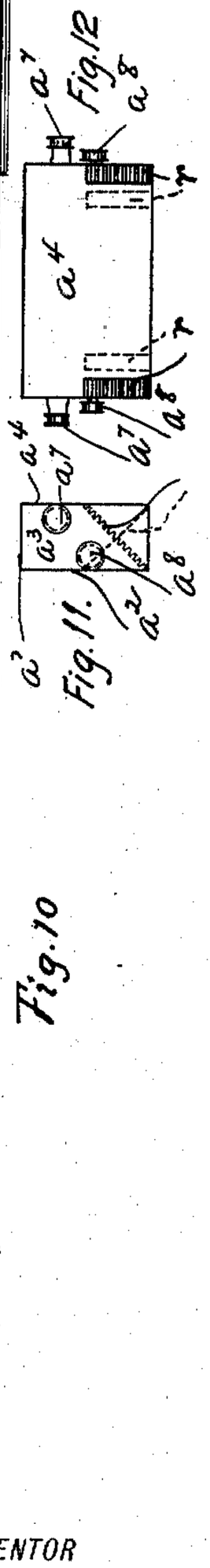


Fig. 12

Fig. 11.

Fig. 10

WITNESSES:

Louis F. Goldmann

John J. Grady Jr.

INVENTOR

George L. Bennett

BY

Frothingham & Wentworth

his ATTORNEYS.

G. L. BENNETT.

ESCALATOR.

APPLICATION FILED JAN. 27, 1906.

967,710. Patented Aug. 16, 1910.

5 SHEETS—SHEET 4.

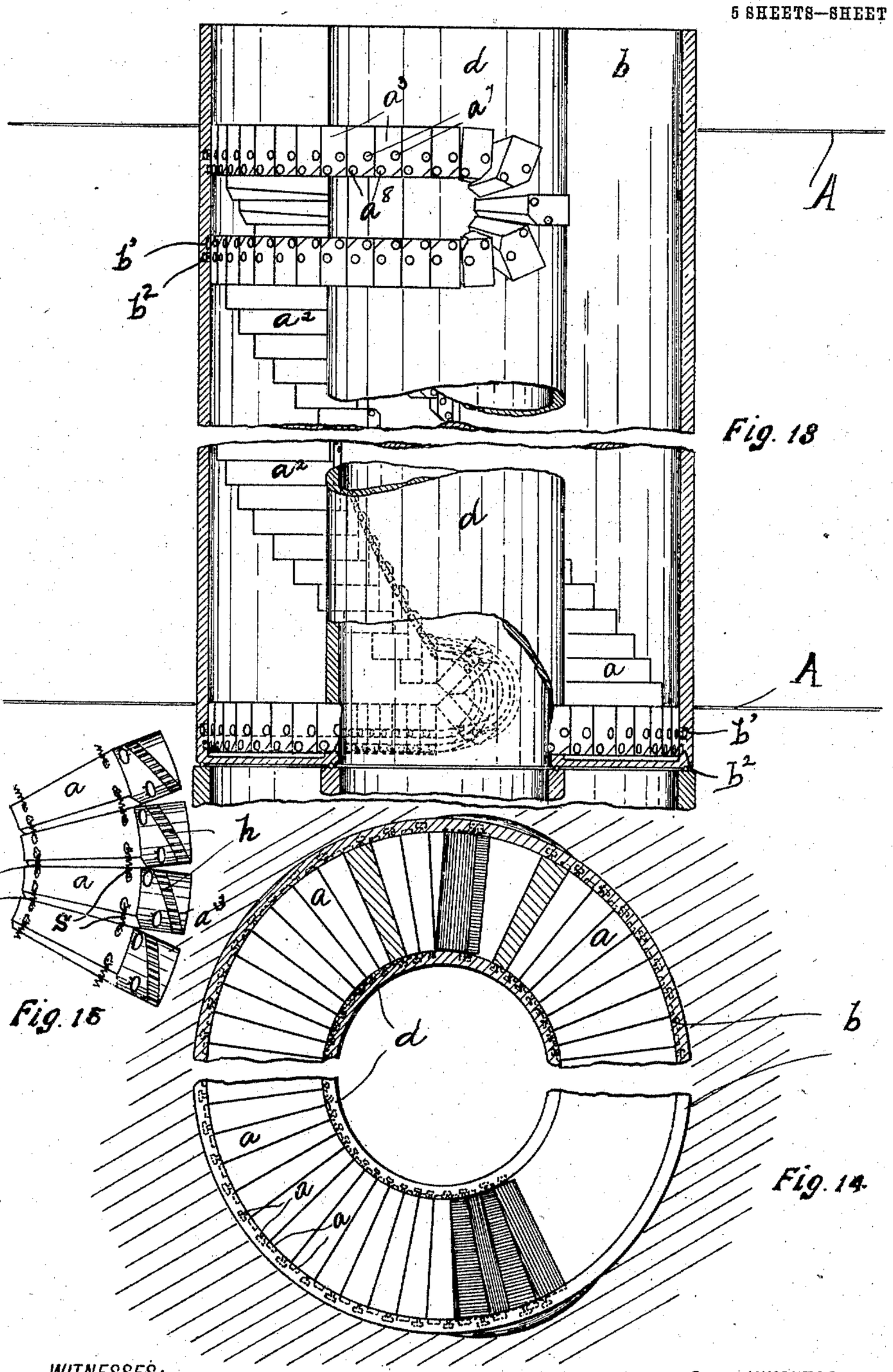


Fig. 18

Fig. 15

Fig. 14.

WITNESSES:

Louis J. Goldmann

John J. Grady Jr.

INVENTOR

George L. Bennett

BY

Prothingham & Wentworth

his ATTORNEYS.

G. L. BENNETT.

ESCALATOR.

APPLICATION FILED JAN. 27, 1906.

967,710. Patented Aug. 16, 1910.

5 SHEETS—SHEET 5.

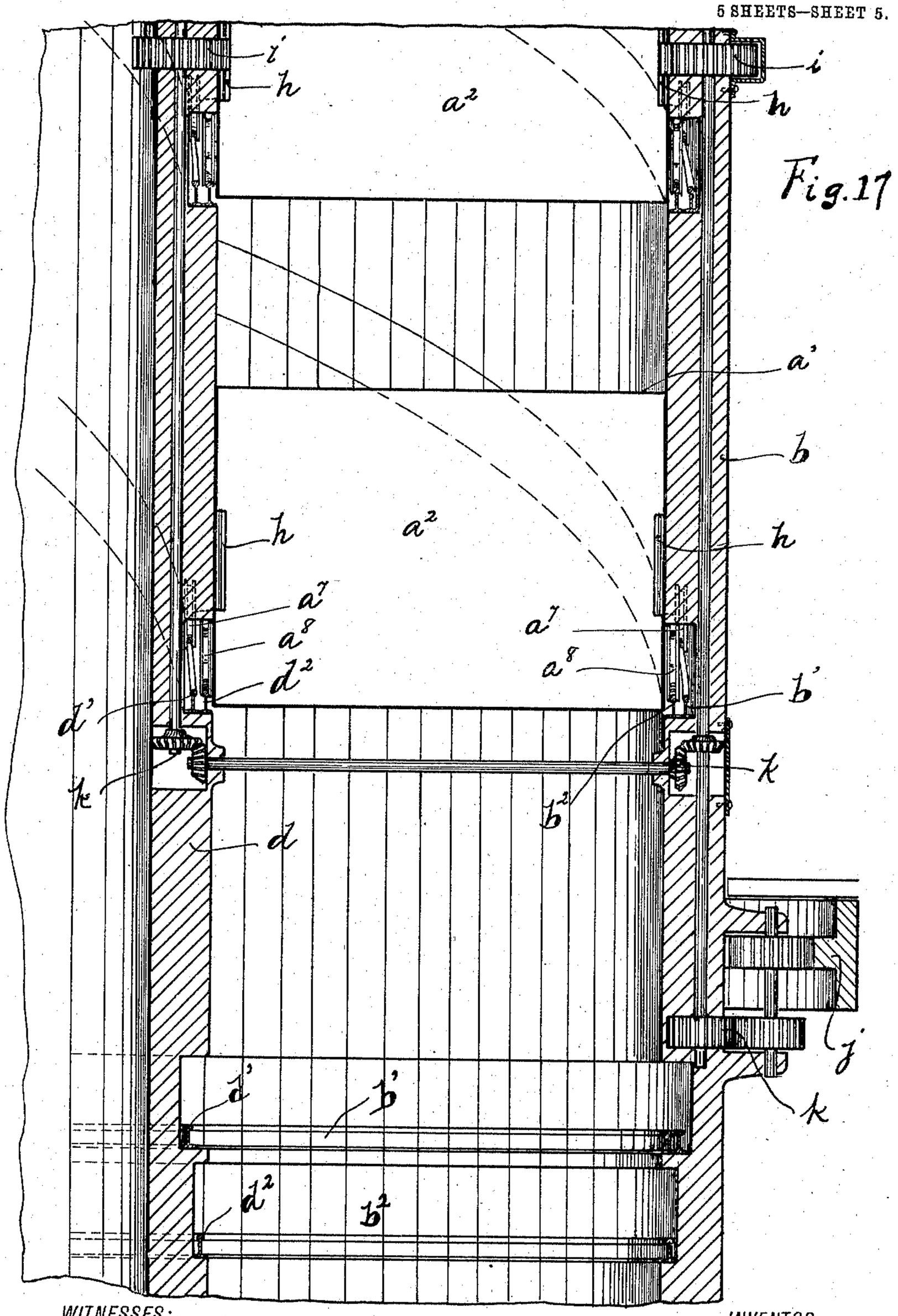


Fig. 17

WITNESSES:

Louie F. Graumann

John D. Helms

INVENTOR

George L. Bennett

BY

Prothingham & Wentworth

his ATTORNEYS.

UNITED STATES PATENT OFFICE.

GEORGE L. BENNETT, OF TRENTON, NEW JERSEY.

ESCALATOR.

967,710. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed January 27, 1906. Serial No. 298,277.

To all whom it may concern:

Be it known that I, GEORGE L. BENNETT, a citizen of the United States, residing at Trenton, in the county of Mercer and State of New Jersey, have invented certain new and useful Improvements in Escalators, of which the following is a specification, reference being had therein to the accompanying drawings, which form a part thereof.

My invention relates to escalators, and more particularly to a class thereof wherein, in operation, a series or flight of steps is formed between two platforms, levels or landings.

The main object of the invention is to provide an escalator wherein the various steps will have a substantially vertical rise or fall from one level to another, and when at a loading or discharging platform, level or landing, will have little or no movement relative thereto, thus eliminating the danger of accident to persons passing upon or leaving the various steps.

A further object is to provide an escalator wherein the several steps in addition to having a substantially vertical rise or fall, will by their progression form a series of steps having substantially no horizontal movement, extending from one level to another, thereby forming at any time whether the actuating mechanism is operative or inoperative, a flight or series of flights of stairs.

A still further object is to provide an escalator which may be compactly arranged and will have such substantially continuous operation as to give great capacity thereto.

A still further object is to provide an escalator employing a plurality or series of independent steps adapted to receive a substantially vertical movement from a movable incline or be permitted to descend to a lower platform, level or landing through the movement of the incline relative thereto.

A still further object is to provide an escalator employing a plurality or series of independent steps and an incline for raising said steps or permitting them to descend from one level to another, and adapted when said steps have reached the limit of their progression as carrying steps, to restore them to the starting level, thereby permitting a substantially continuous operation of the device with the minimum number of step elements.

A still further object is to provide in an escalator of this description means for counteracting or resisting the strains from the movable incline on the series of steps in a manner to prevent a horizontal movement thereof, and impart vertical movement thereto, to give the necessary rise or permit the necessary fall, from one platform, level or landing to another.

A still further object is to provide an escalator of this description embodying safety appliances whereby in case of a jamming of the various step elements, or their failure to act properly in being restored to the starting level, the mechanism driving the incline will be automatically rendered inoperative relative thereto.

A still further object is to provide an escalator wherein the actuating mechanism for the step members will be simple in design and not subject to such disarrangement thereof through varying loads, wear or other reasons, as will render the device inoperative.

A still further object is to provide an escalator wherein the friction engendered in operating same will be reduced to a minimum.

A still further object is to provide an escalator of this character wherein the various mechanisms controlling the step elements will be carried by the main driving inclines, and be actuated through the movement thereof relative to the several platforms, levels or landings, or any of them.

A further object is to provide an escalator wherein the actuating mechanism will be rigid and continuous thus eliminating the element of wear due to a flexing thereof with resultant likelihood of such a separation of the said mechanism as would cause the formation of a gap or gaps between the various platforms, levels or landings.

A still further object is to provide an escalator which is capable of transporting objects or persons from one platform, level or landing to several successive platforms, levels or landings without requiring a series of independent mechanisms corresponding in number to the floor spaces, thus constituting what may be termed a multiple stage escalator.

A still further object is to provide an escalator wherein access may be had thereto or egress therefrom, from some part of each platform, level or landing at all times, thus

facilitating the use of the escalator, increasing its capacity and avoiding a congestion at any one point.

A still further object is to provide an escalator of this character wherein the carrying steps will be limited to a substantially vertical movement, and the return steps will receive that horizontal movement additionally, necessary to restore them to the starting level in the proper relation to the inclines, and in number and at intervals proportionate to the speed of operation.

A still further object is to provide means whereby the steps will be locked on the incline to minimize the danger of a number of steps buckling.

A still further object is to provide an escalator of this description wherein the acceleration of the steps at leaving, or their retardation on entering a level in forming the series of steps as aforesaid and returning to the horizontal, will be gradual, so as to avoid a sudden start or stop of the vertical movement.

A still further object is to provide in an escalator of this character means whereby access to any part of the escalator, as at the extereme levels, may be barred, thus limiting the space to be occupied and cut off other parts of the escalator.

A still further object is to provide an escalator wherein the weight may be distributed among a plurality of bearings proportionate to the number of platforms, levels or landings and a perfect center of rotation may be preserved.

A still further object is to provide an escalator wherein the carrying steps during their intervals of movement will be so guarded as to prevent access thereto or egress therefrom, except in a passage from step to step. And a still further object is to provide an escalator wherein a helical construction of track may be employed without likelihood of resultant discomfort to the user.

The invention consists primarily in an escalator comprising a plurality of independently movable steps, an incline adapted to successively actuate said steps and means actuating said incline whereby said inclines impart a substantially vertical movement to said steps respectively; and in such other novel features of construction and combination of parts as are hereinafter set forth and described and more particularly pointed out in the claims hereto appended.

Referring to the drawings: Figure 1 is a view in elevation of the preferred form of a multiple stage escalator embodying my invention, parts of the incline support and guard being broken away to disclose certain details of construction; Fig. 2 is a similar view of the reversal of the structure shown in Fig. 1 to be used for purposes of descent; Fig. 3 is a top plan view of the structure shown in Fig. 1; Fig. 4 is a section on the line 4—4 of Fig. 2; Fig. 5 is a side elevation of one of the individual steps; Fig. 6 is a plan view thereof; Fig. 7 is a plan view of a single stage escalator embodying the invention and capable of use for purposes of both ascent and descent; Fig. 8 is a side elevation thereof with one side in section to disclose certain details of construction; Fig. 9 is a side elevation of a single stage reciprocating escalator embodying my invention, with one end in section to disclose certain details of construction also capable of use for purposes of both ascent and descent; Fig. 10 is a plan view thereof; Fig. 11 is a side elevation of one of the individual steps used in the construction shown in Figs. 9 and 10; Fig. 12 is a rear elevation of said step; Fig. 13 is a sectional elevation of a still further modification of the invention showing a different form of the step return construction; Fig. 14 is a plan view thereof with one side shown in section; Fig. 15 is a perspective view of the bottom of several steps as used in the modification shown in Figs. 13 and 14; Fig. 16 is a side elevation of a step used in the modification shown in Figs. 7 and 8, with the relieving means therefor, and Fig. 17 is a sectional view of a part of one side of the revolving columns shown in Figs. 1 and 2, showing the relieving mechanism and the track construction on a larger scale, one step of the ascending and descending steps only being shown to avoid confusion.

Like letters refer to like parts throughout the several views.

In devices of this character now in general use, it is the practice to enchain a series of step mechanisms which have a horizontal component of motion in passing up an incline by means of a conveyer mechanism common to all such, said step mechanisms being so constructed as to form a platform on the same horizontal plane as, and movable relative to, the loading or discharging platform, level or landing; and to form a series of steps when taking the incline, which steps move horizontally and along this incline forming a second movable platform on the same horizontal plane as, and movable relative to the loading or discharging platform on the succeeding level. Because of practically insurmountable engineering difficulties, this type of escalator is limited to a single stage, and the mechanism itself is of a nature to be subject to great wear and strains resulting in likelihood of disarrangement of parts. The breakage of the conveyer mechanism enchaining the various step mechanisms will also result in the formation of a gap in the movable stair-way, thus interrupting communication by means of the escalator between the upper and the lower platforms,

levels or landings. In this construction, the movement of the escalator step mechanisms relative to the platforms causes the entrance to and departure from said steps to be accompanied with considerable inconvenience to passengers and likelihood of accident; and the actuating mechanism is both complicated and expensive. To obviate these difficulties, I provide an escalator employing a plurality of steps having no movement either horizontal or vertical at the loading or discharge platform, level or landing, independent of each other so far as their function in transporting objects or persons from one level to another is concerned; and rising from one level to another by a substantially vertical rise imparted through a relatively movable incline.

In the accompanying drawings, I have illustrated several applications of the invention, showing its adaptability to single stage as well as to multiple stage escalators, and the use of various means for restoring the steps to the starting level in a manner to insure a continuous operation of the device.

In the several embodiments of my invention shown in the drawings, a indicates the several steps which are constructed with an ordinary tread a' and riser a^2 and side webs a^3 in lieu of the ordinary stringer. I also provide a face a^4 parallel to the riser a^2 which serves as a bearing surface for the riser of the preceding step. I employ a number of these steps proportionate to the pitch of the inclines actuating same and the distance between, or number of successive loading and discharging platforms. Each said step on the side webs a^3 thereof has a plurality of fore and aft axles a^5 a^6 projecting on different horizontal planes and extended to different vertical planes paralleling the line of motion of the incline; and mounted on said axles respectively are anti-friction rollers a^7 a^8. This arrangement permits the rollers a^7 a^8 to track on the incline, thus affording supports for each step a adjacent to the riser a^2 and the bearing face a^4 on each side thereof, and avoiding possibility of any weight being so applied thereto as to overbalance it.

Mounted in any desired manner between any two levels, are oppositely disposed inclines preferably leading by an easement curve into horizontal sections corresponding with the desired length of the loading and discharging platform, level or landing at any one time, and adapted to pass under said rollers a^7 a^8 and give vertical movement to said steps. The easement curves give a gradual acceleration to each step until it has reached its limit of projection relative to the succeeding step, and retard until it has reached its limit of return at the upper level relative to the preceding step, thereafter the pitch of the incline being regular, a series or flight of steps is formed having uniform vertical movement only, and at uniform velocity. Suitable relieving means are provided, whereby horizontal movement of said steps with the inclines, is prevented. It is also necessary to provide means restoring these steps to the starting level to insure a continuous operation of the device with a minimum number of steps. Any desired means actuating said inclines may be employed, and to limit the dimensions of the loading and discharging platform at any one time, I provide a suitable guard carried by or movable with said inclines and substantially co-extensive therewith, thus providing continuously a platform on each level whereby access or egress may be had to or from the relatively immovable steps.

The foregoing description applies to the more essential features of the invention common to all the forms shown in the drawings, and I shall describe the details of the preferred form of the invention, and such details of the several modifications as vary therefrom materially.

In the preferred form of the invention shown in Figs. 1 to 6 inclusive and Fig. 17, I provide an outer cylindrical column b having openings c therethrough, the bottoms of which correspond in altitude with the several floors so as to give access to and egress from the escalator at each platform, level or landing. These openings may be of any desired size, as they permit access to or egress from the escalator at some point of the platform, level or landing surrounding said column at all times, and of a height of an ordinary doorway. Mounted within said column b and concentric therewith is the inner column d which is suitably connected and braced with relation thereto so as to revolve synchronously therewith. These columns b d carry the inclines which actuate the several steps a and the sections which cause them to come to rest on a plane horizontal with the loading or discharging platform, level or landing, as A, which inclines and sections comprise the parallel tracks or rails b' b^2, d' d^2 carried by said columns b d respectively. The said rails b' b^2 d' d^2 preferably are laid in channels formed in or carried by said columns respectively, thus providing both a rail head and an overhead guard for the flanged rollers a^7 a^8. Inasmuch as these rollers are on different horizontal planes, they will track properly on the inclines, but as the steps pass to the level sections of the tracks or rails at each platform, level or landing, it is necessary to provide parallel horizontal tracks to preserve the balance of the steps while on this level section. This I accomplish by continuing the tracks or rails b' d' forming the tread for the upper rollers

a^7 to the level necessary to give the proper elevation to the steps to bring them flush with the loading or discharging platform, and leading said tracks b^2 d^2 forming the treads for the inner rollers a^8 into a horizontal plane parallel with the continuance of the tracks b' d', thus affording the same degree of support as is afforded the steps while on the incline. These tracks or rails b' b^2 d' d^2 extend on a horizontal line parallel to, below and conterminous with the front and rear edges of each opening c and ascend from one said horizontal section to the next such section on a spiral incline of the desired pitch, preferably, as stated, leading from and into said incline by an easement curve to avoid undue acceleration in starting from, or passing to any horizontal section. The several steps a are segmental shaped so as to be capable of being mounted on these tracks or rails, the rollers a^7 a^8 on each side thereof tracking on the incline and being prevented from buckling out of place by the overhead guard afforded by said channels for said tracks or rails, the rollers a^8 on the horizontal section following the tracks b^2 d^2 respectively. A sufficient number of these steps is provided to form a continuous path from a point beyond the rear edge of the uppermost opening c, those steps in each horizontal section being substantially flush with the loading or discharging platforms, levels or landings A, those on the easement curves being vertically advanced slightly relative to the preceding steps, and those on the inclines being so advanced as to form a flight or series of flights of steps which in motion will all have simultaneous vertical movement only, and in the same quantity, to a point forwardly of the fore edge of the lowermost opening c and extending from this point to the uppermost level in a manner to insure the constant return of the steps as they are elevated. The risers a^2 and treads a' are arranged to extend over the axles a^5 a^6 into such close juxtaposition to the walls of the columns b d as to entirely inclose the space between said columns. It will thus be observed that the columns b d serve as a guard for the passengers on the carrying steps a preventing access to or egress from any step through any opening c while said steps are in motion.

The columns b d are continuously rotated by means of a rack e and the power driven pinion f, a safety friction clutch g being provided on the shaft of said pinion between it and its source of power, whereby any crushing strain on the steps a occasioned by the failure of the mechanism to act properly, will merely cause slippage of this clutch, thus cutting off the power. Said columns are provided with a suitable bottom bearing and the column b at the various floor levels is provided with supporting and centering devices, such as the ball bearings b^4 which both serve to relieve the bottom bearing of accumulated weight, and to center the entire structure, so as to prevent lateral deflection with the resultant possibility of disarrangement, and discomfort to users of the escalator.

The steps a being actuated by the wedging action thereon of the inclined tracks or rails b' b^2 d' d^2, it is essential to provide some means holding said steps against horizontal movement under the pressure thereon from said inclines; and in a multiple stage escalator, it is desirable to provide such means in a relation to relieve all other steps than those on each incline from the pressure from that incline, and to so arrange such relieving mechanism as to take up these pressures at a point beyond the first stages of the incline, or easement curve thereof, so as to minimize the friction between the steps when advancing relative to each other to form a full step. In the preferred form, this relieving mechanism comprises racks h on each side of each step a, adapted to mesh with gears i mounted on, carried by and driven at a peripheral velocity equal to that of, the columns b and d respectively, but with the engaging teeth in the opposite direction, by means of a stationary rack j secured permanently in relation to the under side of each platform, level or landing A, and entirely encircling said columns b d, and transmission gearing k in mesh with said rack and said gears i. The steps a in the bottom of the pit between the columns b d rest upon an extension of the tracks b' b^2 d' d^2 extending about the said pit and are held against horizontal movement by the relieving gear mechanism i, as with the inclosed pit shown, the tendency of these steps to rotate with said columns must be counteracted.

Preferably these escalators are to be used in pairs, one for the ascent of the carrying steps and the other for the descent thereof, as such, as shown in Figs. 1 and 2, the construction of which are substantially identical, the difference in their mode of operation amounting to a mere reversal of all the moving parts, and an added operative feature necessary to restore the steps to the starting level. In Fig. 1, I have shown this means as comprising a continuation of the tracks, rails or ways b' b^2 d' d^2 beyond the rear edge of the uppermost opening c extending by a short downward and outward curve into a section having a substantially vertical fall as shown, sufficient to give the steps a during their descent therein, clearance of the succeeding step a and those rising under the influence of the incline of said tracks or rails, and allow a clear field above each step so descending for the next succeeding step. From this point, the tracks are ex-

tended in a slight decline under the topmost horizontal track section, and thence downwardly substantially paralleling the tracks having the upward trend so as to allow the proper head space above the carrying steps, discharging just behind the bottom of the lowermost incline. These descending tracks terminate at a point above the tracks or rails extending about the pit at the bottom of said columns, said last mentioned tracks or rails being provided with an open joint to permit the steps from said descending tracks or rails to drop therefrom into the pit as aforesaid. The steps descend by gravity and in their descent have both vertical and horizontal movement. The vertical fall at the top and at the bottom of the return tracks or rails, involves the crossing of the plane of these tracks, and the formation of a gap in the inner tracks b^2 d^2 sufficient to permit the axle a^5 to pass therethrough. In the descending escalator, the carrying steps descend by a substantially vertical fall, and the lower set of tracks or rails serve as a means to elevate the steps as they are deposited by the upper inclines, through relieving gears as heretofore described, magnets as l l' serving to raise each step the length of the vertical fall of the tracks or rails between the ascending and descending sections thereof at the top and from the pit, to the upper track level, or to the lowermost relieving gears. These relieving gears differ from those used on the ascending escalator, in that they are driven in the reverse direction or with their engaging teeth moving in the direction of the rotation of the columns b d, and at a speed approximately twice the peripheral velocity of the said columns, thus serving to give the steps horizontal movement relative to the floors proportionate to the speed of descent of the carrying steps.

I also provide a curved cut off or scoop as m carried by the columns b d at the forward edge of the bottom opening c or the rear edge of any other such opening, extending across the treads of the steps a and from column to column, thereby preventing anybody from passing that point of the path formed by said steps. The cut off is formed as shown in order to eject any person or object on a step a over which the cut off or scoop passes. These cut offs or scoops limit the operative scope of the escalator, their arrangement being such as to not interfere with the vertical rise or fall of the individual steps a. With the descending escalator, the position of these scoops will be reversed as to the edge of the openings c, which position is determined solely with relation to the direction of rotation of the columns.

Owing to the difficulties of making a clear showing of the invention in the drawings, I have not illustrated any system of braces, or connections between the columns b d, illumination or other purely mechanical details, it being understood that such may be of any desired character. It is desirable to provide a ceiling for the carrying steps which may take the form of a helical plate metal brace.

In the modification shown in Figs. 7, 8 and 16, I have shown the application of the invention to a single stage escalator. In this form of the invention, the columns b d are of larger diameter than those of the preferred form and are rotated by a carriage as n carrying ascending inclined tracks n', a horizontal section n^2 on the level above, and descending tracks or rails n^3 on the opposite end of the carriage. The arrangement of these tracks, and the manner of spreading same, is as heretofore described, the reverse incline n^3 however, requiring that they should remain spread thereon, instead of running together on the same horizontal plane for the next incline as in the preferred form of the invention. The column b has an opening therein for any desired distance in advance of the incline n' and beyond the decline n^3 on the lower platform, level or landing and for the entire length of the horizontal section n^2 on the upper platform, level or landing. The relieving mechanism in this form of the invention, comprises a socket as n^4 in the side webs a^3 of each step, and corresponding pins or studs n^5 arranged successively in the pit at the bottom of said columns and between them, for the steps.

In the modification shown in Figs. 9 to 12 inclusive, I have shown the application of the invention to a single stage escalator. In this form of the invention, I employ a plurality of substantially rectangular steps a disposed in a substantially straight pit on the lower platform, level or landing, which are actuated by a reciprocating carriage o having ascending inclined tracks or rails o', a horizontal section o^2 on the level above, and descending inclines o^3 on the opposite end of the carriage. The general arrangement of these tracks or rails and the manner of spreading same, is as heretofore described except that they extend on a straight away course instead of in a helical incline. As in the modification shown in Figs. 7, 8 and 16, the tracks or rails remain spread on the descending incline o^3. Both ends of the pit p are inclosed by an immovable inclosure for a distance equaling the length of an incline o' or o^3, and the carriage o is also inclosed. The upper platform, level or landing A has mounted thereon telescoping partitions as q q', the outer end element of each of which is secured to the top of opposite ends of the level section o^2 thus providing an opening on each side of and conterminous

with said section, whatever the position of the carriage. The under side of each web a^3 is cut away on an angle corresponding with the pitch of the inclines o' and a rack r is set therein, which rack is in mesh with each relieving gear r' carried by the carriage o and driven through the movement thereof, or the mechanism driving said carriage, at a peripheral velocity equaling the direct movement of said carriage, but with the engaging teeth moving in the direction opposite that of said carriage.

In the modification shown in Figs. 13 to 15 inclusive, I have illustrated another arrangement for restoring the steps to the starting level, capable of use with the general form of structure used in the preferred form of the invention. In this modification, the track or rails b' b^2 d' d^2 extend in a gradual curve from the ascending to the descending tracks or rails, instead of by a short curve to cause a sudden advance of the step relative to the succeeding step, and then a short substantially vertical fall, to allow space for the succeeding step. The descending tracks or rails, as in the preferred form, are below the ascending, and have a direction substantially parallel thereto to afford sufficient space above the ascending steps. In this form of the invention, the steps a on their return are inverted, being restored with the tread upward by a reverse curve as at the uppermost level. To facilitate the taking of the curves aforesaid and the restoration of the steps to their normal position in carrying, I join them together by links s s pivotally connected to each of the adjoining steps, which are capable of such extension as will permit the several steps to receive in their ascent that vertical projection relative to each other, as is requisite to permit them to take the incline and form the flight of steps between the several platforms, levels or landings, and so restrict the movement of the steps in taking the curves of the tracks at both the top and the bottom of the escalator, as to cause them to assume the inverted position, and to be restored to their normal position. I bevel off the under forward edge of each step, as shown, to provide a suitable clearance for said links.

The operation of the preferred form of the invention is substantially as follows: The various columns and steps having been installed as described, power is applied to rotate the columns b d and with them the tracks or rails b' b^2 d' d^2 through the rack and pinion mechanism described, and in the direction indicated by the horizontal arrows in the drawings. The movement of the tracks or rails b' b^2 d' d^2 relative to the steps a will at the levels sections of said tracks or rails permit said steps to remain perfectly stationary, and at the inclines exert a wedging action thereon which will give the said steps a substantially vertical movement, as indicated by the vertical arrows Fig. 1, inasmuch as the steps are held against all horizontal movement by the various relieving means. The gears i will, through the transmission gearing k, actuated by the rotation of the columns b d relative to the stationary racks j, be driven with the teeth thereof in mesh with the racks h on any step, moving in a direction opposite to that of the columns b d carrying them, and at a peripheral velocity equaling that of the said columns respectively, thus counteracting any tendency of the steps on the incline and level above them, to move with said columns. These steps, it will thus be observed, are always held in the same vertical plane, so that on the level sections of the tracks or rails they will have absolutely no movement relative to the loading or discharging platforms, levels or landings, and as the openings c are conterminous with said level sections, persons may pass to or from any platform, level or landing A from or to steps a having no movement relative thereto, through the full extent of any said opening c; and as the columns b d rotate, successive steps are exposed by the movement of the curved cut offs or scoops m thereover, or reach any level section at the top of the inclined sections of the tracks or rails, thus presenting at all times upon each landing or discharging platform, level or landing A means at some point of the escalator whereby access may be had to or egress may be had from the steps, thus insuring continuity of its operation. The steps a being raised from one level to another by inclines extending from one level section to another, it is apparent that these inclines and level sections may be multiplied to any reasonable extent, permitting the transportation of the steps a and their burdens to any desired height. The easement curve at the bottom of each incline serves to produce a gradual acceleration of the successive steps, thus avoiding a sudden jar at the start of the rise, and the easement curve at the top of the inclines, produces a gradual reverse acceleration, avoiding a jar when said steps change from the vertical movement to a stationary condition on the level section of the tracks or rails. The arrangement of rollers and the spreading of the tracks at the top of each incline, prevents toppling or jarring thereof as the tracks or rails engaging each step change from an inclined to a horizontal section of track. The upper roller a^7 and the lower roller a^8 being set on different vertical planes as described, permits this spreading of tracks. Undue friction and binding of the steps during this acceleration is prevented by the aforesaid relieving gears, which take up all strains at

a point beyond that at which said steps are so accelerated, thus tending to allow the formation of a slight space between the steps on the easement curve. When the steps reach the uppermost level, they remain stationary until the cut off or scoop on that level passes over any step, ejecting therefrom any person or object thereon. Thereafter the steps pass to the descending tracks or rails b' b^2 d' d^2, the short curve serving to give a small lead to each step sufficient to permit it to drop down the vertical fall in the tracks and allow time for the step to pass below the succeeding step before that step passes into said vertical section of track. The steps through gravity thereafter move on the descending inclines, both horizontally and vertically as indicated by the inclined arrows Fig. 1, or if desired relieving gears acting thereon may be used to impart or permit movement thereto or thereof along said tracks or rails until they reach the end of the tracks or rails, whereupon they drop into the rails in the pit at the bottom of said columns directly behind the downwardly projected ends of the lowermost inclines. This pit supports the several steps which are held against movement with the columns by the lowermost set of relieving gears in the manner heretofore described.

The power driving the supports for the inclines, being derived through a friction clutch set below the crushing strength of the various steps and rail supports therefor, any jamming of said steps will result in the stoppage of the rotation of said rails or tracks, and the cessation of the vertical movement of the steps. As the steps in their vertical movement form a flight of steps or stairs between the several platforms, levels or landings respectively, such stoppage merely results in the establishment of a permanent stair or stairs from level to level, by which the occupants may reach any platform, level, or landing A.

The cylinders b d form a guard for all the steps a while they are in motion, and these steps are so fitted in relation to each other as to avoid any possibility of accident to an occupant or object at either end of an incline through the movement of the steps relative to each other.

In the descending escalator, the mode of operation is the reverse of that of the ascending one, thus permitting the carrying steps to descend from the upper levels to the lower, by a vertical fall through the recession of the inclines as indicated by the arrows Fig. 2, the relieving gears holding said steps so as to prevent any horizontal movement thereof. The restoration of the steps to the starting or upper level, however, requires that these steps should have a direct vertical rise at both the bottom and the top of the return tracks, and that their ascent should be against gravity. The magnets l l' impart this direct vertical rise, and the relieving gears in connection with these tracks, not only prevent their descending, but through their higher velocity actually drive them up the return tracks or rails, as indicated by the inclined arrows Fig. 2. While the movement of these gears is described as being approximately twice the peripheral velocity of the columns b d respectively, it is apparent that the exact speed may have to be varied to meet the requirements of the conditions of use.

It will thus be observed that the motion of any given step a in use as a carrying step for ascending purposes, will be from a stationary level, to a point vertically above it, where it will come to rest during an interval corresponding with the length of the level section, and again vertically upwardly to successive levels in this manner, then downwardly with a horizontal component of motion, to the starting level, thus being used repeatedly as required. The speed of operation may be run up as desired, it being purposed to run at about the rate of two hundred steps per minute.

In the modification shown in Figs. 7, 8 and 16, as the carriage n is driven about its circular track carrying with it the columns b d, vertical movement is imparted to the several steps a by the inclined tracks or rails n' while they remain stationary on the level section n^2 and are permitted to descend through the withdrawal of the incline n^3 from thereunder, thus utilizing the steps being returned to the starting level as carrying steps. The sockets n^4 and spurs n^5 hold each step a in the pit and all steps on the incline n' and level section n^2 against horizontal movement.

In the modification shown in Figs. 9 to 12 inclusive, the mode of operation is substantially the same as that of the form shown in Figs. 7 and 8 except that the carriage reciprocates, first using one set of steps for ascending carriers, and then on the return reciprocation, for descending carriers. The relieving mechanism of this form of the invention is substantially the same in mode of operation as in the preferred form of the invention. The telescoping partitions q q' open and close with the movement of the carriage o limiting the opening by which access may be had to or egress from, the escalator to the length of the level track section o^2.

In the modification shown in Figs. 13 to 15 inclusive, the operation is identical with that of the preferred form of the invention, except that of the step return. In this modification, the steps leave the uppermost level track section and pass around the curve of the track, assuming the inverted position, the

links *s s* holding the lower edges of the steps so as to insure their taking the curve properly. As the steps are accelerated relative to each other, the extension of these links serves to permit such movement, the under bevels of the steps allowing a free field for the vertical swing of the said links on their pivots.

It is not my intention to limit the invention to the precise details of construction shown in the drawings. I believe it to be broadly new to provide an escalator wherein the carrying steps at the point of access and egress are stationary relative to the loading and discharging platform, level or landing during the uninterrupted operation of the device, and I intend to claim such broadly. It is also apparent that the details of construction shown in the drawings may be varied without departing from the spirit and scope of the invention.

Having described the invention, what I claim as new and desire to have protected by Letters Patent is:

1. In an escalator, a plurality of independently movable steps, an incline adapted to actuate said steps and means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively.

2. In an escalator, a plurality of independently movable steps, means whereby said steps are held against horizontal movement, an incline and a substantially level section movable therewith adapted to successively actuate said steps and means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively, and said steps are permitted to remain stationary on said level section.

3. In an escalator, a plurality of independently movable steps, an incline adapted to actuate said steps, means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively, and means whereby said steps are restored to their starting level after reaching their limit of progression.

4. In an escalator, a plurality of independently movable steps, means whereby said steps are held against horizontal movement, an incline adapted to actuate said steps, means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively, and means whereby said steps are restored to their starting level after reaching their limit of progression.

5. In an escalator, a plurality of independently movable steps, an incline adapted to actuate said steps, means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively, and a guard movable with said incline and disposed on opposite sides of said steps having openings therethrough communicating with the several loading and discharging platforms, levels or landings.

6. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, and means rotating said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement.

7. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, means rotating said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, and means whereby said steps are held against horizontal movement.

8. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, and a return track extending from the uppermost to the lowermost level, and means rotating said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement.

9. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, and a return track extending from the uppermost to the lowermost level, means rotating said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, and means whereby said steps are held against horizontal movement.

10. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately and connected by easement curves, and means rotating said tracks whereby said steps are alternately permitted to remain stationary, and to receive substantially vertical movement with a gradual acceleration relative to each other.

11. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, and a return track extending from the uppermost to the lowermost level, concentric cylindrical columns supporting said tracks having opening therethrough corresponding in position to said track levels and communicating with the several platforms, levels or landings, means rotating said columns and said tracks

whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, and means whereby said steps are held against horizontal movement.

12. In an escalator, a plurality of independent steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately and connected by easement curves, and a return track extending from the uppermost to the lowermost level, concentric cylindrical columns supporting said tracks having openings therethrough corresponding in position to the track levels and communicating with the several platforms, levels and landings, means rotating said columns and said tracks whereby said steps are alternately permitted to remain stationary, and receive substantially vertical movement with a gradual acceleration relative to each other, relieving gears carried by said columns beyond said easement curves, racks carried by said steps respectively adapted to mesh with said gears, transmission gearing actuating said relieving gears and means actuating said transmission gearing.

13. In an escalator, a plurality of independently movable steps, an incline adapted to actuate said steps, means actuating said incline, a relieving gear carried by said means actuating said incline, racks carried by said steps respectively adapted to mesh with said gears, and means whereby said gears are driven at a velocity equaling the travel of said incline, with the teeth thereof engaging said racks moving in a direction opposite to that of the travel of said incline, whereby said steps are held against horizontal movement.

14. In an escalator, a plurality of independently movable steps, means whereby said steps are held against horizontal movement, inclined tracks adapted to actuate said steps, an overhead guard for said tracks respectively whereby said steps are prevented from leaving said tracks, and means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively.

15. In an escalator, a plurality of independent steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately and connected by easement curves, and a return track comprising a short outward curve extending from the uppermost level, a substantially vertical section, and sections substantially paralleling and beneath the tracks actuating the carrying steps, discharging into the lowermost level, concentric cylindrical columns supporting said tracks having openings therethrough corresponding in position to the track levels and communicating with the several platforms, levels or landings, means rotating said columns and said tracks whereby said steps are alternately permitted to remain stationary, and receive substantially vertical movement with a gradual acceleration relative to each other, relieving gears carried by said columns beyond said easement curves, racks carried by said steps, respectively adapted to mesh with said gears, transmission gearing actuating said relieving gears, and means actuating said transmission gearing.

16. In an escalator, a plurality of independent steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately and connected by easement curves, and a return track comprising a short outward curve extending from the uppermost level, a substantially vertical section and sections substantially paralleling and beneath the tracks actuating the carrying steps, discharging into the lowermost level, magnets adjoining and above the discharge point of the substantially vertical sections and above the discharge point at the lowermost level, and relieving gears driving said steps up said tracks, concentric cylindrical columns supporting said tracks having openings therethrough corresponding in position to the track levels and communicating with the several platforms, levels or landings, means rotating said columns and said tracks whereby said steps are alternately permitted to remain stationary, and receive a substantially vertical movement with a gradual acceleration relative to each other, relieving gears carried by said columns beyond said easement curves, racks carried by said steps, respectively adapted to mesh with said gears, transmission gearing actuating said relieving gears, and means actuating said transmission gearing.

17. In an escalator, a plurality of independently movable steps, a continuous track for said steps comprising therein a succession of substantially circular levels and helical inclines arranged alternately, and a return track extending from the uppermost to the lowermost level, concentric cylindrical columns supporting said tracks having openings therethrough corresponding in position to said track levels and communicating with the several platforms, levels or landings, centering supports for said columns on the various platforms, levels or landings, means rotating said columns and said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, and means whereby said steps are held against horizontal movement.

18. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succes-

sion of substantially circular levels and helical inclines arranged alternately, and a return track extending from the uppermost to the lowermost level, concentric cylindrical columns supporting said tracks having openings therethrough corresponding in position to said track levels and communicating with the several platforms, levels or landings, means rotating said columns and said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, means whereby said steps are held against horizontal movement, and a cut-off or scoop carried between and rotatable with said columns in a relation to any of said openings therethrough to prevent objects passing said opening.

19. In an escalator, a plurality of independently movable steps, a continuous track for said steps embodying therein a succession of substantially circular levels and helical inclines arranged alternately, means rotating said tracks whereby said steps are alternately permitted to remain stationary and to receive substantially vertical movement, and a safety appliance disposed between said means and a source of power whereby resistance beyond a predetermined amount will render such means inoperative.

20. In an escalator, a plurality of independently movable steps, an incline adapted to successively actuate said steps and a substantially level section movable therewith, means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively and said steps are permitted to remain stationary on said level section, a return incline leading from and into said other incline by a substantially vertical rise or fall whereby said steps are restored to their starting level after reaching their limit of progression, and magnets located above the said substantially vertical sections of said return incline, whereby the steps are severally raised from and into the lower and the upper levels.

21. In an escalator, a plurality of independently movable steps, an incline adapted to successively actuate said steps and a substantially level section movable therewith, means actuating said incline whereby said incline imparts a substantially vertical movement to said steps and said steps are permitted to remain stationary on said level section, and a cut-off or scoop disposed above said level section and the steps thereon whereby passage beyond a predetermined point of said escalator is prevented.

22. In an escalator, a plurality of independently movable steps, parallel level sections connected by an incline adapted to permit said steps to remain stationary and to actuate said steps respectively, and means actuating said incline whereby said incline imparts a substantially vertical movement to said steps respectively.

In witness whereof, I have hereunto affixed my signature this 25 day of January, 1906, in the presence of two witnesses.

GEORGE L. BENNETT.

Witnesses:
F. T. WENTWORTH,
WM. H. BLAIN.