April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 1

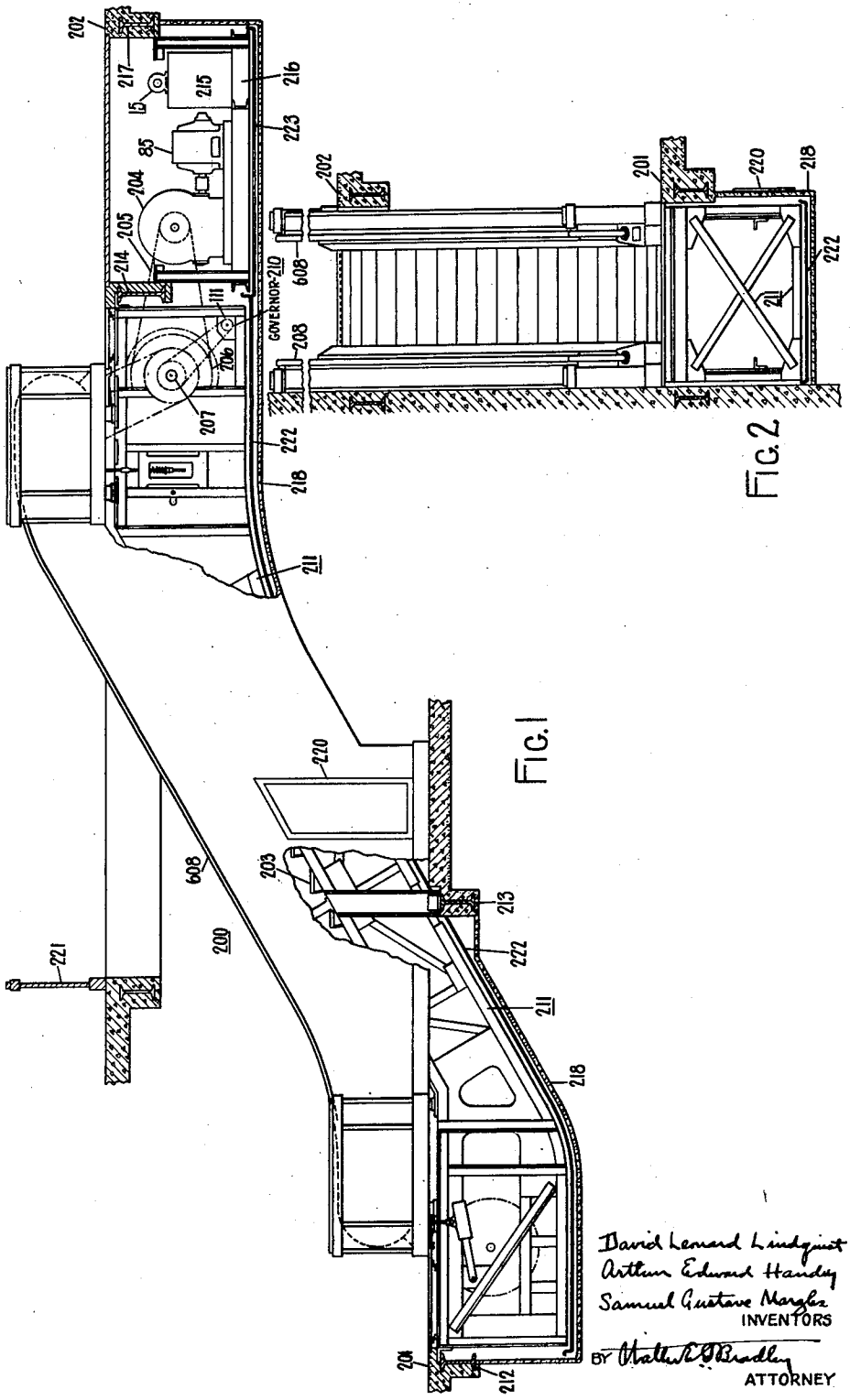


FIG. 2

FIG. 1

David Leonard Lindquist
Arthur Edward Handley
Samuel Gustave Marglen
INVENTORS

BY Walter S. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 2

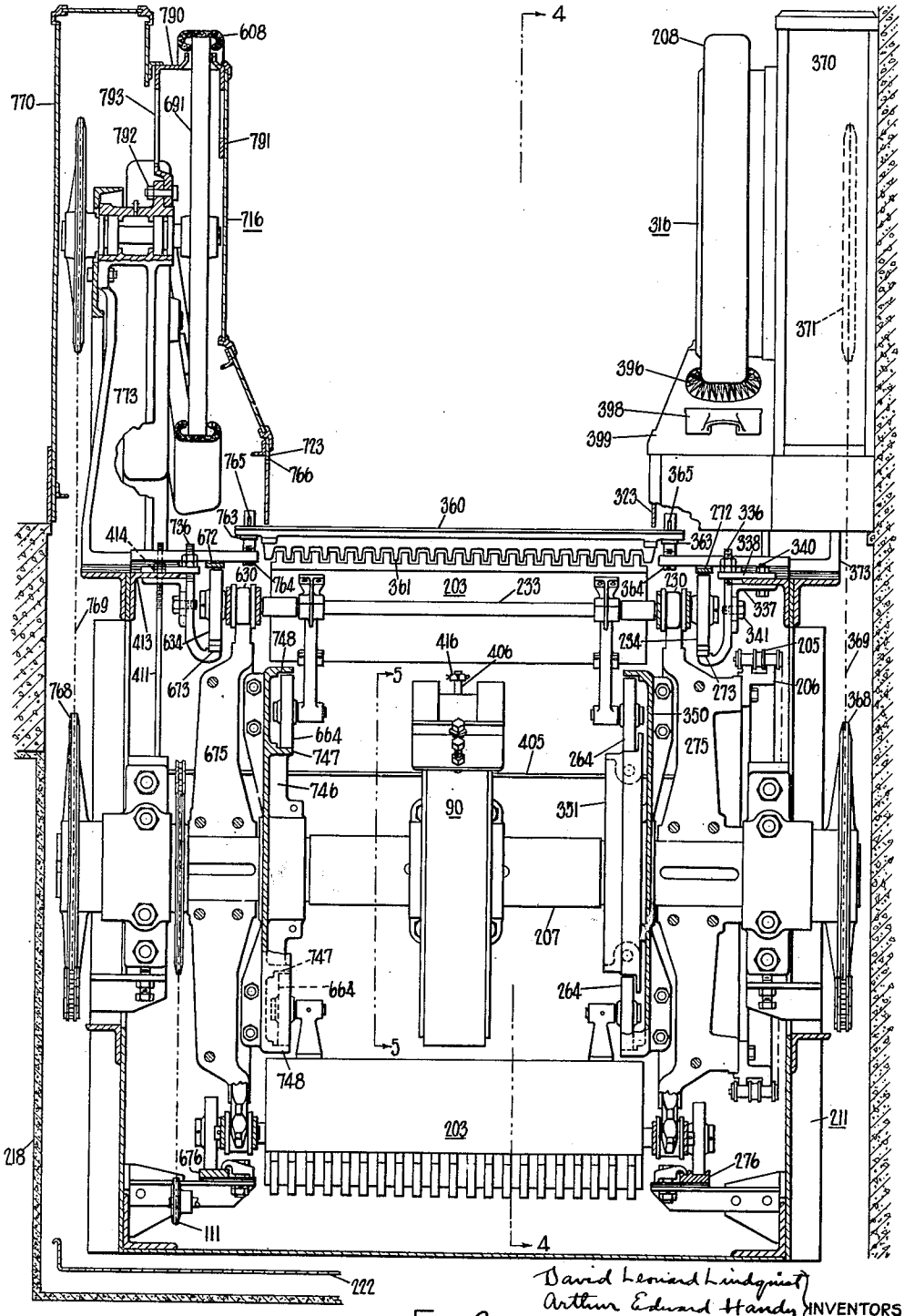


FIG. 3

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangle
INVENTORS

BY Walter E. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 3

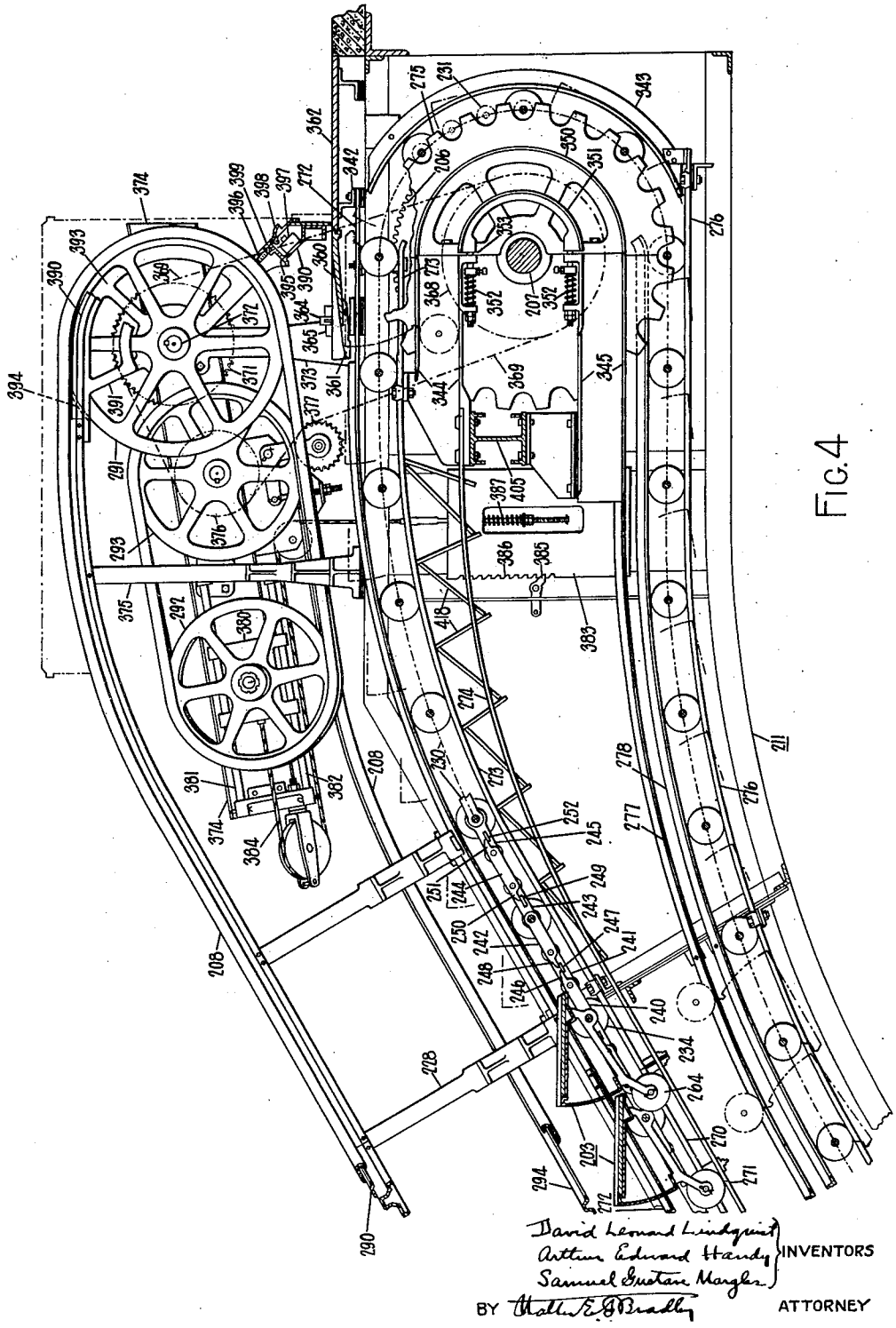


FIG. 4

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustav Magler
INVENTORS

BY Walter E. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 4

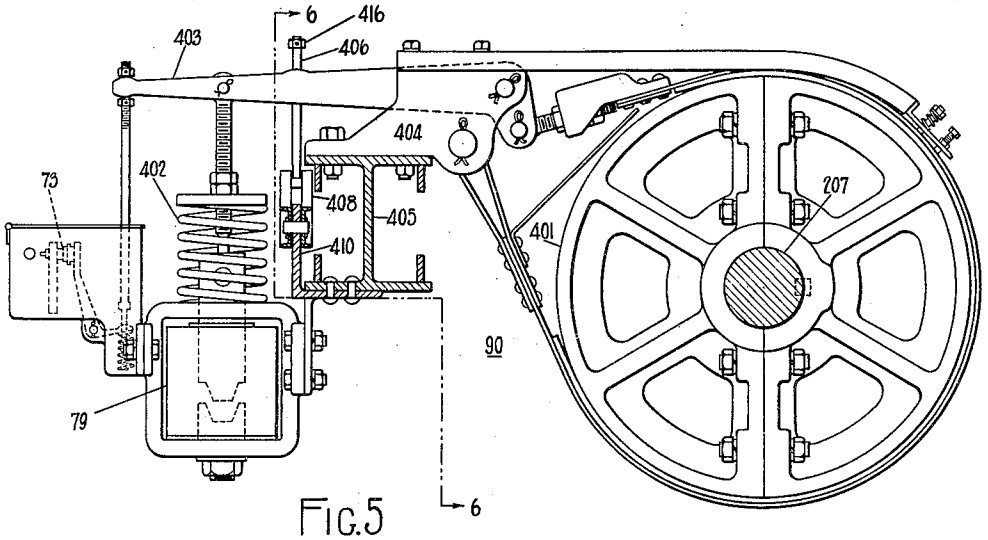


FIG. 5

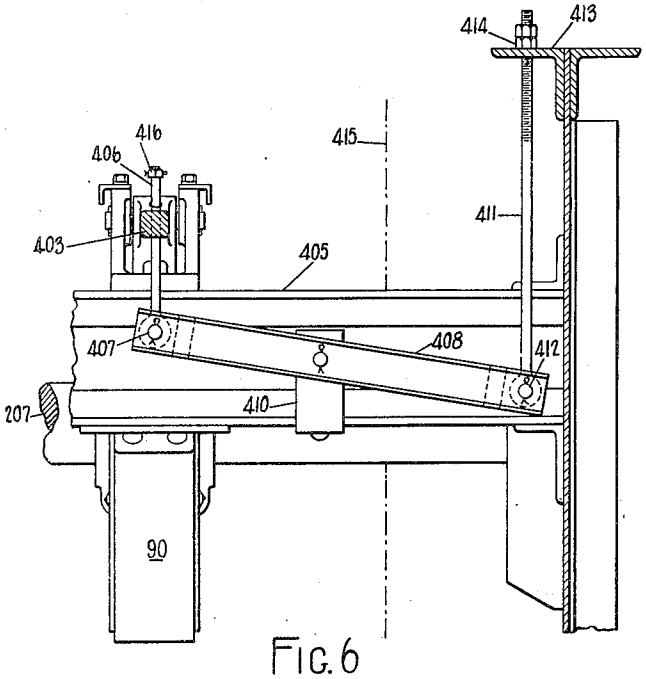


FIG. 6

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangle
} INVENTORS

BY Charles T. Bradley ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 5

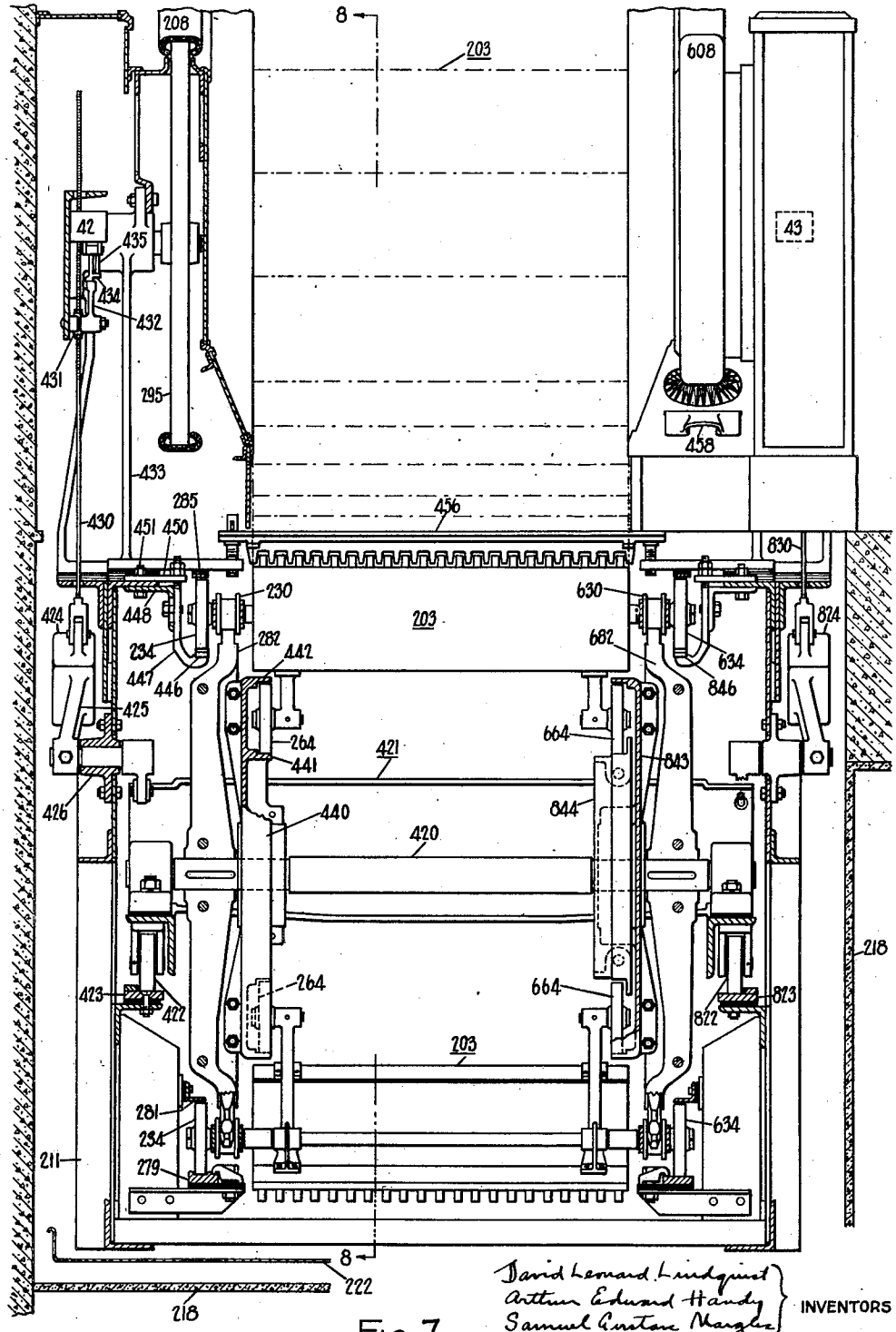


FIG. 7

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangles
INVENTORS

BY Wallace G. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 6

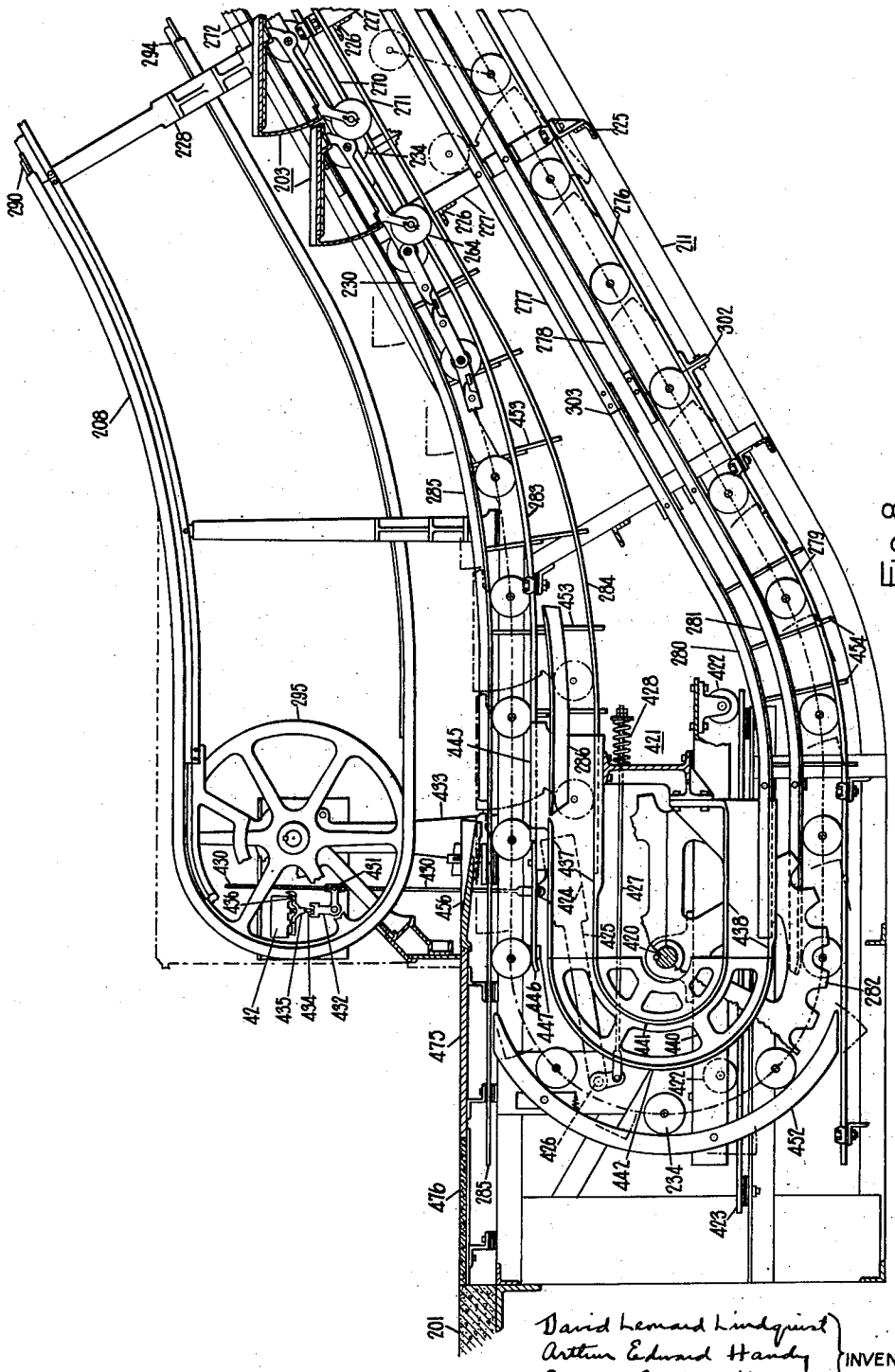


FIG. 8

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangle
INVENTORS

BY Walter T. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 7

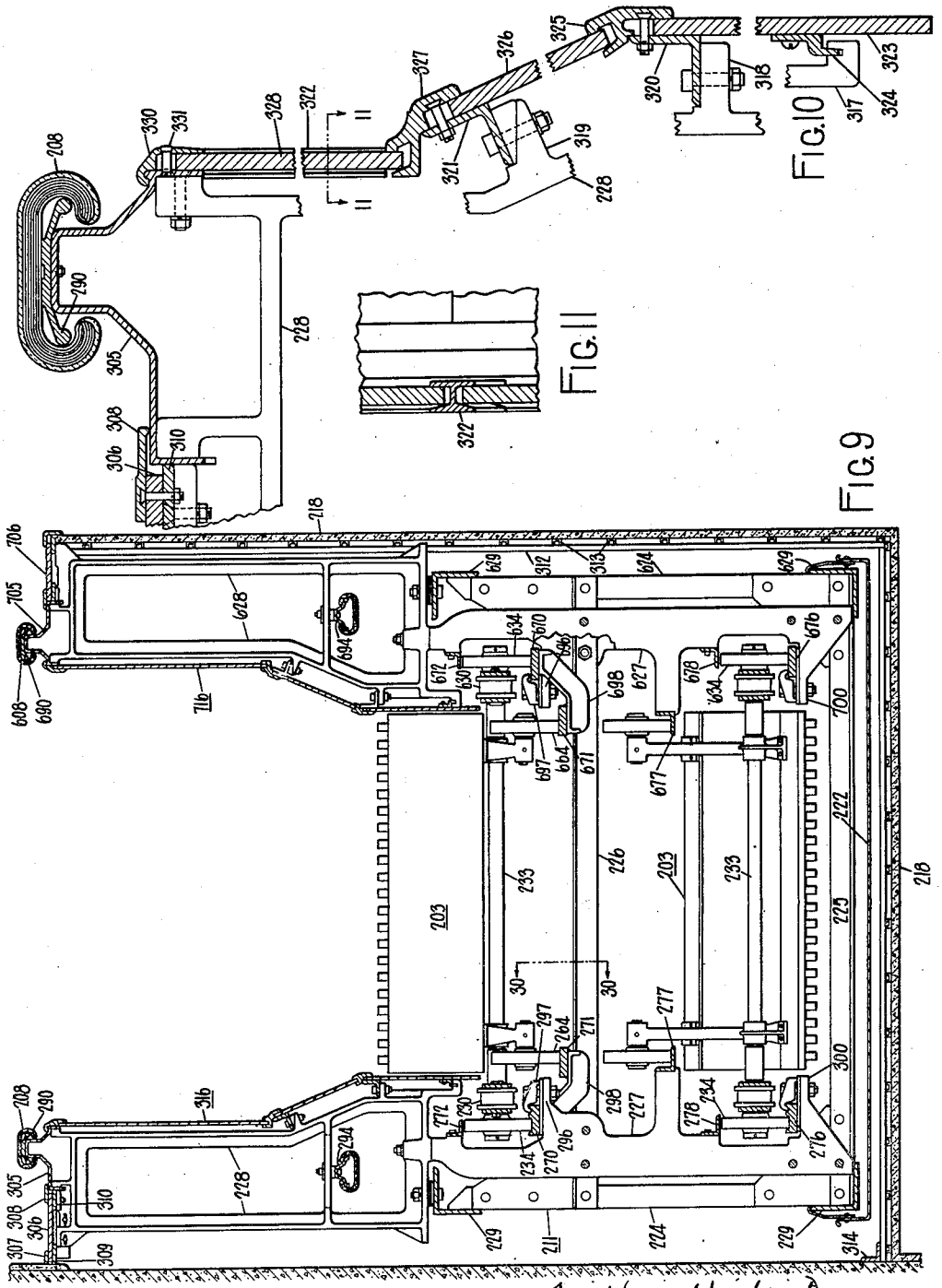


FIG. 10

FIG. 11

FIG. 9

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangel
INVENTORS

BY Matthew C. Bradley
ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 8

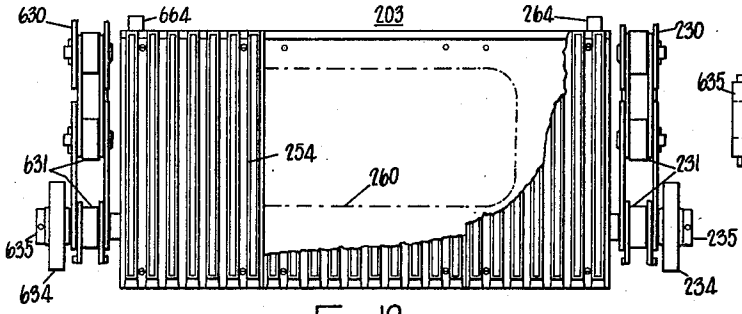


FIG. 12

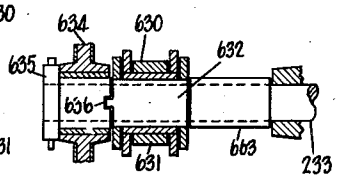


FIG. 15

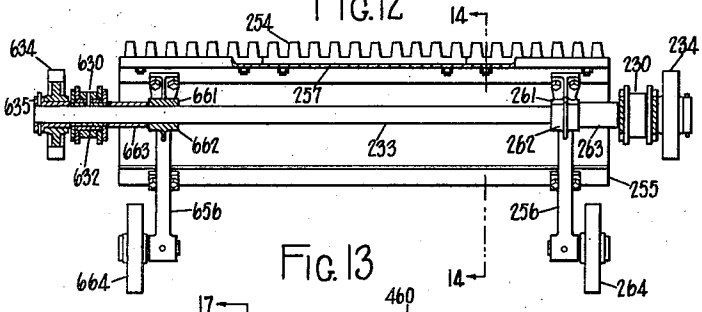


FIG. 13

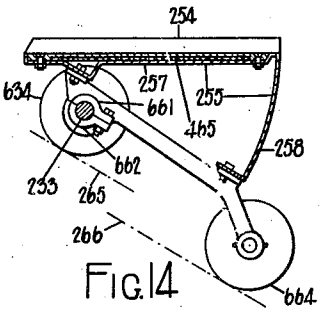


FIG. 14

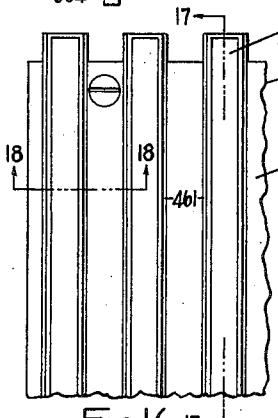


FIG. 16

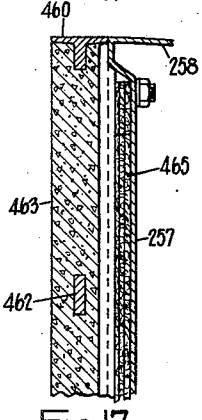


FIG. 17

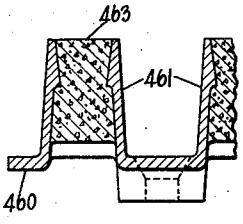


FIG. 18

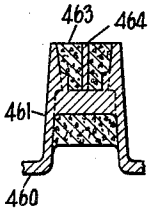


FIG. 21

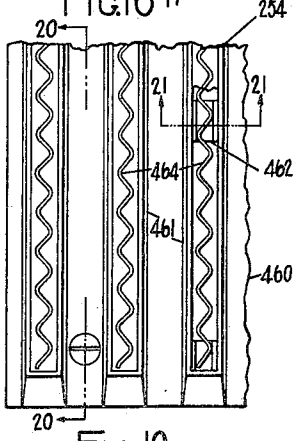


FIG. 19

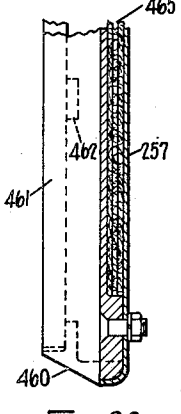


FIG. 20

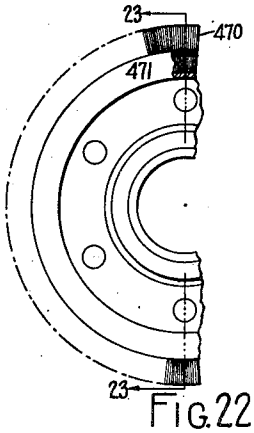


FIG. 22

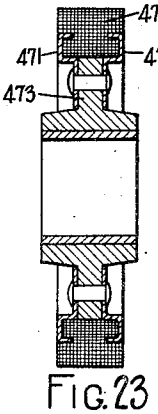


FIG. 23

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mayer
} INVENTORS

BY Hall & Bradley ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 9

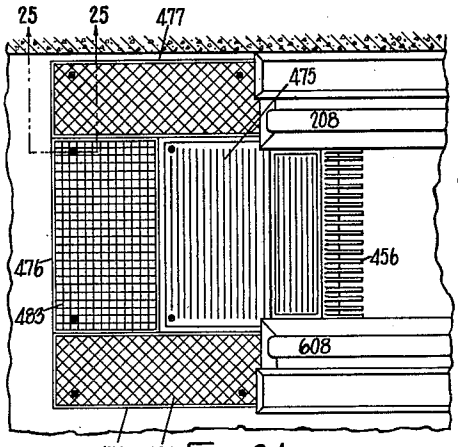


Fig. 24

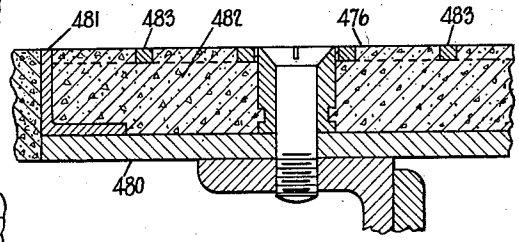


Fig. 25

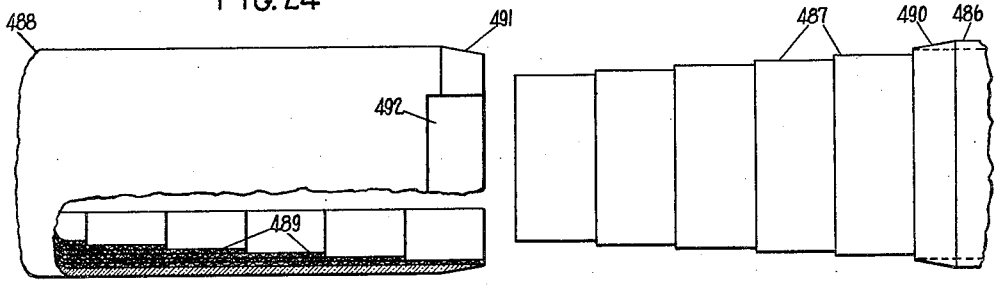


Fig. 26

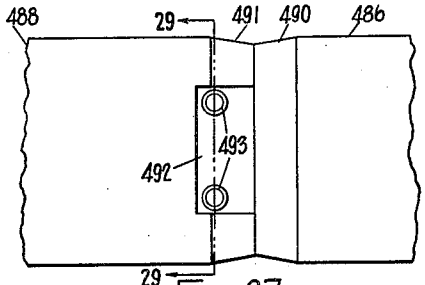


Fig. 27

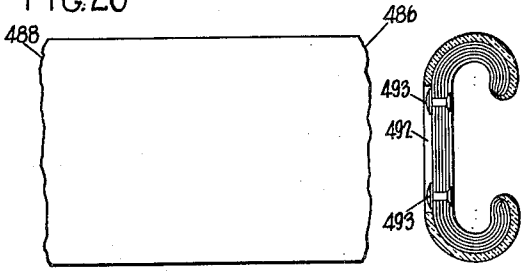


Fig. 28

Fig. 29

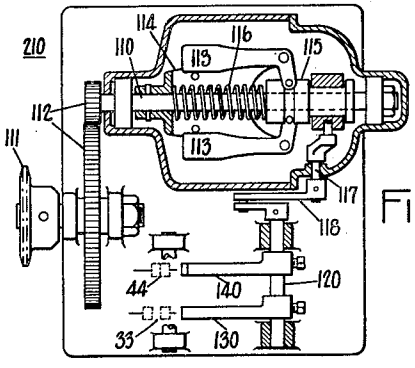


Fig. 31

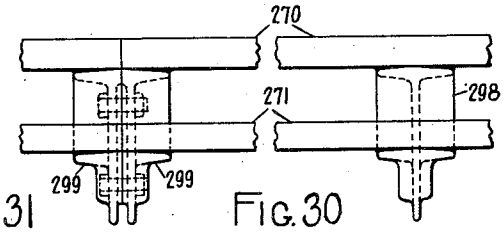


Fig. 30

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Maeglin
} INVENTORS

BY Walter C. Bradley ATTORNEY

April 24, 1934. D. L. LINDQUIST ET AL 1,956,153

MOVING STAIRWAY

Filed Sept. 22, 1932 10 Sheets-Sheet 10

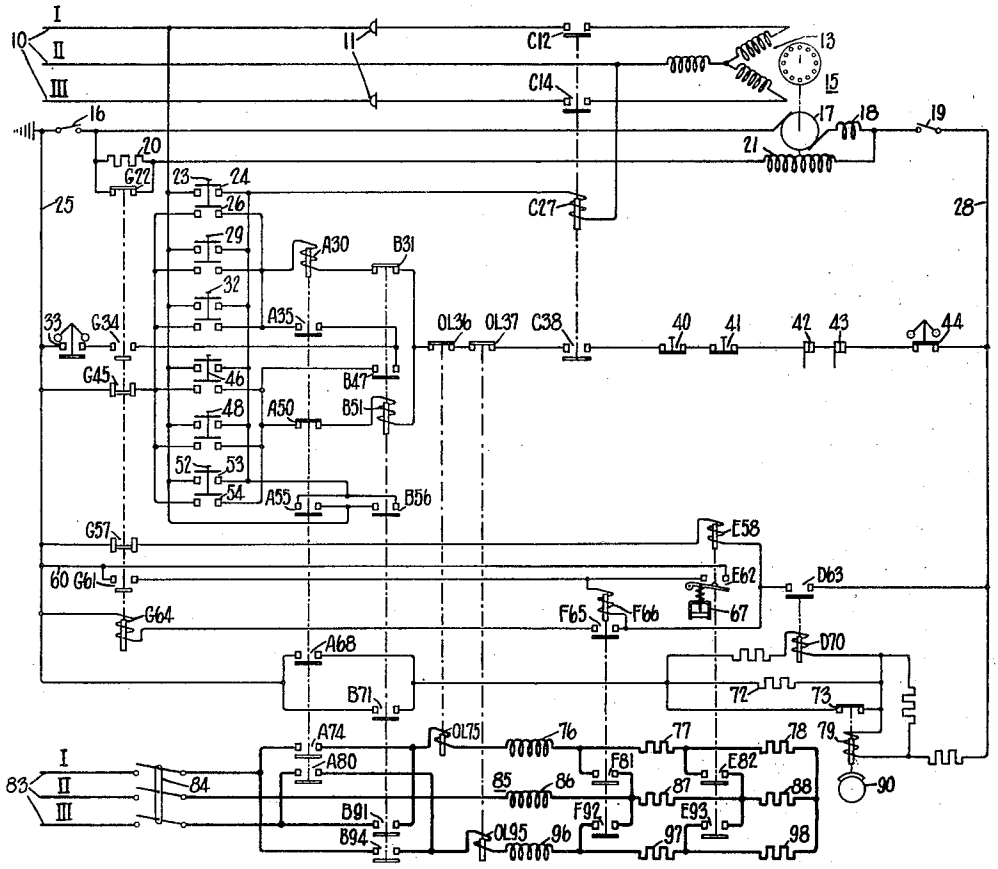


FIG. 33

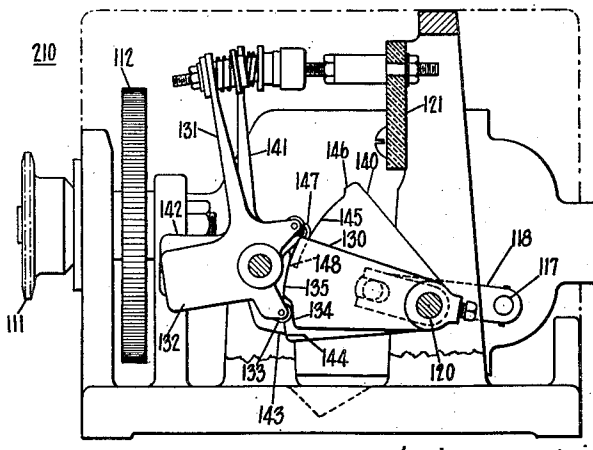


FIG. 32

David Leonard Lindquist
Arthur Edward Handy
Samuel Gustave Mangler
} INVENTORS

BY Mallon & Bradley ATTORNEY

Patented Apr. 24, 1934 1,956,153

UNITED STATES PATENT OFFICE

1,956,153

MOVING STAIRWAY

David Leonard Lindquist, Hartsdale, Arthur Edward Handy, Lynbrook, and Samuel Gustave Margles, Brooklyn, N. Y., assignors to Otis Elevator Company, New York, N. Y., a corporation of New Jersey

Application September 22, 1932, Serial No. 634,338

25 Claims. (Cl. 198—16)

This invention relates to moving stairways.

It is the object of this invention to provide a moving stairway which is noiseless, is particularly adapted for high speed operation, and is economical to manufacture, install and maintain.

Among the features of the moving stairway in accordance with this invention are the following:

Two equal-lengthed running gear chains, one at each side of the stairway, are connected at regular intervals by a series of uniformly spaced step axles, each step axle extending through corresponding hollow chain pins in the chains at opposite sides of the stairway. To each of such step axles, between the two running gear chains, is removably mounted a step, while on the portions of each of such step axles projecting out on either side of the stairway beyond the corresponding running gear chain are mounted two step wheels, for convenience hereafter identified as the chain wheels. A unitary endless loop is thereby formed of the two connected running gear chains, from which loop any step or number of steps may be removed and replaced with ease, and without opening up either running gear chain or removing the step axle or axles connecting the running gear chains. Further, any one or more of the chain wheels on either side of the stairway may be removed and replaced with equal ease without opening up either running gear chain or removing any step axles. In addition, not only may uniformly pitched running gear chains be employed so that the sprocket wheels for such chains at the upper and lower landing are formed with uniform teeth, but the pitch of the running gear chains and the size of the chain wheels are not interdependent, so that the optimum size for each may be employed.

Tracks are provided for the chain wheels both while the steps are on the upper and while on the return runs of the stairway, with each set of chain wheel tracks extending at least up to and slightly beyond the points at which the running gear chains engage with and disengage from the sprockets therefor at the upper and lower landings. In this manner, it is assured that each step is supported by its chain wheels until after the support of such step is fully assumed by the sprocket wheels as a result of the engagement of the running gear chains therewith, and that the support of each step, prior to the termination of its support by the sprocket wheels, due to the disengagement of the running gear chains therefrom, is fully resumed by its chain wheels.

In addition, it is preferred that the ends of the chain wheel tracks be adjustable vertically so as to insure that the running gear chains enter and leave the sprocket wheels therefor tangentially. As a result of these provisions, it has been found that the moving stairway is very quiet in operation.

Each step axle connecting the running gear chains at either side of the stairway is preferably free to rotate with respect to such chains, to the chain wheels mounted thereon, and to the step secured thereto. In the event, however, that the step axles display a tendency to rotate with the chain wheels, due, for example, to a possible predominance of the friction between the chain wheels and the step axles over the friction between the chains and the step axles, such rotation of the step axles may be prevented, if desired, by suitably interlocking the chains to the step axles.

The two remaining step wheels for each step, for convenience hereafter identified as the trailer wheels, are located adjacent either side of such step and run upon trailer wheel tracks both while the steps are on the upper and while on the return runs of the stairway. To guide the trailer wheels while the steps are passing around the sprocket wheels at the upper and lower landings, substantially semi-circular guides, each with an inner and an outer track flange, are provided. At at least one of the two landings the inner track flange at one side of the stairway is flexibly supported through the medium of springs so that they urge such inner track flange outwardly. A cramping action of the steps thereby results which takes up clearance and lost motion and eliminates knocks as the steps pass around the sprocket wheel. In the event such cramping action is employed at both the upper and lower landings, it is preferred that the cramping action be effected on one side of the stairway at one landing and on the other side of the stairway at the other landing.

The chain wheel tracks are preferably cold rolled strips of steel clamped to suitable supports along the stairway, with the tracks at one side of the stairway having a groove formed therein so as to guide the corresponding set of chain wheels, and thus guide the steps. The trailer wheel tracks are either flat cold rolled steel strips clamped to suitable supports along the stairway, or angle strips secured along the stairway through their vertical sides. By means of this construction each track has a smooth, even surface over which roll the appropriate set of step wheels, irregulari-

ties such as bolt holes and bolt heads being particularly absent. Furthermore, such a track construction readily lends itself to fabrication in units prior to shipment from the factory, so that not only are erection costs of such track units small, but the complete track installation is accurately spaced and aligned.

The step wheels are preferably provided with a canvas or fabric tread formed of a series of canvas, or other fabric, squares radially supported around the circumference of a rotatable disc so that the edges of the squares constitute the rolling surface of each wheel. Noiseless wheels therefore result. In addition, due to the comparatively large coefficient of sliding friction between canvas, or such other fabric as is employed, and the tracks, it is assured that the step wheels roll upon the tracks, rather than slide thereon and develop flat spots.

The frame of each step is formed of sheet material, such as steel, pressed into shape so as to provide a curved step riser and a portion upon which removable tread plates are mounted. Each tread plate is preferably die cast from zinc alloy, with the side walls of cleats formed therein. The resulting hollow cleats are filled with a suitable plastic stone, which, after hardening, provides a durable wearing surface for the cleats and one which can withstand considerable abuse. In addition, a completely fireproof step is obtained. If still longer life for the cleats is desired, a corrugated steel strip may be placed on edge in each cleat.

One or more of the step frames is provided with an opening through the tread support so that, when the tread plates for such step or steps are removed, access may be had therethrough to the inner parts of the stairway.

The combplates at the upper and lower landings under which each step passes have their toothed ends vertically adjustable so that the teeth may be made to mesh properly with the recesses between the cleats in the tread plates on the steps. This vertical adjustment is preferably obtained by rotating each combplate about its base end, where it is suitably supported to permit such rotation. In addition, the toothed end of each combplate is preferably secured to its adjustable supports so that it can quickly be released therefrom without the use of tools. Thus, in an emergency, the combplate can be quickly and readily raised to release anything that may have become wedged between the combplate and a step.

One brake is provided for the stairway and the driving motor, such brake being mounted between the two driving sprockets at the upper landing for the running gear chains, with the brake drum secured to the same shaft to which such two driving sprockets are secured. Such brake—preferably of the spring-applied, electromagnetically-released band type—is applied whenever the stairway is stopped, whether intentionally or by reason of the operation of any safety device. As a result of these provisions, a separate brake for the driving motor is unnecessary and space requirements at the upper landing are reduced. In addition, it is assured that the brake is in condition to respond effectively to the operation of any safety device at any time.

A member is provided at the upper landing extending laterally from the brake—which, being between the two sides of the steps, is enclosed by the loop of steps at the upper landing—to one side of the stairway outside the line of the steps. This member is supported upon the stairway truss and connected to the brake in such a manner that when the outer end of such member is caused to move, as by turning an appropriate nut, the other end thereof actuates the brake mechanism so as to release the brake. The stairway brake may thus be released exteriorly and without dismantling the stairway. This is of particular value in the event the brake, due to some accident thereto, fails to release when the step or steps having the access openings therein are elsewhere than directly over the brake. In such event, the brake may be released exteriorly by the member just described and then the stairway inched around until a step or steps having access openings therein come directly over the brake. Access may then be had to repair the brake.

Each handrail is maintained taut by means of a tensioning weight secured though the intermediary of a suitable flexible cable to the handrail tightener wheel. Slack is prevented from developing in the handrail by preventing upward movement of the tensioning weight, downward movement thereof, however, being freely permitted.

The two ends of each handrail are joined together by lapping the ends in steps, riveting them together with the rivets below the surface of the handrail, and vulcanizing the joint. This produces a smooth joint which is nearly as strong as the handrail itself.

The balustrading along either side of the runway of the stairway is in units so constructed that the balustrading at any point along the stairway can be removed without disturbing the balustrading at any other point. The individual panels of the balustrating are preferably formed of two plys of thin sheet metal, such as steel, with one ply over each side of a relatively thin core of suitable material. The resulting balustrading is easy to manufacture and install, is fireproof, and is adaptable to varied architectural treatments.

The exposed exterior surfaces of the stairway are preferably encased, from the deckboard adjacent the handrail at one side of the stairway down around the bottom of the stairway truss and up to the deckboard adjacent the handrail at the other side of the stairway, by a monolithic enclosure, such as plaster, suitably supported from the stairway. A simple enclosure is thereby formed, and one which reduces the paneling to be furnished for each stairway to a minimum. In addition, such an enclosure is more fireproof, and has less tendency to vibrate, than wood paneling. In the event the stairway is located along a wall so that only one side and the bottom of the stairway are exposed, a monolithic enclosure is employed to encase such exterior surfaces of the stairway as are exposed, from the deckboard adjacent the handrail on the exposed side of the stairway down and around the bottom of the stairway truss.

The floor plates at the upper and lower landings are preferably metallic pans into which a composition flooring, such as artificial stone, is poured while it is in a plastic state. Preferably also, before the flooring hardens, a perforated sheet metal plate is pressed into the surface of the floor plate so that it is flush with the edges thereof, excess flooring material being removed. a durable floor plate is thereby obtained, and one which lends itself readily to architectural treatment, since not only may various metals be employed for the exposed metal parts of the floor plates, including the perforated plate, but

the perforations in the perforated plate may be cut in any desired design.

The stairway is controlled for overspeed by means of a ball governor driven from the main drive shaft of the stairway at the upper landing. The contacts responsive to overspeed of the stairway are weighted to separate, but are maintained in engagement by the action of a cam. In the event of overspeed the cam is moved so that it is ineffective to overcome the biasing weight for the overspeed contacts. Normally, therefore, the contacts then separate. In the event the contacts do not separate, and the stairway continues to overspeed, provision is made for causing the previously mentioned cam to positively effect the separation of the overspeed contacts. The arrangement is such that once the overspeed contacts separate, they do not reengage as the stairway slows down and stops, but must be reset manually, thereby insuring that the stairway is stopped, and is not started again, until after an experienced attendant has inspected the stairway.

The governor also controls a second set of contacts. Such set is controlled so that the contacts are separated when the stairway is stationary and engage when the stairway attains a speed appropriately below normal full speed, remaining engaged while the stairway operates at normal full speed. Such contacts are utilized in the control system for the stairway in such a manner that if the stairway, while it is operating in the ascending direction, for example, stops due to the breaking of the driving chain, the brake is applied and the stairway prevented from moving in the decending direction due to the presence of passengers thereon.

Other features and advantages will become apparent from the specification taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a side elevation of a moving stairway according to this invention, with portions broken away to illustrate schematically certain portions thereof;

Figure 2 is a front elevation of a moving stairway from the lower landing, with certain portions thereof and of the adjacent building structure shown in section;

Figure 3 is a vertical elevation of the upper landing, looking in the direction of the lower landing, with certain parts broken away;

Figure 4 is a vertical section of the moving stairway taken along the line 4—4 of Figure 3;

Figure 5 is a vertical section of the stairway taken along the line 5—5 of Figure 3, illustrating the stairway brake;

Figure 6 is a vertical section taken along the line 6—6 of Figure 5;

Figure 7 is a vertical elevation of the lower landing, looking in the direction of the upper landing, with certain parts broken away;

Figure 8 is a vertical section of the moving stairway taken along the line 8—8 of Figure 7;

Figure 9 is a section through the inclined portion of the moving stairway, at right angles thereto, looking in the direction of the upper landing;

Figure 10 is an enlarged section showing the handrail and balustrade paneling and moulding;

Figure 11 is a section through the balustrade paneling taken along the line 11—11 of Figure 10;

Figure 12 is a plan view of one of the steps of the moving stairway;

Figure 13 is a vertical elevation of the step shown in Figure 12;

Figure 14 is a section taken along the line 14—14 of Figure 13;

Figure 15 is an enlarged detail illustrating a modified construction;

Figure 16 is an enlarged plan view of a portion of the step tread of the step illustrated in Figure 12;

Figure 17 is a section taken along the line 17—17 of Figure 16;

Figure 18 is an enlarged section taken along the line 18—18 of Figure 16;

Figure 19 is an enlarged plan view of a portion of a step tread illustrating a modified construction for the step tread;

Figure 20 is a section taken along the line 20—20 of Figure 19;

Figure 21 is an enlarged section taken along the line 21—21 of Figure 19;

Figure 22 is an enlarged fragmental side elevation of a step wheel;

Figure 23 is a section taken along the line 23—23 of Figure 22;

Figure 24 is a plan view of the lower landing, showing the combplate and the floor plates positioned thereat;

Figure 25 is an enlarged section of a floor plate taken along the line 25—25 of Figure 24;

Figure 26 is a plan view of a handrail joint before assembly;

Figure 27 is a plan view of a handrail joint assembled;

Figure 28 is a plan view of a finished joint;

Figure 29 is a section taken along the line 29—29 of Figure 27;

Figure 30 is a side elevation of a portion of the chain and trailer wheel tracks as viewed in accordance with the arrows 30—30 of Figure 9;

Figure 31 is a schematic plan view of the governor and associated apparatus, with parts broken away;

Figure 32 is a side elevation of the governor and switches operated thereby, with certain parts broken away; and

Figure 33 is a schematic wiring diagram of the circuits controlling the moving stairway.

In general, the following numerology is employed in the description and drawings so as to facilitate a rapid understanding of the invention:

Numbers below 100 designate equipment illustrated in the wiring diagram, Figure 33. Certain of this equipment, however, is also illustrated in other figures.

Numbers between 100 and 199 designate details of certain special equipment, such as the governor illustrated in Figures 31 and 32.

Numbers 200 and above designate the remaining equipment. Numbers which differ by 400 units designate corresponding apparatus for the two sides of the stairway. Thus 208 designates the handrail at one side of the stairway and 608 the handrail at the other side of the stairway.

Referring to Figures 1 and 2, the moving stairway, generally designated 200, extends between a lower landing 201 and an upper landing 202. The moving stairway comprises an endless series of steps 203 driven by a motor 85, preferably located at the upper landing as illustrated. Motor 85 operates through reduction gearing 204, driving chain 205 and sprocket 206, to drive the main drive shaft 207 of the moving stairway. By appropriate equipment, illustrated in subsequent figures, the steps 203 of the moving stairway are driven from drive shaft 207. Two endless mov-

ing handrails 208, 608, one at each side of the stairway, likewise are driven from drive shaft 207, as is also a governor, generally designated 210.

The moving stairway is mounted upon supporting framework in the form of a truss, generally designated 211, the construction of which is shown in Figure 1. The lower portion of the truss is secured to two crossbeams 212 and 213 at the lower landing, while the upper portion of the truss is secured to a crossbeam 214 at the upper landing. These beams form supports for the truss, being secured to the building structure. When the driving motor 85, control panel 215 and reduction gearing 204 are positioned as shown in Figure 1, such equipment is mounted upon suitable framework 216 secured at one end to crossbeam 214 and at the other end to a crossbeam 217. Preferably the truss 211 is enclosed, as by plaster 218 or other covering medium suitably mounted upon the framework of the truss. Similarly, the driving motor 85 and the equipment related thereto may be enclosed. Suitable access doors 220 may be provided at convenient points as illustrated, to afford access to the enclosed portions of the moving stairway. The stair well at the upper landing is protected by means of balustrading 221 secured to the floor of the upper landing.

Beneath the framework of the truss 211, and between the truss and the plaster or other medium 218, there is provided a drip pan 222 extending the length of the truss. If desired, this drip pan may be formed of a plurality of removable sections, each overlapping the adjacent section so that oil or other lubricant drippings from the stairway do not seep through to the plaster 218. A similar drip pan 223 may be provided under the framework mounting the driving equipment.

The endless series of steps 203 is driven by two endless running gear chains, extending along either side of the steps. The relation of the two running gear chains to the steps and to the step rollers is most clearly shown in Figures 12 and 13. The single step illustrated, generally designated 203, is shown between a running gear chain 230 at the right thereof and a running gear chain 630 at the left thereof. The two running gear chains are similar in construction, each being of the double link roller type, with uniformly spaced chain bushings or rollers, 231 for chain 230 and 631 for chain 630, of uniform outside diameter. At every third chain roller in each of the two running gear chains, the chain is provided with a hollow pin, such as pin 632 for chain 630. Connecting the two running gear chains at each of the points therein having such hollow pins, there is a step axle 233 extending across the stairway, through the hollow chain pins, and projecting out beyond each chain. Upon each such projecting portion of each step axle 233 is mounted a chain wheel, the chain wheels adjacent running gear chain 230 being designated 234 while the chain wheels adjacent running gear chain 630 are designated 634. At the extreme ends of each step axle there are two collars 235 and 635, which are retained in position preferably by taper pins driven therethrough and through the step axle. The ends of such pins are split, and after assembly are spread apart. It is preferred that each collar 235 and 635 be provided with a sleeve extending through the chain wheel and on which the chain wheel rotates. This sleeve is of sufficient length and diameter to provide clearance for the chain wheel between the running gear chain and the collar.

As a result of the foregoing construction, the two running gear chains 230 and 630 are connected together at every third chain link by the series of step axles 233 throughout the entire loops of the two running gear chains.

As shown in Figures 12 and 13, each step axle 233 is free to rotate with respect to the hollow chain pins and to the chain wheels associated therewith. Preferably, the bore of the hollow chain pins is slightly larger than the diameter of step axles 233. This is to prevent binding of the step axles in the chain pins in the event there should be irregularities in the construction or movement of the running gear chains of such a nature that any hollow chain pin for one chain should not be in alignment with the corresponding hollow chain pin for the other chain.

Under certain conditions of design and operation, when step axle 233 may have a tendency to rotate with the chain wheel and in the hollow chain pin, it may be desirable to prevent such rotation of step axle 233. Under such circumstances, hollow chain pin 632 and the sleeve extension of collar 635 may be constructed, as illustrated in Figure 15, with a lug-and-slot connection 636. Such lug-and-slot connection 636 is preferably employed, when employed, on only one side of the stairway.

In order to insure that the distance between adjacent step axles in the upper run of the stairway does not fall below a predetermined value, due, for example, to any tendency of a running gear chain to sag between adjacent step axles, the running gear chains are preferably of jackknife construction. This is illustrated for chain 230 in Figures 4 and 8, where links 240 and 242 are provided with extensions 246 and 248, respectively, and link 244 is provided with extensions 250 and 251. These extensions cooperate with stops 247, 249 and 252 on links 241, 243 and 245, respectively, to prevent flexure of the chain links downwardly between adjacent step axles 233, while such chain links are on the upper run of the stairway. If desired, the stops and extensions may be so proportioned that when the chain links between adjacent step axles are in a straight line, there is a small clearance between each extension and its cooperating stop. Under normal conditions, with such a construction, the extensions do not engage the stops, so that any noise resulting from such engagement is eliminated.

Each step 203 comprises a step tread 254, a step frame 255 and two step yokes 256 and 656. The step frame is formed of suitable sheet material bent into the shape illustrated in Figure 14 so as to provide a tread support 257 and a curved riser 258. Step tread 254 is preferably made up of a plurality of tread plates each of which is bolted or otherwise secured to tread support 257 of the step frame. A small number of the steps, frequently two, in a complete moving stairway preferably have their tread plates secured to tread support 257 by means of screws so that the tread plates may be removed from such steps, and replaced thereon, from the exterior of the stairway. The step frames of such steps are formed with an opening therein, illustrated by the dot and dash outline 260 in Figure 12, so that access may be had to the under side of such steps and to the inner parts of the moving stairway when the tread plates have been removed. If desired, however, each step of the stairway may be con-

structed with such opening therein, and with screwed down tread plates.

The tread plates are preferably constructed with cleat formations as illustrated in Figures 12 and 13. The details of such tread plates will be discussed later in this description.

The two step yokes 256 and 656 are secured to the step frame near the sides of the step, as illustrated in Figures 13 and 14. These two step yokes are conveniently die cast of appropriate zinc alloy and formed with hubs 261 and 661, respectively, of bearings for step axle 233. Each step is secured to its step axle by means of bearing caps 262 and 662 bolted to the hubs of the step yokes. In the event it is desired to remove a step, the two bearing caps 262 and 662 for such step are removed, whereupon such step may be removed from the stairway as a unit. In so removing and replacing a step, it is to be noted that no part of the running gear chains 230, 630 is disturbed. Each step is centered and maintained in position on its step axle 233 by means of spacing sleeves 263 and 663.

At the trailer end of each of the two step yokes 256 and 656, there is mounted a short stub shaft parallel to the step axle 233. On each stub shaft there is provided a trailer wheel rolling in a plane just inside the adjacent side edge of the step. The trailer wheel at the side of the step adjacent chain 230 is designated 264, while the trailer wheel at the side of the step adjacent chain 630 is designated 664.

In the illustrated embodiment of the moving stairway, step yokes 256 and 656 are shaped as illustrated in Figure 14 so that, when the step is on the upper incline run of the stairway, the trailer wheels roll on an inclined plane, indicated at 266 in Figure 14, which is parallel to but below the inclined plane, indicated at 265, on which roll the chain wheels. With such illustrated construction, a perpendicular line extending upwardly through the axis of the trailer wheels is just within the nose of the step. It is thus practically impossible for anyone to stand near the nose of a step in such a manner that he produces any appreciable turning moment tending to rotate the step clockwise about the trailer wheels, as viewed in Figure 14. It is therefore practically impossible for anyone to stand on the step in such a manner that he lifts the chain wheels from the track along which they roll. In addition, as a result of this construction, the weight of a person standing on the step where a person normally would stand thereon is approximately equally distributed between the chain wheels and the trailer wheels.

Reference is now made to Figures 4 and 8, which, when pieced together with the lower left hand corner of Figure 4 slightly overlapping the upper right hand corner of Figure 8, illustrate in vertical section the stairway shown in Figure 1. For convenience, let it be assumed that the stairway is in motion in the ascending direction. Two steps 203 are shown complete, in section, in stair formation on the upper run of the incline near the lower left hand corner of Figure 4. These two steps will be followed as they move through a complete cycle and return to their illustrated position.

While the steps are on the upper run of the incline, chain wheels 234 roll on a track 270 and the trailer wheels 264 roll on a track 271. During this time, the chain wheels are directly beneath an upthrust track 272. Near the upper landing the chain wheels roll upon a track 273 while the trailer wheels roll upon a track 274. These two tracks 273 and 274 curve away from each other as shown in Figure 4 so as to gradually bring the steps into a horizontal platform formation when the steps move horizontally at the upper landing. The upthrust track for the chain wheels 234 during the evolution of the steps from a chair formation to a horizontal platform formation is a continuation of upthrust track 272, secured in a suitable manner so that it is possessed with an appropriate curve, as illustrated. The steps thereafter are reversed in direction as running gear chain 230 passes around a sprocket 275 at the upper landing. While the steps are on the lower or return run of the incline, the chain wheels roll on a track 276 while the trailer wheels roll on a track 277. During this time the upthrust track for the chain wheels is a track 278. As the steps near the lower landing, chain wheels 234 roll upon a curved track 279 and trailer wheels 264 roll upon a curved track 280, a track 281 becoming the upthrust track for the chain wheels. At the lower landing, the direction of movement of the steps is reversed as running gear chain 230 engages and passes around a sprocket wheel 282. After the direction of movement of the steps has been reversed at the lower landing and the running gear chain disengages from sprocket 282, chain wheels 234 roll upon a track 283 and trailer wheels 264 roll upon a track 284. During this time a track 285 is the upthrust track for chain wheels 234. Track 286 is a short upthrust track provided for the trailer wheels. The initial portion of tracks 283 and 284 are horizontal so that the steps, as they leave the lower landing, are initially in a horizontal platform formation. Tracks 283 and 284 subsequently curve so that they gradually bring the steps into stair formation as the steps enter upon the upper run of the incline. The two steps whose action has thus been traced are then back in their initial illustrated position with the chain wheels on track 270 and the trailer wheels on track 271.

While the stairway has been in motion as described above, handrail 208 has also been in motion. This motion has been at substantially the same speed as that of the steps, due to the action of driving equipment for the handrail that is to be described in detail later. At this point it is sufficient to note that the handrail, while the stairway is in motion as described above, moves upwardly along a handrail guide 290, around a newel wheel 291 at the upper landing, around a take-up wheel 292 and a wheel 293 mounted in the balustrading at the upper landing, down along a handrail guide 294, around a newel wheel 295 at the lower landing, and then back along handrail guide 290.

The equipment on the side of the moving stairway not shown in Figures 4 and 8 operates in the same general fashion as the corresponding equipment illustrated in Figures 4 and 8. Certain specific differences exist, however, but these will appear as the description proceeds.

Reference is now made to Figure 9, in which the equipment at both sides of the moving stairway is illustrated. It will be recalled that this figure is a section through the inclined portion of the moving stairway, at right angles to the incline, looking in the direction of the upper landing. The framework of the truss 211 along the inclined portion of the stairway includes side members 224 and 624 spaced along longitudinal members 229 and 629, respectively, at either

side of the stairway, bottom members 225 at the bottom of the truss connecting two opposite side members, and cross members 226 connecting two opposite side members between the ends of such opposed side members. Secured to the truss at each cross member 226 are two track brackets of similar construction, 227 and 627, one at each side of the stairway. Above each track bracket 227 and 627 (except near the lower landing, as shown in Figure 8), there is secured thereto and to the truss, a balustrade bracket 228 and 628, respectively.

Each track bracket is formed with a shoulder 296 or 696, and to each shoulder is fastened, as by clamps 297 or 697, a track for the chain wheels on the corresponding side of the stairway, track 270 being for chain wheels 234 and track 670 being for chain wheels 634. Suitable sound-deadening shims may be interposed between the tracks and the shoulders. Tracks 270 and 670 are cold rolled strips of metal, such as steel, with track 270 preferably being rolled with a groove therein as illustrated so as to guide chain wheels 234, and thus to guide the steps. There is secured to track 270, between each two adjacent track brackets, one or more (customarily two) separator brackets 298. Similar separator brackets 698 are secured to track 670. Preferably these separator brackets are welded to the underside of tracks 270 and 670. The other ends of these separator brackets are secured to the tracks for the trailer wheels, track 271 being for trailer wheels 264 and track 671 being for trailer wheels 664. As with tracks 270 and 670, it is preferred to weld the underside of tracks 271 and 671 to the separator brackets. The upthrust track 272 for chain wheels 234 is an angle strip the vertical side of which is secured, as by bolts, to track bracket 227. Upthrust track 672 for chain wheels 634 is similarly constructed and mounted.

Near the base of each track bracket 227 and 627 there is formed another shoulder, 300 and 700, respectively, to which tracks 276 and 676, similar to tracks 270 and 670, respectively, are secured in a manner similar thereto. Tracks 276 and 676 are tracks for chain wheels 234 and 634, respectively, during the travel of the steps on the return run of the stairway. Upthrust tracks for chain wheels 234 and 634 are angle strips 278 and 678, respectively, similar to upthrust tracks 272 and 672, and secured to the track brackets in a similar manner. The tracks for trailer wheels 264 and 664 are angle strips 277 and 677, respectively, the vertical sides of which are secured, as by countersunk bolts, to the track brackets.

The track strips are preferably furnished and installed in standard lengths, except for the length of each track of the upper run on the inclined portion of the stairway nearest the upper landing, which length is made variable to suit the particular installation, and also is provided with an allowance for field cuts. It is also preferred to secure trailer wheel tracks 271 and 671 to their respective chain wheel tracks 270 and 670 by means of the separator brackets 298 and 698 before the tracks leave the factory, thereby forming a chain and trailer wheel track unit. It is thus insured that the proper spacing between these tracks exists. A side elevation of a portion of a chain and trailer wheel track unit, such as of tracks 270 and 271, together with a separator bracket 298, is illustrated in Figure 30. Separator brackets 299 at the ends of each unit are formed of standard separator brackets 298 from which a portion of the flange on one side of the center rib has been removed. Adjacent chain and trailer wheel track units are joined by bolting together adjoining separator brackets 299, as shown in Figure 30. Adjacent lengths of chain wheel tracks 276 and 676 are joined in a manner similar to joint 302, illustrated in Figure 8 as the joint between chain wheel track 276 and chain wheel track 279. Adjacent lengths of upthrust tracks and other tracks formed from angles are joined by splice bars welded at one side of the joint and bolted at the other, as indicated at 303 in Figure 8.

As a result of the foregoing track construction, there is provided a track system free from projections and depressions in the track surfaces on which the chain and trailer wheels operate, so that as a result the steps move along the stairway smoothly, easily and quietly.

Continuing the description by referring to Figure 9, and also to Figures 10 and 11, there is, extending along each side of the stairway and secured to the top of each balustrade bracket, a handrail support, support 305 being secured to balustrade brackets 228 and support 705 being secured to balustrade brackets 628. These supports are preferably formed of sheet material and shaped as illustrated. The base edge further removed from the center of the stairway fits into a slot in the balustade bracket, while the other base edge is suitably secured to the balustrade bracket, preferably by countersunk bolts. A guide, 290 for support 305 and 690 for support 705, is formed and secured to the corresponding handrail support as illustrated. Handrail 208 fits over and runs upon guide channel 290, while handrail 608 fits over and runs upon guide channel 690. Guides 294 and 694 support and guide handrails 208 and 608, respectively, on the return portions of their loops.

The stairway illustrated in Figures 2 and 9 is located so that one side thereof (the left) is adjacent a wall, while its other side (the right) is exposed. The space between the wall and handrail support 305 is spanned by a deckboard 306. Deckboard 306 is retained in place by moulding strips 307 and 308, bolts projecting from the underside of which extend through the deckboard and through suitable longitudinal strips 309 and 310 appropriately secured to each balustrade bracket 228. In an analogous fashion, deckboard 706 at the other side of the stairway spans the area between handrail support 705 and stairway enclosure 218. Stairway enclosure 218 is preferably of plaster applied to metal lathing extending along the side of the stairway from the bottom of the truss to deckboard 706. The metal lathing may be fastened to a lattice-work composed of channels 312 and 313, channels 312 being appropriately secured to the balustrade brackets and extending from the top of each balustrade bracket to below the bottom of the truss, and channels 313 being small longitudinal channels appropriately secured to channels 312. The underside of the stairway may similarly be enclosed with plaster, the lattice-work for the metal lathing for such enclosure being supported from the lower ends of channels 312 at one side of the stairway, and suitable angles 314 at the other side of the stairway.

In the event the stairway is located so that both sides of it are exposed, instead of only one side as illustrated in Figures 2 and 9, both sides of the stairway may be enclosed with plaster, from the

deckboards to below the bottom of the truss, in a manner similar to that described for the one exposed side of the illustrated stairway. In such instance, the framework supporting the plaster below the bottom of the truss is secured to the lower ends of channels 312 extending down each side of the stairway. As a result of this construction, there is a monolithic enclosure for the exterior of the stairway extending from the deckboard at the top of the balustrade on one side of the stairway, down around the bottom of the stairway and up to the deckboard at the top of the balustrade on the other side of the stairway. Such an enclosure is readily made, presents a pleasing appearance, is cheaper to install and is more fireproof than panel work and has considerably less tendency to vibrate and transmit sound than panel work.

For similar reasons, it is preferred to employ a continuous monolithic enclosure for the exteriorly exposed parts of the stairway when the stairway is located along a wall, as illustrated in Figures 2 and 9.

Along each side of the runway of the strairway is the balustrading, generally designated 316 and 716. Inasmuch as the balustrading is similar on both sides of the stairway, only that for the left hand side of Figure 9 (balustrading 316) is described in detail. Figure 10 is an enlargement of such balustrade to show details thereof. Each balustrade bracket 228 is provided with three shoulders 317, 318 and 319. The lower shoulder, 317, is provided with a slot therein, while the two upper shoulders, 318 and 319, have secured thereto angle strips 320 and 321, respectively, which extend along the stairway. Assuming that the balustrading is being installed, a panel 323 is inserted adjacent the sides of the steps so that a hook 324 thereon fits in the slot in shoulder 317. The top edge of panel 323 is secured to angle strip 320 by a moulding strip 325, as illustrated in Figure 10. Moulding strip 325 has a recess therein and into this recess is inserted the lower edge of a second panel 326. The upper edge of this panel rests against angle strip 321 and is secured thereto by a moulding strip 327, as illustrated in Figure 10. Moulding strip 327 is formed with a recess therein, and in this recess is inserted the lower edge of a third panel 328, the upper edge of which extends to the top of the balustrade bracket. A moulding strip 330 secures the top of panel 328 to the balustrade bracket and provides a rounded corner at the top thereof. It is to be noted that moulding strip 330 is secured to the balustrade bracket by screws 331 accessible from the runway of the stairway. Thus, in the event it is desired to obtain access to the inside of the balustrading at any point along the incline, the balustrading adjacent such point may be readily removed without disturbing the balustrading at other parts of the stairway.

It is preferred that the joints between adjacent panels 328, in view of the relative length of such joints, be protected with an H section 322 as illustrated in Figure 11. The joints between adjacent sections of panels 323 and of panels 326 may be simple butt joints.

The panels themselves are preferably formed of two thin sheets or plys of metal, such as steel, between which is a core of one or more plys of wood or other suitable material. The core is preferably "fireproofed" if it is not of material inherently fireproof. The exposed ply of metal may be given a suitable surface finish, or, if desired, formed of such material that it inherently has the desired appearance. If a wood surface is desired, the exposed ply or metal may be provided with a thin veneer of the appropriate wood. The moulding strips are also preferably formed of metal. The balustrading is thus not only fireproof but adaptable architecturally to its surroundings with comparative ease.

Referring now to Figures 3 and 4, which illustrate the upper landing equipment, main drive shaft 207 is driven from the motor by means of the engagement of driving chain 205 with sprocket 206. Sprocket 206 is a ring, on which suitable teeth are formed, secured to a shoulder on sprocket 275 for running gear 230. A similar sprocket 675, without sprocket ring 206, is provided for running gear chain 630. Sprocket 675 is driven by sprocket 275 by virtue of the fact that both sprockets are keyed to main drive shaft 207.

The chain wheel tracks 273 and 673 extend to a point slightly beyond the center line of the main drive shaft so that each step 203 is supported by chain wheel tracks 273 and 673 until running gear chains 230 and 630 seat in sprockets 275 and 675, respectively. The ends of chain wheel tracks 273 and 673 are supported by brackets 336 and 736, respectively, which are mounted upon the truss by means of a suitable angle, a plate and one or more bolts, such as 337, 338 and 340, respectively, for bracket 336. As illustrated in Figure 3, bracket 336 is preferably threaded, and securable in adjusted position by clamping bolt 341, so as to provide a vertical adjustment for track 273. In a similar manner the end of track 673 is vertically adjustable. By means of such adjustments, the running gear chains may be led tangentially onto sprockets 275 and 675. The ends of the chain wheel upthrust tracks 272 and 672 are also preferably made vertically adjustable by virtue of removable shims positioned between them and their supports, such as 342 for track 272. Chain wheel tracks 273 and 673 are narrowed down to the width of the chain wheels adjacent the two sprocket wheels so as to provide appropriate clearances between the tracks and the sprocket wheels.

While the steps are reversed in direction as they pass around sprocket wheels 275 and 675, step axles 233 are supported thereby due to the fact that the chain bushings of the running gear chains seat at the bottom of the tooth formations in the sprocket wheels. Chain wheels 234 and 634, during this time, overhang sprocket wheels 275 and 675, respectively. End thrust tracks are provided for the chain wheels while the steps pass around sprocket wheels 275 and 675, one such track, 343, being shown in Figure 4.

The upper landing is provided with a track carriage in which are formed horizontal track formations for the trailer wheels, track formations 344 and 345 for trailer wheels 264 being illustrated in Figure 4. Track formation 344 is above the center line of drive shaft 207 and track formation 345 is below the center line of the drive shaft 207. To guide the trailer wheels while the steps pass around sprocket wheels 275 and 675, a semi-circular track connects the upper and lower horizontal track formations at each side of the stairway. For trailer wheels 664, such semi-circular track is a unitary member 746, secured to the track carriage at the upper landing, and provided with an inner track 747 and an outer track 748 for the trailer wheels 664, as illustrated in Figure 3. The semi-circular track for trailer wheels 264 is composed of two elements. The first element is member 350 secured to the track

carriage and having formed therein the outer track for trailer wheels 264. The second element is a substantially semi-circular member 351, the exterior of which forms the inner track for trailer wheels 264. Member 351 is supported from the track carriage by means of springs 352 which urge member 351 to a normal position in which the base portions of the member are separated from the track carriage. This separation or clearance, indicated at 353 in Figure 4, is subject to being taken up by movement of member 351 against the action of springs 352.

The foregoing construction of the semi-circular tracks at the upper landing, by which the trailer wheels (264) at one side of the stairway are urged outwardly by member 351 while the trailer wheels (664) at the other side of the stairway are guided by a fixed semi-circular track, results in wedging the steps as they pass around sprocket wheels 275 and 675 so that a quiet reversal of movement of the steps is thereby effected. Such a construction, among other things, eliminates the slap which tends to occur when the trailer wheels change their bearing surface from the inner semi-circular track to the outer semi-circular track when the stairway is operating in the ascending direction, and vice versa when it is operating in the descending direction.

Chain wheel tracks 276 and 676 extend past the centerline of main drive shaft 207, as illustrated for track 276 in Figure 4, so that when the running gear chains disengage from sprockets 275 and 675, the steps are already supported by the chain wheels on tracks 276 and 676. The ends of chain wheel tracks 276 and 676 are vertically adjustable by means of suitable shims positioned between such ends and their supports so that the running gear chains may be caused to disengage tangentially from sprockets 275 and 675.

The upper landing is provided with a combplate 360 having combs or teeth 361 which project into the spaces between the cleats of the step treads as the steps pass under the combplate. The base end of the combplate is tongue and grooved to a floor plate 362, while the toothed end is supported on suitable shoulders 363 and 763 on pins 364 and 764, respectively, one at each side of the stairway. Pins 364 and 764 are preferably threaded into their respective supporting members so as to provide a vertical adjustment for the teeth of combplate 360. Preferably, also, the stems of the pins above shoulders 363 and 763 are such that the combplate may be raised upwardly off such pins. Normally wedges 365 and 765, extending through suitable slots in pins 364 and 764, respectively, retain the combplate against pin shoulders 363 and 763. As a result of such construction, in the event of an umbrella end or other body becoming snagged between the teeth of the combplate and a step, the combplate may be raised, the obstruction removed, the combplate replaced and operation of the stairway resumed, all in a minimum of time. In practice, it is customary to provide, proximate to each of the wedges 365 and 765, a small hammer, by means of which one may release the combplate without other tools, and without waiting for the building engineer.

Access is obtained to wedges 365 and 765, which are positioned inside the balustrading, by virtue of the fact that a portion of the bottom panels 323 and 723 is hinged, as shown at 766 for panel 723 in Figure 3. The doors thereby formed extend the length of the combplate so that the combplate may be raised without interference from the bottom panels.

Handrails 208 and 608 are driven at the upper landing from sprockets 368 and 768 on main drive shaft 207, handrail 208 being driven by a chain 369 which engages sprocket 368 and then extends up into upper landing balustrade 370, and handrail 608 being similarly driven by a chain 769 which engages sprocket 768 and then extends up into upper landing balustrade 770. Inasmuch as the drives for the two handrails are similar, further details of the drive are described only for handrail 208, illustrated in Figure 4.

Chain 369 engages a sprocket wheel 371 keyed to a shaft 372 on which newel wheel 291 is also keyed. Shaft 372 is suitably supported by a newel stand 373 which also supports one end of a channel 374, channel 374 being also supported by upper balustrade bracket 375. Wheel 293 and a sprocket 376, suitably connected thereto, are rotatably mounted upon channel 374. Chain 369 engages sprockets 371 and 376 to drive the handrail, the diameters of sprockets 371 and 376 being properly proportioned with respect to the diameters of wheels 291 and 293, respectively, so that the circumferential speed of wheels 291 and 293 is the same. An adjustable tightener sprocket 377 is provided for chain 369.

Tightener wheel 292 is rotatably mounted on a carriage 380 which is arranged to slide along two rods, 381 and 382, parallel to channel 374, the spacing between rod 382 and the plane of the channel being made greater than the spacing between rod 381 and the plane of the channel so that tightener wheel 292 tilts, and thus guides the handrail from the vertical plane of newel wheel 291 to the vertical plane of wheel 293. Rods 381 and 382 are secured at one end to upper balustrade bracket 375, and at the other end to channel 374. Tightener wheel 292 is urged in the direction to maintain tension in handrail 208 by means of a vertically movable weight 383, such weight being connected to carriage 380 by a cable 384 as illustrated in Figure 4.

Preferably a device, such as dog 385 and ratchet teeth 386 formed on the side of weight 383, is employed to prevent upward movement of the weight while permitting free downward movement thereof. Weight 383 thus automatically moves tightener wheel 292 to take up stretch and other elongations in the handrail and thus serves to keep the handrail taut. By preventing upward movement of weight 383, slack in the handrail is prevented from developing. Thus, for example, when the normal motion of the handrail is prevented or retarded at a point removed from the handrail drive, while the handrail continues to be driven by the handrail drive (i. e., while the slippage point is not yet reached at both newel wheel 291 and wheel 293), the handrail drive tends to cause tightener wheel 292 to move so that slack results in the handrail. Such slack is objectionable for many reasons, of which one is that the handrail slack may become entangled with other moving parts of the stairway, and another is that when the means obstructing the normal motion of the handrail is removed after weight 383 has been raised and slack developed, the falling back of weight 383 to its initial position in taking up the handrail slack may cause the handrail to break. By preventing upward movement of weight 383, as in the manner illustrated, so as to prevent movement of tightener wheel 292 in the direction that develops handrail slack, handrail slack under such conditions is thereby prevented.

It is preferred that the hitch between cable

384 and weight 383 includes a spring 387. This spring permits such small oscillations of tightener wheel 292 as may occur during normal operation of the stairway without causing undue strain upon the handrail.

The handrail drive for each handrail is enclosed within the balustrading at the upper landing. The top cover piece of such balustrading is preferably removable so as to afford access to the handrail drive. The balustrading 316 and 716, extending along the sides of the runway in the inclined portion of the stairway, is continued along the horizontal portion thereof at the upper landing. The individual panels of such balustrading, and their manner of support, are substantially identical with that described for the panels along the inclined portion of the stairway, so that the details of such balustrading at the upper landing have not been shown. As mentioned before, however, the lower panels at each side of the upper landing are provided with a hinged section, as indicated by hinges 766 in panel 723.

The upper portion of the balustrading 316 and 716 at each side of the stairway adjacent the newel wheels rests against the exterior portion of a newel frame for the corresponding newel wheel. This is illustrated in Figure 3, where balustrading 716 rests against exterior portion 791 of newel frame 790. Newel frame 790 is supported upon newel stand 773, as by bolts 792. The interior portion 793 and the exterior portion 791 of newel frame 790 are separated by a portion of the circumference of newel wheel 691 which projects through the newel frame. Exterior portion 791 of the newel frame is secured to the interior portion thereof at the points where the newel wheel ceases to project through the newel frame. Such points are illustrated in Figure 4 for newel wheel 291 and interior and exterior portions 393 and 391, respectively, of newel frame 390, where one such point, designated 394, is adjacent the transition of handrail 208 from guide 290 to newel wheel 291, and the other, designated shoulder 395, is adjacent the entry of handrail 208 into the upper landing balustrading. Such shoulder for each upper landing newel frame is formed to provide a support for the circular handrail brush, brush 396 for handrail 208 being illustrated in Figures 3 and 4. In addition, shoulder 395 of newel frame 390 is preferably formed with a suitable recess in which is mounted a set of control buttons for the stairway, generally designated 397. There are three individual buttons in such set, one, 23, for starting the stairway in the ascending direction, a second, 46, for starting the stairway in the descending direction, and a third, 40, for stopping the stairway. The three individual control buttons comprising set 397 are shown only in the wiring diagram, Figure 33. All three control buttons are protected by a hinged cover 398 secured to a cover plate 399. The first two buttons are preferably operable only with keys in the possession of proper attendants. The third, or "stop" button, directly under the cup formation in hinged cover 398, may be operated by anyone should occasion require it.

The newel frames may be made of any suitable metal or alloy so that their exposed surfaces match the metal mouldings, or otherwise be subject to architectural treatment.

Main drive shaft 207 is provided with a brake, generally designated 90, positioned on the shaft between sprockets 275 and 675. Brake 90, as illustrated in Figures 3, 5 and 6, is of the band type, operating on brake drum 401 keyed to shaft 207, and is applied by the action of spring 402 raising arm 403. Arm 403 is pivotally supported upon a bracket 404, which in turn is secured to crossbeam 405 of the upper landing drive assembly. A brake magnet 79, when energized, releases the brake by depressing arm 403 against the action of spring 402. Arm 403 actuates a brake switch 73, the functions of which will appear later.

Arm 403 is provided with an aperture through which extends a vertical rod 406. The lower end of this rod is formed into an eye, through which extends pin 407, this pin also passing through two channels secured together to form a member 408. Member 408 is pivotally mounted upon an angle 410 secured to crossbeam 405 so that the other end of member 408 normally rests upon a lip of crossbeam 405. A vertically extending rod 411 is pivotally secured to such end of member 408, as by a pin 412 passing through an eye formed on rod 411. The upper end of rod 411 passes through a chord angle 413 of the truss, and is provided with a threaded nut 414 bearing against angle 413, and with one or more lock nuts.

It is to be noted that the end of member 408 to which rod 411 is secured extends out beyond the vertical plane, indicated at 415 in Figure 6, including the side edges of steps 203.

In the normal position of the parts, with the outer end of member 408 resting on crossbeam 405, a nut 416 secured to rod 406 is spaced from arm 403 so that arm 403 does not engage it during normal application and release of the brake. When rod 411 is raised, however, as by screwing nut 414 down on rod 411, member 408 is rotated so as to cause nut 416 on rod 406 to engage arm 403 and depress such arm, thereby mechanically releasing the brake. Resort may be had to this simple manner of releasing brake 90 from outside the loop of steps 203 in the event it jams or for any cause refuses to release when the brake magnet is energized or in the event the brake magnet burns out. The starting can then be inched along until the two or more steps having the removable tread plates come opposite the brake so that access may be had to the brake through such steps, or by removing such steps, in order to repair the brake. In the absence of this external release for brake 90, access could be obtained to the brake, and the brake repaired and released, only with considerable difficulty and with appreciable dismantling of the stairway.

The upper landing equipment is preferably constructed into three principal assembly units, these being the main drive unit and the two handrail drive units. The main drive unit comprises all the equipment mounted upon or about main drive shaft 207, including the brake, the track carriages, and the crossbeam. The handrail drive unit for each side of the stairway comprises the newel stand, the upper balustrade bracket, the channel supported by such stand and bracket, and the equipment mounted on such stand, bracket and channel, the newel frames excepted. These three principal assembly units are shipped complete from the factory, so that as a result there is a minimum of field work in aligning and installing the upper landing equipment. Upper landing curved tracks 273 and 274 are also preferably shipped from the factory in an assembled unit, being secured together by suitable separator members 418 welded to the undersides of the

tracks. An assembled unit is similarly formed of the corresponding tracks at the other side of the stairway.

Referring now to Figures 7 and 8, which illustrate the lower landing equipment, running gear chains 230 and 630 engage two sprocket wheels 282 and 682, respectively, while the direction of travel of the steps is reversed at the lower landing. Shaft 420, to which sprocket wheels 282 and 682 are keyed, turns in suitable bearings at either side of the stairway, such bearings being supported upon a carriage generally designated 421. Carriage 421 is provided with rollers 422 and 822 rolling upon tracks 423 and 823, respectively, at each side of the stairway so that it has a horizontal movement in the line of the stairway. Running gear chains 230 and 630 are maintained under tension as a result of carriage 421 being urged leftwardly, as viewed in Figure 8, this being effected by weights 424 and 824, one at each side of the stairway. Weight 424 is formed on the end of an arm 425 that is pivotally mounted at 426 upon the truss. To a short bell crank lever extension of arm 425 is secured a rod 427, rod 427 being connected, preferably through the compression spring 428 as illustrated, to carriage 421. In a similar manner weight 824 at the other side of the stairway is connected to carriage 421.

To each weight is secured a rod extending vertically up into the lower landing balustrade, rod 430 being secured to weight 424 and rod 830 being secured to weight 824. Inasmuch as the equipment associated with such rods is similar, only that for rod 430 is illustrated and described in detail.

Surrounding rod 430, and maintained in position by suitable nuts, is a collar 431. A bell crank lever 432, pivotally supported upon a plate secured to lower newel stand 433, has the end of one of its arms pivotally secured to collar 431. The end of the other of its arms is formed so as to straddle a tripper arm 434. Tripper arm 434 is provided with a shoulder by means of which a switch arm 435, pivotally supported at 436, is maintained in raised position. When tripper arm 434 is actuated so as to remove its shoulder as a support for switch arm 435, switch 435 rotates downwardly about its pivot and actuates a carriage safety switch 42, the contacts of which are enclosed within the box illustrated. Appreciable movement of the forked end of bell crank lever 432 in either direction from its normal position mechanically actuates tripper arm 434, so that as a consequence, any appreciable movement in either direction of weight 424 and thus of the corresponding side of carriage 421, from its normal position, causes the operation of carriage safety switch 42.

Similarly, any appreciable movement from its normal position, in either direction, of the side of carriage 421 to which weight 824 is secured, results in operating a corresponding carriage safety switch, 43, for that side of the stairway.

The operating mechanisms for the carriage safety switches are initially adjusted so that, as long as carriage 421 remains in its position determined by the length of the running gear chains and by the tension therein imparted by weights 424 and 824, the switches are not operated. In the event either or both sides of the carriage move appreciably from this normal position—due, for example, to the breaking of one or both running gear chains, or to the snagging of a chain or step—the resulting motion of the carriage, whether forward or backward, causes the operation of the appropriate carriage safety switch. By means of instrumentalities to be described later, the operation of either carriage safety switch effects the stopping of the stairway.

Preferably the carriage safety switches are required to be reset manually. This insures that the stairway will not be restarted until the proper attendant is summoned and has made an inspection and has repaired the trouble.

Carriage 421 is provided with horizontal track formations for the trailer wheels, track formations 437 and 438 for trailer wheels 264 being illustrated in Figure 8. Track formation 437 is above the centerline of shaft 420 and track formation 438 is below the centerline of shaft 420. To guide the trailer wheels while the steps pass around sprocket wheels 282 and 682, a semi-circular track connects the upper and lower horizontal track formations at each side of the stairway. For trailer wheels 264, such semi-circular track is a unitary member 440, similar in construction and function to unitary member 746 for trailer wheels 664 at the upper landing. Member 440 is secured to the lower carriage 421 and is provided with an inner track 441 and an outer track 442 for trailer wheels 264. The semi-circular track for trailer wheels 664 at the lower landing is preferably composed of two elements 843 and 844, similar in construction and function to the two elements 350 and 351, respectively, for trailer wheels 264 at the upper landing. In this manner quiet operation is assured as the steps pass around the sprockets at the lower landing as well as when they pass around the sprockets at the upper landing.

It will be noted that the movable semi-circular member, 351, at the upper landing engages trailer wheels 264, while the movable semi-circular member, 844, at the lower landing engages trailer wheels 664. The wedging action of the steps is thus effected at one side of the stairway at the upper landing and at the other side of the stairway at the lower landing. This is the preferred arrangement. If desired, however, such wedging action may be effected at either landing only, or on the same side of the stairway when provided at both landings.

The end of trailer wheel track 280 fits into an appropriate slot alongside the lower track of lower horizontal track formation 438 so as to provide a continuous support for trailer wheels 264 regardless of the position of the movable lower carriage 421. A similar provision is made for the joint between the lower track of upper horizontal track formation 437 and trailer wheel track 284, and for the joint between chain wheel track 283 and chain wheel track 445 carried by the carriage, as well as for the three corresponding joints at the other side of the stairway.

Also movable with carriage 421 is a short track 446 for chain wheels 234. One end of this track is secured to carriage 421 so that track 446 is a continuation of track 445. The other end of track 446 rests on a bracket 447 bolted to an angle 448. Bracket 447 extends through a plate 450 and is provided with adjusting nuts threaded thereto. Bracket 447 is secured to the truss by means of one or more bolts 451 passing through plate 450, the truss, and angle 448. Bracket 447 is secured on the truss after carriage 421 is installed and its normal position ascertained, bracket 447 being positioned so as to support track 446 near its free end when in its normal position. Track 446 is of such a length that its

free end extends to a point slightly beyond the centerline of shaft 420, so that when running gear chain 230 disengages from sprocket 282 (assuming the stairway operating in the ascending direction), the steps are already supported by chain wheels 234 rolling on track 446. Bracket 447, after being loosened up from angle 448, may be moved vertically by means of the nuts thereon so as to provide a vertical adjustment for the free end of track 446. By means of such adjustment, running gear chain 230 may be led tangentially from sprocket wheel 282.

A similar short track 846, for chain wheels 634, is provided at the other side of the stairway, and is similarly adjustable.

Chain wheel track 279 and upthrust track 285, and the corresponding tracks at the other side of the stairway, are supported upon suitable removable shims so as to provide a vertical adjustment for such tracks. The end thrust tracks for the chain wheels, such as track 452 for chain wheels 234, are mounted upon carriage 421.

It is preferred to shape tracks 285, 283 and 284 in the factory and secure them together into one unit by welding suitable spacing brackets 453 thereto. Similarly, after shaping, tracks 280, 281 and 279 are secured together by spacing brackets 454. The corresponding tracks at the other side of the stairway are constructed in a similar manner.

The combplate 456 at the lower landing, under which the steps pass, is constructed and installed similarly as combplate 360 at the upper landing. In order to insure that the steps properly enter the lower landing combplate 456 when the stairway is operating in the descending direction, a short length of upthrust track 286 is preferably secured to spacing brackets 453. A similar upthrust is preferably also provided for the other side of the stairway.

The balustrade construction at the lower landing is similar to that at the upper landing, and so it is not described in detail. Also, as at the upper landing, there is mounted in the right hand newel frame at the lower landing a set of control buttons for the stairway. There are three individual buttons in such set, one, 32, for starting the stairway in the ascending direction, a second, 52, for starting the stairway in the descending direction, and a third, 41, for stopping the stairway. These three individual control buttons are shown only in the wiring diagram, Figure 33. Access may be had to these buttons by raising hinged cover 458. As with the stop button at the upper landing, the stop button at the lower landing is directly under the cup formation in the protecting hinged cover, and may be operated by anyone in an emergency without the use of a key.

The preferred construction of the tread plates making up step tread 254 of each step is illustrated in Figures 16, 17 and 18. Each plate comprises an aluminum or zinc alloy die casting 460 provided with upwardly extending portions 461 which form the side walls of the cleats. Reinforcing ribs 462 are provided between the side walls of each individual cleat. The cleats are formed by filling the spaces between the side walls 461 with a suitable artificial stone, preferably a magnesite composition flooring 463, such as "asbestolith", when the material is in a plastic state, and allowing it to set in place. A durable non-slip tread surface is thereby obtained. In addition, the resulting tread plate is sound damping and fireproof.

A modified construction for the tread plates is illustrated in Figures 19, 20 and 21. (Incidentally, Figures 19 and 20 are continuations of Figures 16 and 17, respectively, so as to show the construction of casting 460 both at the heel and the nose of the step.) The tread plate is similar to that previously described, but has, in addition, a corrugated steel or other metal strip 464 inserted on edge in each cleat. Such a construction may be employed where the stairway is subjected to very extensive use, or where it is desired to further increase the life of the tread plates.

When mounting the tread plates 460 upon tread supports 257 of the steps, there is preferably interposed between each tread plate and the tread support a filler of fireproof sound-deadening material 465, such as asbestos.

Chain wheels 234 and 634 and trailer wheels 264 and 664 are preferably constructed as illustrated in Figures 22 and 23. The circumference of each wheel comprises a plurality of canvas squares 470 which are compressed together circumferentially and maintained in position between two steel rings 471 and 472 that are secured to a rotatable disc 473. In this manner the edges of canvas squares 470 constitute the rolling surface of the wheel. There is thereby obtained an exceedingly quiet wheel, and one which develops enough friction between its surface and the tracks to insure rotation of the wheel.

The floor plates 362 and 475 at the upper and lower landings, respectively, to which the base ends of the combplates are tongue-and-grooved, are preferably of abrasive-surfaced cast iron or bronze. The lower landing end floor plate 476 and the lower landing side floor plates 477 and 478, illustrated in Figure 24, and the upper landing side floor plates corresponding to plates 477 and 478, are preferably formed with composition tread surfaces. Each of such plates comprises a frame formed of a metallic base plate 480 around the edges of which angles 481 are secured, as by spot-welding. The recess thereby formed in such frame is filled with a suitable artificial stone, preferably a magnesite composition flooring 482, such as "asbestolith", when the material is in a plastic state. Before the material sets, a perforated metallic plate 483 is pressed into the surface of the flooring so that it is flush with angles 481, and the excess flooring material removed. Upon the setting of the floor material there is obtained a durable non-slip surface for the floor plates. In addition, as the perforations in plate 483 may be made in various designs (as suggested by the different design for plates 477 and 478 than for plate 476), and the plate itself made of different metals in various colors and tones, the composition floor plates readily lend themselves to architectural treatment. Also, if, after long and heavy use, metallic plate 483 has worn thin, the old flooring of the floor plate may be knocked out, a new flooring cast in the original frame, and a new plate 483 inserted. Such a renewal of a floor plate is effected comparatively simply, and without requiring a new frame.

The two ends of each handrail are preferably joined together in the manner to be described, referring to Figures 26, 27, 28 and 29, so as to provide a strong, smooth, safe and durable joint. One end 486 of a handrail is stepped down from the outside in a plurality of steps 487 as illustrated in Figure 26, each step preferably constituting a cut through only one layer of the canvas re-

inforcement of the handrail. The other end of the handrail, 488, is stepped on the underside in a plurality of steps 489 so as to fit the steps 487 on end 486. The outside layer of rubber is beveled off from each end, as at 490 and 491. In addition, a rectangular piece of the outside layer of rubber on the top of end 488 is removed, as at 492. After being suitably cleaned, steps 487 and 489 and recess 492 are coated with several coats of rubber cement, allowing time for drying between applications. A thin sheet of rubber is then wrapped around the steps on end 486, and the two ends assembled together. Two rivets 493 are driven through the handrails from the underside to secure the extremity of handrail end 488 to end 486, the heads of rivets 493 being well embedded in the canvas at the underside of the handrail, and the peened ends of the rivets being positioned in recess 492 below the exterior surface of the handrail. Figure 27 illustrates the joint at this stage. Recess 492 is then filled with thin sheets of rubber, and a strip of such material wrapped around the joint. The entire joint is then placed in a suitable vulcanizing mould, preferably electrically heated, and baked at an appropriate temperature (138° C. has been found satisfactory) for about thirty minutes, with at least a thirty minute cooling period while still in the mould. The resulting vulcanized handrail joint is smooth, as illustrated in Figure 28, and includes no gap in which fingers may be caught.

As mentioned in describing Figure 1, a governor 210 is driven from main drive shaft 207. This governor is illustrated in more detail in Figures 31 and 32. It comprises a horizontal shaft 110 driven from sprocket 111 through multiplying gearing 112. Governor arms 113 are pivotally secured to rotating member 114 with their inner ends engaging collar 115, which works against spring 116. Longitudinal motion of collar 115, which is dependent upon the speed of shaft 110, and thus upon the speed of the stairway, is made to cause rotation of a shaft 117 extending through the casing of the governor. Arm 118 is thereby rotated, and thus cams 130 and 140, mounted upon shaft 120, are rotated. Cams 130 and 140 control the position of weighted arms 131 and 141, respectively, at the end of each of which arms is a contact adapted to engage with a stationary contact mounted on an insulating panel 121. The contacts controlled by cam 130 through arm 131 are designated 33, while the contacts controlled by cam 140 through arm 141 are designated 44. These contacts are indicated diagrammatically in Figure 31.

The positions of the parts as shown in Figures 31 and 32 are the positions when the stairway is stationary. At this time contacts 33 are separated and contacts 44 are in engagement Contacts 33 are maintained separated due to weight 132 on arm 131 maintaining arm 131 so that roller 133 thereon engages recessed surface 134 of cam 130. Contacts 44 are maintained in engagement due to the engagement of end 143 of arm 141 with surface 144 of cam 140. Motion of the stairway in either direction causes counterclockwise rotation of cams 130 and 140, as viewed in Figure 32. Before the stairway attains normal full speed the rotation of the cams is such as to cause roller 133 on arm 131 to roll on surface 135 of cam 130, and thereby cause the engagement of contacts 33. When the stairway is operating at normal full speed, both contacts 33 and 44 are in engagement.

In the event the stairway commences to operate at a speed greater than the allowable maximum, cam 140 is rotated so that recessed surface 145 of cam 140 is under end 143 of arm 141. Weight 142 on arm 141, always urging arm 141 counterclockwise, thereupon causes the separation of contacts 44 and the engagement of end 143 of arm 141 with recessed surface 145. In the event, for any reason, such as the presence of dirt, weight 142 should not effect the separation of contacts 44, further rotation of cam 140 as the stairway continues to overspeed brings lobe 146 on cam 140 into engagement with roller 147 on arm 141. Arm 141 is thus positively actuated to effect the separation of contacts 44. The separation of contacts 44, as will be explained later, brings the stirway to a stop. In order to maintain contacts 44 separated, once they have been caused to separate by overspeeding of the stairway, while the stairway slows down and while the stairway is stationary, the transition surface 148 between surface 144 and recessed surface 145 on cam 140 is so shaped, in conjunction with the shape of end 143 of arm 141, that end 143 of arm 141 is latched therein. After an inspection of the stairway to ascertain and remedy the cause for its overspeeding, the proper attendant manually resets governor contacts 44 by releasing end 143 of arm 141 from cam 140, and the stairway is then in condition to be restarted.

Figure 33 shows a schematic wiring diagram of the motor and controlling circuits for the moving stairway. In this figure, the coils and contacts of the electromagnetic switches are separated in the interest of simplification of circuits. For convenience in understanding the diagram, however, each coil is associated with the contacts which it actuates by means of a dot-and-dash line.

The various electromagnetic switches employed in illustrated control system are designated as a whole as follows:

A—Up direction switch
B—Down direction switch
C—Starting switch
D—Auxiliary accelerating switch
E—First accelerating switch
F—Second accelerating switch
G—Running switch
OL—Overload switches

Throughout the description which follows, these letters are applied as prefixes to the reference numerals for the parts of the above designated switches. Thus, for example, A30 indicates that the coil referred to is the actuating coil of the up direction switch, while A35 indicates contacts of such switch. In the case of numerals employed in the control system of Figure 33, the lowest number (10) appears in the upper left-hand corner of the figure, with the succeeding numbers following in numerical sequence, from left to right, downwardly of the sheet of drawings. The arrangement of the numbers in this sequence facilitates the ready location of any element referred to in the description. Electromagnetic switches are shown in their deenergized positions.

In the diagram, driving motor 85 is shown as of the alternating current type, being supplied with three phase current from mains 83 Brake release coil 79 of brake 90, and substantially all of the control equipment for the stairway are energized with direct current obtained from generator armature 17 of a small motor generator

set 15. Motor 13 of this set is an alternating current motor supplied from mains 10.

To start the stairway in the ascending direction, knife switches 16 and 19 on control board 215 having been closed, either up starting button 23 at the upper landing or up starting button 32 at the lower landing or up starting button 29 on control board 215 is operated. It is assumed in the following description that up starting button 23 at the upper landing is operated. A circuit is thereby completed for actuating coil C27 of the starting switch, said circuit being from phase I of supply line 10, by way of contacts 24 of button 23, actuating coil C27 to phase II. The resulting operation of starting switch C causes the engagement of contacts C12, C14 and C38. The engagement of contacts C12 and C14 completes the circuit for motor 13 of motor generator set 15. As a result, motor generator set 15 commences operation. Motor 13 is protected by thermal overload cut-outs 11 in the leads to phases I and III of source 10. The engagement of contacts C38 is in preparation of a circuit for the direction switches.

The generator of the motor generator set 15 is provided with a shunt field 21 and a series field 18 arranged for self-excitation. During the starting of the stairway, resistance 20 in the shunt field circuit of the generator is short-circuited by contacts G22 so that the generator builds up to normal voltage comparatively rapidly. As the voltage impressed across conductors 25 and 28, connected across armature 17 of the generator, approaches the rated voltage for the control system, actuating coil A30 of the up direction switch is energized sufficiently to cause its operation. The circuit for coil A30 may be traced from conductor 25, by way of contacts G45, contacts 26 of up button 23, actuating coil A30, electric interlock contacts B31, overload switch contacts OL36 and OL37, contacts C38, stop buttons 40 and 41 at the upper and lower landings, respectively, carriage safety switches 42 and 43 at either side of the lower landing, governor overspeed contacts 44, to conductor 28. The resulting operation of up direction switch A causes the engagement of contacts A35, A55, A68, A74 and A80, and the separation of contacts A50. The engagement of contacts A35 is of no effect at the present moment, its function appearing later in the description. The separation of contacts A50 assures that down direction switch B cannot be energized while up direction switch A is operated. The engagement of contacts A55 completes a holding circuit for actuating coil C27 of the starting switch by establishing a by-pass circuit around contacts 24 of up button 23. The engagement of contacts A74 and A80 connects the three windings 76, 86 and 96 of driving motor 85 to supply mains 83 so as to cause the motor to drive the stairway in the ascending direction, knife switch 84 having previously been closed. Windings 76, 86 and 96 are connected in star relation through starting resistances 77 and 78 for the first leg, 87 and 88 for the second leg and 97 and 98 for the third leg. The engagement of contacts A68 completes the circuit for brake release magnet 79.

As the brake release magnet 79 releases brake 90, motor 85 commences rotation so as to drive the stairway in the ascending direction. When brake 79 is fully released, brake contacts 73 are caused to separate to insert cooling resistance 72 in series with brake release coil 79. The separation of brake contacts 73 also results in the energization of actuating coil D70 of the auxiliary accelerating switch. Contacts D63 are thereby caused to engage and complete a circuit for actuating coil E58 of the first accelerating switch. This circuit may be traced from conductor 25, by way of contacts G57, coil E58, contacts D63, to conductor 28. Contacts E82 and E93 thereupon engage to short-circuit starting resistances 78, 88 and 98.

At the expiration of a predetermined interval of time after the energization of actuating coil E53 and engagement of contacts E82 and E93, contacts E62 engage. This time delay may be effected in any suitable manner, as by the dashpot 67. The engagement of contacts E62 completes a circuit for actuating coil F66 of the second accelerating switch. This circuit may be traced from conductor 25, by way of conductor 60, contacts E62, coil F66, contacts D63, to conductor 28. The resulting engagement of contacts F81 and F92 short-circuits starting resistances 77, 87 and 97 so that the windings of driving motor 85 are connected in star relation directly across the power mains.

Driving motor 85, after the engagement of contacts A74 and A80, gradually increases its speed. Before driving motor 85 and stairway 200 attain normal full speed, governor contacts 33 engage, as explained previously in reference to Figures 31 and 32. The function of these contacts will appear shortly. The operation of second accelerating switch F, in addition to causing the engagement of contacts F81 and F92, as described previously, also causes the engagement of contacts F65. A circuit is thereby completed for actuating coil G64 of the running switch. Running switch G thereupon operates to cause the engagement of contacts G34 and G61 and the separation of contacts G22, G45 and G57. The construction of running switch G is such that contacts G34 and G61 engage before contacts G45 and G57, respectively, separate. This construction is diagrammatically illustrated in Figure 33 by having each movable contact bridge for contacts G34, G45, G57 and G61 arranged to slide between stationary segments, with the location and dimensions of the bridges and segments such that the circuits through contacts G34 and G61 are completed before the breaking of the circuits through contacts G45 and G57.

The engagement of contacts G61 completes a holding circuit for actuating coil F66 of the second accelerating switch so that, when contacts G57 subsequently separate to deenergize actuating coil E58 of the first accelerating switch, second accelerating switch F remains operated.

The engagement of contacts G34 completes a holding circuit for actuating coil A30 of the up direction switch. This circuit may be traced from conductor 25, by way of governor contacts 33 (the stairway having attained such a speed that these contacts are now engaged), contacts G34, contacts A35, actuating coil A30, contacts B31, and out to conductor 28 in the manner previously described. It is to be noted that this holding circuit is established before the initial energizing circuit for coil A30, by way of contacts G45 and contacts 26 of up button 23, is broken. (Up to this time up starting button 23 must be held in operated position.) The subsequent separation of contacts G45 therefore does not interrupt the operation of the stairway, but merely renders ineffective all the starting buttons, both up and down. Up starting button 23 can now be released. The circuit originally

established through contacts 24 of up starting button 23 is maintained by contacts A55, while the circuit originally established through contacts 26 of up starting button 23 is maintained by way of governor contacts 33, contacts G34 and contacts A35.

The separation of contacts G22 inserts resistance 20 in the circuit of generator field 21 to reduce the current therethrough after the stairway has been set in operation.

It is to be noted that in the event the stairway fails to attain the speed at which governor contacts 33 engage, the holding circuit for actuating coil A30 by way of governor contacts 33 and contacts G34 is not established. As a consequence, when up starting button 23 is released, actuating coil A30 becomes deenergized. The attendant return of the contacts of up direction switch A to their initial positions thereupon causes the deenergization of the driving motor and of the brake release coil so that as a consequence the stairway is brought to a stop. Unsafe operation of the stairway is thus prevented.

When it is desired to stop the stairway, either stop button 40 at the upper landing or stop button 41 at the lower landing may be operated. The holding circuit for actuating coil A30 of the up direction switch is thereupon broken. The up direction switch drops out, thereby stopping the stairway and applying the brake. When the brake applies, contacts 73 reengage, thereupon short-circuiting actuating coil D70. The resultant dropping out of auxiliary accelerating switch D causes the deenergization of actuating coils F66 and G64, so that these two switches return to their original positions. Starting switch C drops back to its initial position, and motor generator set 15 is shut down, due to the separation of contacts A55 when up direction switch A returns to its initial position.

In the event either or both carriage safety switches 42 or 43 operate, or governor overspeed contacts 44 operate, the holding circuit for the direction switch is broken and the stairway brought to a stop, in a manner similar to that just described. In the event there is an excessive current through either coils OL75 or OL95 of the overload switches, so as to cause a separation of contacts OL36 or OL37, respectively, a similar shutting down of the stairway results.

When it is desired to operate the stairway in the descending direction, either down starting button 46 at the upper landing or down starting button 52 at the lower landing or down starting button 48 on control panel 215, is operated. In the following description, it is assumed that down starting button 52 at the lower landing is operated. Starting switch C is operated and motor generator set 15 brought up to speed in a manner similar to that described for starting the stairway in the ascending direction, due to the fact that contacts 53 of down starting button 52 are in parallel with contacts 24 of up starting button 23. Rated voltage for the controller thereupon being impressed across conductors 25 and 28, sufficient current passes through actuating coil B51 of the down direction switch to cause the operation of such switch. The circuit by which actuating coil B51 is energized may be traced from conductor 25, by way of contacts G45, contacts 54 of down starting button 52, electric interlock contacts A50, actuating coil B51 and out to conductor 28 in the manner as described for the energizing circuits of up direction switch A. The resulting operation of down direction switch B causes the engagement of contacts B47, B56, B71, B91 and B94 and the separation of contacts B31. The separation of contacts B31 prevents the energization of up direction switch A while down direction switch B is operated. The engagement of contacts B47 is of no effect at the present moment. The engagement of contacts B56 establishes a holding circuit for actuating coil C26 in a manner similar to that described for contacts A55. The engagement of contacts B71 completes a circuit for the brake release magnet 79. The engagement of contacts B91 and B94 effects the energization of driving motor 85 in such a manner that the stairway is driven in the descending direction. The subsequent operations of the control system in bringing the stairway up to normal speed and in effecting the stopping of the stairway, are similar to those described for starting and stopping the stairway when operating in the ascending direction, and as a consequence are not described.

It is to be noted that in the event the stairway stops without such stopping having been caused intentionally or by the operation of a safety or protective device—as by the breaking of driving chain 205 or the blowing of the fuses in the supply main for the driving motor—the slowing down of the stairway results in the separation of governor contacts 33. The energizing circuit for the operated direction switch is thereby broken, and driving motor 85 deenergized and brake 90 applied. The stairway is thus brought to a stop and maintained stationary until the cause of the trouble has been ascertained and fixed and the stairway restarted manually. This function of governor contacts 33 is particularly effective in preventing the stairway, while it is in operation in the ascending direction, from reversing and commencing operation in the descending direction of its own accord.

It is to be noted that in the description of the mechanical parts of the stairway, it is, for convenience, generally assumed that the stairway, when operating, is operating in the ascending direction. When the stairway is operating in the descending direction, however, the mechanical parts operate in a fashion analogous to that when the stairway is in operation in the ascending direction, as is believed evident without further description.

Attention is directed to the fact that no part of the upper landing drive equipment overhangs on either side beyond the width of the stairway. As a consequence, the complete stairway may be installed in locations where the available space at the upper landing is no wider than the stairway. In addition, the same assembly of equipment at the upper landing may be employed regardless of whether the stairway, when placed against a building wall, has one or the other side adjacent thereto.

It is to be noted that the handrail and balustrade constructions are such that the handrail and the related equipment can be installed and completely tested prior to the installation of any balustrading.

It is also to be noted that any chain wheel may be replaced easily and quickly, without dismantling the running gear chain.

Inasmuch as many changes could be made in the above constructions and many apparently widely different embodiments of this invention could be made without departing from the scope

thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a moving stairway; two similarly pitched endless running gear chains of equal length, one at each side of the stairway; a plurality of axles, said axles connecting corresponding parts of said chains at uniform intervals and each having a portion projecting beyond each of said chains; a plurality of steps, one for each of said axles, mounted on said axles between said chains; and two step wheels for each of said steps, one for either side thereof, mounted on the portions of the axle for such step that project beyond said chains.

2. In a moving stairway; two uniformly pitched endless running gear chains of equal length, one at each side of the stairway, the chain pins at regular intervals in each of said chains being hollow; a plurality of axles, each of said axles extending through corresponding hollow chain pins in said chains at opposite sides of the stairway, and projecting out beyond said chains at both sides of the stairway; a plurality of steps, one for each of said axles; means for mounting each step upon its corresponding axle and for dismounting such step therefrom, while such axle remains in place connecting said two chains; and two step wheels for each of said steps, one for either side thereof, mounted on the portions of the axle for such step that project beyond said chains.

3. In a moving stairway; two uniformly pitched endless running gear chains of equal length, one at each side of the stairway, the chain pins at regular intervals in each of said chains being hollow; a plurality of axles, each of said axles extending through corresponding hollow chain pins in said chains at opposite sides of the stairway, and projecting out beyond said chains at both sides of the stairway, said axles fitting loosely in said chain pins so that they are free to turn therein, and do not bind in the event corresponding chain pins of said chains are not in alignment; a plurality of steps, one for each of said axles; means for rotatably mounting each step upon its corresponding axle and for dismounting such step therefrom, while such axle remains in place connecting said two chains; and two step wheels for each of said steps, one for either side thereof, rotatably mounted on the portions of the axle for such step that project beyond said chains, whereby each axle is free to rotate with respect to its chain pins, and to the step and the step wheels mounted thereon.

4. In a moving stairway; two uniformly pitched endless running gear chains of equal length, one at each side of the stairway, the chain pins at regular intervals in each of said chains being hollow; a plurality of axles, each of said axles extending through corresponding hollow chain pins in said chains at opposite sides of the stairway, and projecting out beyond said chains at both sides of the stairway; means securing each axle to one of said chains so as to prevent rotation of said axles with respect to said chains; a plurality of steps, one for each of said axles; means for rotatably mounting each step upon its corresponding axle and for dismounting such step therefrom, while such axle remains in place connecting said two chains; and two step wheels for each of said steps, one for either side thereof, rotatably mounted on the portions of the corresponding axle for such step that project beyond said chains.

5. In a moving stairway; and endless series of steps, each having at least two unflanged step wheels, one on either side thereof, with all said step wheels on the same side of the steps running in the same vertical plane; tracks for said step wheels, said tracks comprising thin strips of metal substantially rectangular in cross section, with the tracks for said step wheels at one side of the steps having a groove formed therein for guiding said steps, and the tracks for said step wheels at the other side of the steps having a flat track surface; stairway trusswork for supporting said tracks, said trusswork having shoulders upon which said tracks rest; and clamps for clamping said tracks to said shoulders.

6. In a moving stairway; an endless series of steps, each having two step wheels at one side thereof rolling in different vertical planes, with corresponding step wheels of the steps rolling in the same vertical plane; a track for each set of step wheels that roll in the same vertical plane, said tracks comprising thin strips of metal substantially rectangular in cross section; stairway trusswork including longitudinally spaced members having shoulders thereon upon which rest one of said tracks; means for securing such track to the shoulders upon which it rests; and means for supporting the other of said tracks from the first mentioned track, said means comprising brackets secured to the supporting and supported tracks intermediate said shoulders.

7. In a moving stairway; an endless series of steps, each having two unflanged step wheels at each side thereof rolling in different vertical planes, with corresponding step wheels of the steps rolling in the same vertical plane; a track for each set of step wheels that roll in the same vertical plane, said tracks comprising thin strips of metal substantially rectangular in cross section, with the track for one of said sets of step wheels having a groove therein for guiding said steps, and each of said remaining tracks having a flat track surface; stairway trusswork including longitudinally spaced members having shoulders thereon upon which rest one of said tracks at each side of the stairway; clamps securing each of such tracks to the shoulders upon which it rests; and means for supporting the other of said tracks at each side of the stairway from the first mentioned track at such side of the stairway, said means comprising brackets secured to the supporting and supported tracks intermediate said shoulders.

8. In a moving stairway; two similarly pitched endless running gear chains of equal length, one at each side of the stairway; a plurality of axles, said axles connecting corresponding parts of said chains at uniform intervals and each having a portion projecting beyond each of said chains; a plurality of steps, one for each of said axles, mounted on said axles between said chains; two unflanged step wheels for each of said steps, one for either side thereof, mounted on the portions of the corresponding axle for such step that project beyond said chains; two unflanged trailer wheels for each of said steps, one for either side thereof, mounted upon such step between the vertical side planes thereof and beneath the treads thereof, said chain wheels and trailer wheels being so mounted that corresponding wheels of the steps roll in the same vertical plane; a track for each set of wheels that roll in the same vertical plane, said tracks comprising thin strips of metal

substantially rectangular in cross section, with the track for the set of chain wheels at one side of the stairway having a groove therein for guiding said steps, each of said remaining tracks having a flat track surface; stairway trusswork including longitudinally spaced members at each side of the stairway having shoulders thereon upon which rest the chain wheel tracks; means for securing each of such chain wheel tracks to the shoulders upon which it rests; and means for supporting the trailer wheel track at each side of the stairway from the chain wheel track at such side of the stairway, said means comprising brackets secured to the respective chain and trailer wheel tracks intermediate said shoulders.

9. In a moving stairway, an endless series of steps, each having two step wheels at one side thereof rolling in different vertical planes, with corresponding step wheels of the steps rolling in the same vertical plane, thereby forming two sets of step wheels; a plurality of track units for said step wheels, each unit comprising a length of track for each of said sets of step wheels on the upper incline run of said stairway, each length of track being formed of a thin strip of metal substantially rectangular in cross section, and a plurality of separator brackets, said brackets securing together the two lengths of track of each track unit; stairway trusswork including longitudinally spaced members having shoulders thereon upon which rest the lengths of track for one of said sets of step wheels; means for securing each track unit to said trusswork, said means comprising means for securing the lengths of tracks which rest upon said shoulders to such shoulders; and means for securing together the abutting ends of adjacent track units so that the track surfaces are smooth and continuous.

10. In a moving stairway having an endless series of steps; two endless running gear chains for said steps, one chain at each side of said stairway; shaft means connecting each side of each step with the running gear chain at the corresponding side thereof so as to pivotally secure each step to both of said chains; two chain wheels for each step mounted on the shaft means for such step in vertical planes differing from the planes of said chains, one wheel at either side of each step; a pair of sprockets, one for each chain, engaging said chains at one end of said stairway; a track for said chain wheels at each side of said stairway for supporting said steps as said chains approach and engage said sprockets while said steps are on the upper run of said stairway, both of said tracks extending up to and ending slightly beyond the centerline of said sprockets so as to support said steps by means of said chain wheels until said chains are fully seated in said sprockets and said sprockets assume the support of said steps; and means for vertically adjusting the ends of said tracks so as to cause said chains to engage said sprockets tangentially.

11. In a moving stairway having an endless series of steps; two endless running gear chains for said steps, one chain at each side of said stairway; shaft means connecting each side of each step with the running gear chain at the corresponding side thereof so as to pivotally secure each step to both of said chains; two chain wheels for each step mounted on the shaft means for such step in vertical planes differing from the planes of said chains, one wheel at either side of each step; a pair of sprockets, one for each chain, engaging said chains at one end of said stairway; a track for said chain wheels at each side of said stairway for supporting said steps as said chains approach and engage said sprockets while said steps are on the upper run of said stairway, both of said tracks extending up to and ending slightly beyond the centerline of said sprockets so as to support said step by means of said chain wheels until said chains are fully seated in said sprockets and said sprockets assume the support of said steps; a track for said chain wheels at each side of said stairway for supporting said steps as said chains disengage and recede from said sprockets after said steps have passed around said sprockets and while they are on the return run of said stairway, the ends of both of said tracks proximate to said sprockets being substantially horizontal and extending at least up to and slightly beyond the centerline of said sprockets so as to effect the support of said steps by means of said chain wheels just prior to the disengagement of said chains from said sprockets and thus, just prior to the resulting termination of the support of said steps by said sprockets; and means for vertically adjusting the ends of all four of said tracks so as to cause said chains to engage with, and disengage from, said sprockets tangentially.

12. In a moving stairway having an endless series of steps, two endless running gear chains for said steps, one chain at each side of said stairway; shaft means connecting each side of each step with the running gear chain at the corresponding side thereof so as to pivotally secure each step to both of said chains; two chain wheels for each step mounted on the shaft means for such step in vertical planes differing from the planes of said chains, one wheel at either side of each step; and means for supporting said steps and chains continuously as they approach one end of said stairway on the upper run thereof, reverse their direction of travel at said end of said stairway, and recede from said end of said stairway on the return run thereof, said means comprising, a track for said chain wheels at each side of said stairway for supporting said steps and chains as they approach said end of said stairway on the upper run thereof, a pair of sprockets, one for each of said chains, at said end of said stairway engaging said chains and supporting said chains and steps as they reverse their direction of travel, and a track for said chain wheels at each side of said stairway for supporting said steps and chains as they recede from said end of said stairway on the return run thereof, said first mentioned set of tracks extending alongside said sprockets so as to continue to support said chains and steps until said chains are fully seated in said sprockets, and then terminating, and said second mentioned set of tracks extending alongside said sprockets so as to partake in the support of said chains and steps shortly before said chains disengage from said sprockets.

13. In a moving stairway; two uniformly pitched endless running gear chains of equal length, one at each side of the stairway, the chain pins at regular intervals in each of said chains being hollow; a plurality of axles, each of said axles extending through corresponding hollow chain pins in said chains at opposite sides of the stairway, and projecting out beyond said chains at both sides of the stairway; a plurality of steps, one for each of said axles; means for mounting each step upon its corresponding axle and for dismounting such step therefrom, while such axle remains in place con-

necting said two chains; two chain wheels for each of said steps, one for either side thereof, mounted on the portions of the axle for such step that project beyond said chains; a pair of sprockets, one for each chain, engaging said chains at one end of said stairway; a track for said chain wheels at each side of said stairway for supporting said steps as said chains approach and engage said sprockets while said steps are on the upper run of said stairway, both of said tracks extending up to and ending slightly beyond the centerline of said sprockets so as to support said steps by means of said chain wheels until said chains are fully seated in said sprockets and said sprockets assume the support of said steps; and means for adjusting the ends of said tracks so as to cause said chains to engage said sprockets tangentially.

14. In a moving stairway; two uniformly pitched endless running gear chains of equal length, one at each side of the stairway, the chain pins at regular intervals in each of said chains being hollow; a plurality of axles, each of said axles extending through corresponding hollow chain pins in said chains at opposite sides of the stairway, and projecting out beyond said chains at both sides of the stairway; a plurality of steps, one for each of said axles; means for mounting each step upon its corresponding axle and for dismounting such step therefrom, while such axle remains in place connecting said two chains; two chain wheels for each of said steps, one for either side thereof, mounted on the portions of the axle for such step that project beyond said chains; and means for supporting said steps and chains continuously as they approach one end of said stairway on the upper run thereof, reverse their direction of travel at said end of said stairway, and recede from said end of said stairway on the return run thereof, said means comprising, a track for said chain wheels at each side of said stairway for supporting said steps and chains as they approach said end of said stairway on the upper run thereof, a pair of sprockets, one for each of said chains, at said end of said stairway engaging said chains and supporting said chains and steps as they reverse their direction of travel, and a track for said chain wheels at each side of said stairway for supporting said steps and chains as they recede from said end of said stairway on the return run thereof, said first mentioned set of tracks extending alongside said sprockets so as to continue to support said chains and steps until said chains are fully seated in said sprockets, and then terminating, and said second mentioned set of tracks extending alongside said sprockets so as to partake in the support of said chains and steps shortly before said chains disengage from said sprockets.

15. In a moving stairway having an endless series of steps passing in a loop at one end of said stairway, means for cramping the steps in said loop, said means comprising a guide for said steps at one side thereof fixed with respect to the position of said loop, and a guide for said steps at the other side thereof flexible with respect to the position of said loop.

16. In a moving stairway; an endless series of steps, with each step having two step wheels at each side thereof rolling in different vertical planes, and with corresponding step wheels of the steps rolling in the same vertical plane thereby forming four sets of step wheels, said endless series of steps having a loop at each end of said stairway where said steps, when said stairway is in motion, pass from one run of said stairway to the other; and guiding means for two of said sets of step wheels, one set at each side of said steps, as said steps pass around one of said loops, said guiding means comprising, arcuate track means for said set of step wheels at one side of said steps fixedly mounted with respect to the position of said loop, arcuate track means for said set of step wheels at the other side of said steps, means mounting said last mentioned arcuate track means with respect to the position of said loop so that it has movement in a direction longitudinally of the stairway, and spring means urging said last mentioned arcuate track means in said direction taking up clearance and lost motion in the running gear as said steps pass around said loop.

17. In a moving stairway having an endless series of steps; two endless running gear chains for said steps, one chain at each side of said stairway; shaft means connecting each side thereof so as to pivotally secure each step to both of said chains; two chain wheels for each step mounted on the shaft means for such step, one wheel at either side thereof; two trailer wheels for each step mounted adjacent either side of such step in vertical planes differing from the planes in which said chain wheels are mounted; a pair of of sprockets, one for each chain, engaging said chains at one end of said stairway as said steps pass from one run of said stairway to the other, thereby forming a loop in said endless series of steps; and means for cramping said steps transversely as they pass through said loop, said means comprising two arcuate guides for said trailer wheels, one at each side of said steps, the guide at one side being fixedly mounted with respect to the path of the steps in said loop, and the guide at the other side being resiliently mounted with respect to the path of the steps in said loop so as to urge such side of the steps to a position where the path for the trailer wheels at such side of the steps is longer than the path for the other trailer wheels.

18. Guiding means for the trailer wheels at each side of the steps in a moving stairway as the running gear chains thereof pass around the sprocket wheels at one end of said stairway, said guiding means comprising; an arcuate guide having an inner and an outer flange for guiding the trailer wheels at one side of the steps, said guide being fixedly mounted with respect to the axis of said sprocket wheels; an arcuate guide having an inner and an outer flange for guiding the trailer wheels at the other side of the steps, the outer flange of said guide being fixedly mounted with respect to the axis of said sprocket wheels; and spring means mounting the inner flange of the last mentioned guide so that it is urged perpendicularly to the axis of said sprockets in a direction toward the outer flange of said last mentioned guide.

19. In a moving stairway, means for cramping the steps in the loop thereof at each end of said stairway, said means for one end comprising a guide for said steps at one side thereof fixed with respect to the position of said loop at such end and a guide for said steps at the other side thereof flexible with respect to the position of said loop at such end, and said means for the other end comprising a guide for said steps at the first mentioned side thereof flexible with respect to the position of said loop at such end, and a guide for said steps at the second mentioned side thereof fixed with respect to the position of said loop at such end.

20. In a moving stairway; an endless series of steps, with each step having two step wheels at each side thereof rolling in different vertical planes, and with corresponding step wheels of the steps rolling in the same vertical plane thereby forming four sets of step wheels, said endless series of steps having a loop at each end of said stairway where said steps, when said stairway is in motion, pass from one run of said stairway to the other; and guiding means for two of said sets of step wheels, one set at each side of said steps, as said steps pass around each of said loops, said guiding means at one end of said stairway comprising, arcuate track means for said set of step wheels at one side of said steps fixedly mounted with respect to the position of the loop at such end, arcuate track means for said set of step wheels at the other side of said steps, means mounting said last mentioned arcuate track means with respect to the position of the loop at such end so that it has movement in a direction toward the outside of the loop at such end, and spring means urging said last mentioned arcuate track means in said direction to effect a cramping action upon said steps as they pass around the loop at such end, and said guiding means at the other end of said stairway comprising, arcuate track means for said set of step wheels at the second mentioned side of said steps fixedly mounted with respect to the position of said loop at such second end, arcuate track means for said set of step wheels at the first mentioned side of said steps, means mounting said last mentioned arcuate track means with respect to the position of said loop at such second end so that it has movement in a direction toward the outside of the loop at such second end, and spring means urging said last mentioned arcuate track means in said direction to effect a cramping action upon said steps as they pass around the loop at such second end, whereby the forces for effecting cramping are applied at one side of the stairway at one end and at the other side of the stairway at the other end.

21. Guiding means for the trailer wheels at each side of the steps in a moving stairway as the running gear chains thereof pass around the sprocket wheels at each end of said stairway, said guiding means comprising; a pair of arcuate guides, each having an inner and an outer flange, one guide for guiding the trailer wheels at one side of the steps at the upper end of the stairway, and the other guide for guiding the trailer wheels at the other side of the steps at the lower end of the stairway, each of said guides being fixedly mounted with respect to the axis of the sprocket wheels at the corresponding end of the stairway; a second pair of arcuate guides, each having an inner and an outer flange, one guide for guiding the trailer wheels at the first mentioned side of the steps at the lower end of the stairway, and the other guide for guiding the trailer wheels at the second mentioned side of the steps at the upper end of the stairway, the outer flange of each of said second pair of guides being fixedly mounted with respect to the axis of the sprocket wheels at the corresponding end of the stairway; and spring means mounting the inner flange of each guide of said second pair of guides so that each inner flange is urged perpendicularly to the axis of the sprockets at the corresponding end of the stairway in a direction toward its outer flange.

22. In a moving stairway having an endless series of steps; two endless running gear chains for said steps, one chain at each side of said stairway, so that said steps are positioned between said two chains; a shaft positioned transversely to said stairway; two sprocket wheels, one engaging each of said chains, mounted upon and secured to said shaft; braking mechanism for said stairway positioned between said two sprocket wheels and acting on said drive shaft, said braking mechanism being of the spring-applied power-released type; and means for mechanically releasing the brake of said braking mechanism exteriorly of the endless series of steps.

23. In a moving stairway having an endless series of steps; two endless running gear chains for said steps, one chain at each side of said stairway, so that said steps are positioned between said two chains; means for driving said two chains at the upper end of the stairway, and thus effecting movement of said steps, said means comprising, a sprocket wheel for each of said chains, each chain passing around its sprocket wheel as it reverses its direction of travel at the upper landing, and a drive shaft upon which said two sprocket wheels, one for each of said two chains, are mounted and secured; braking mechanism for said stairway positioned between said two sprocket wheels and acting on said drive shaft, said braking mechanism being of the spring-applied power-released type; and means, including a member extending from said braking mechanism to one side of said stairway beyond the vertical plane including the chain at such side of the stairway, for mechanically releasing the brake of said braking mechanism exteriorly of the endless series of steps.

24. In a moving stairway; a motor; connections from said motor to the stairway by which said motor drives the stairway; a brake effective to stop the stairway and maintain it stationary regardless of said connections; switching mechanism for releasing said brake and for energizing said motor so that it drives the stairway in the ascending direction; and means, including a switch directly responsive to a predetermined decrease of the speed of the stairway below its normal full speed, due, for example, to the failure of said connections, for deenergizing said motor and applying said brake to thereby prevent reversal of the stairway due to passenger load.

25. In a moving stairway; a motor; connections from said motor to the stairway by which said motor drives the stairway; a brake effective to stop the stairway and maintain it stationary regardless of said connections; a manually operable starting switch for starting the stairway in the ascending direction; switching mechanism responsive to operation of said starting switch for releasing said brake and for energizing said motor so that it drives the stairway in the ascending direction; and means, including a switch directly responsive to the speed of the stairway, and effective after the stairway has attained a certain speed less than normal full speed, for rendering said starting switch ineffective to cause operation of the stairway, and for maintaining said brake released and said motor energized subject to said speed responsive switch, so that in the event the speed of the stairway falls below said certain speed, due, for example, to the failure of said connections, said motor is deenergized and said brake is applied, thereby bringing the stairway to a stop and preventing any load on the stairway from overhauling it and causing it to run in the descending direction.

DAVID LEONARD LINDQUIST.
ARTHUR EDWARD HANDY.
SAMUEL GUSTAVE MARGLES.