May 26, 1959 L. J. NIXON 2,888,182

VARIABLE PITCH STAIRS

Filed April 2, 1957 3 Sheets-Sheet 1

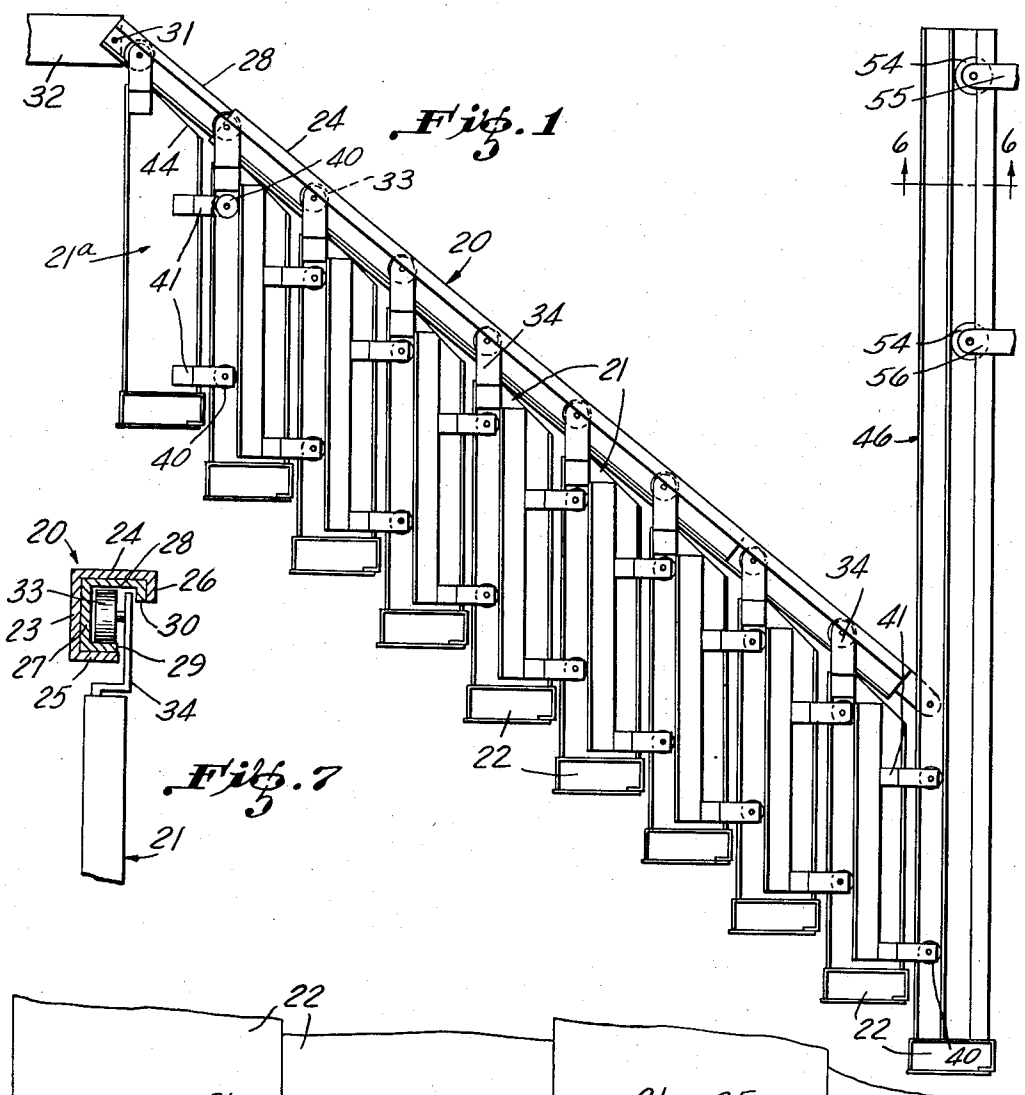


Fig. 1

Fig. 7

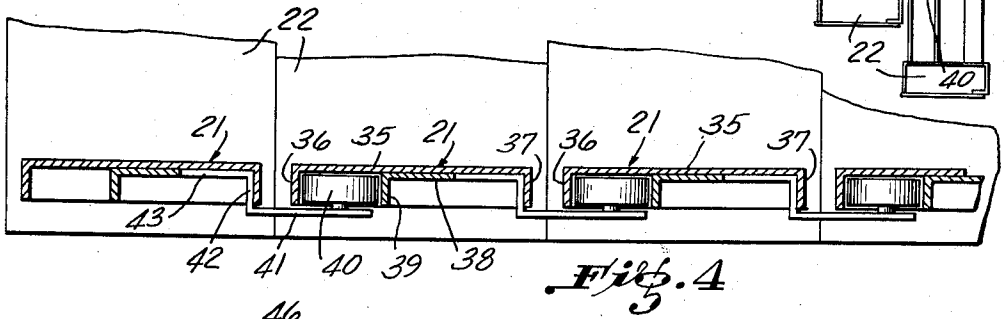


Fig. 4

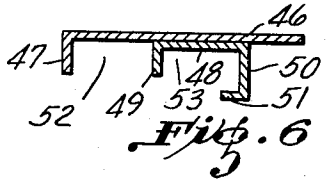


Fig. 6

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VARIABLE PITCH STAIRS

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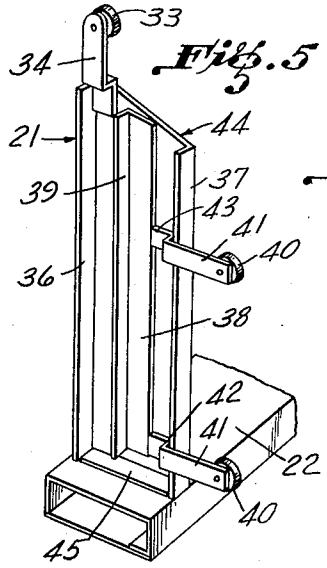


Fig. 5

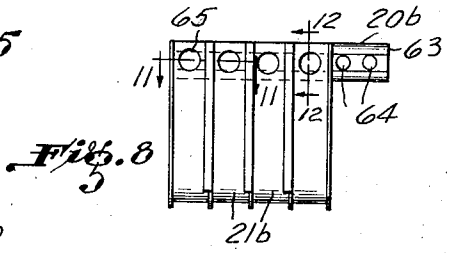


Fig. 8

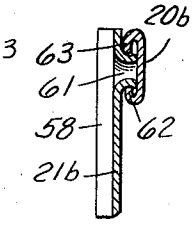


Fig. 12

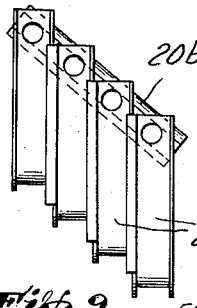


Fig. 9

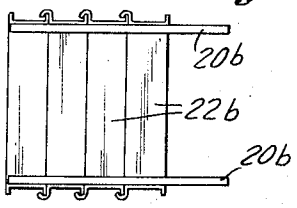


Fig. 10

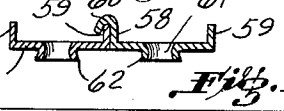


Fig. 11

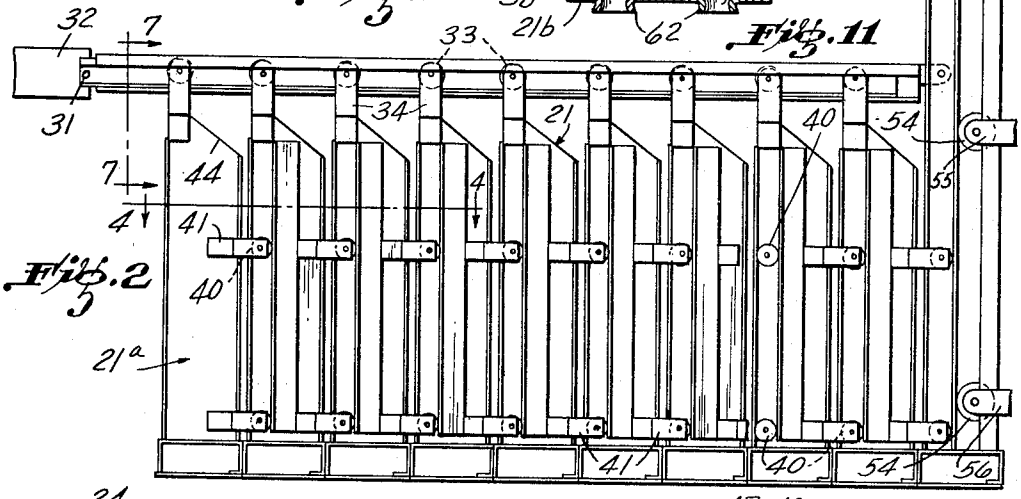


Fig. 2

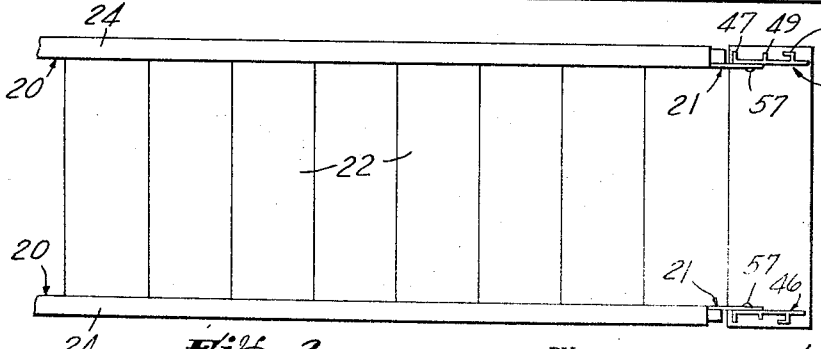


Fig. 3

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VARIABLE PITCH STAIRS

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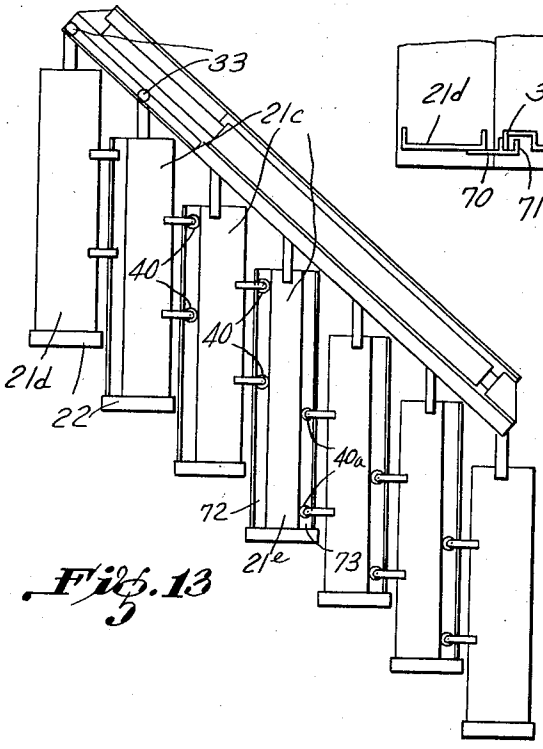


Fig. 13

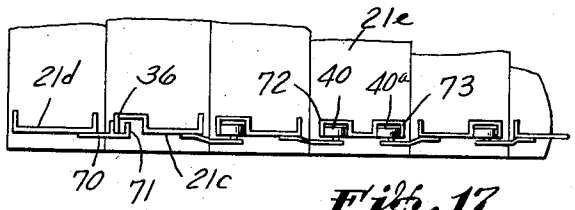


Fig. 17

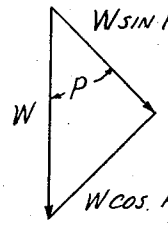


Fig. 18

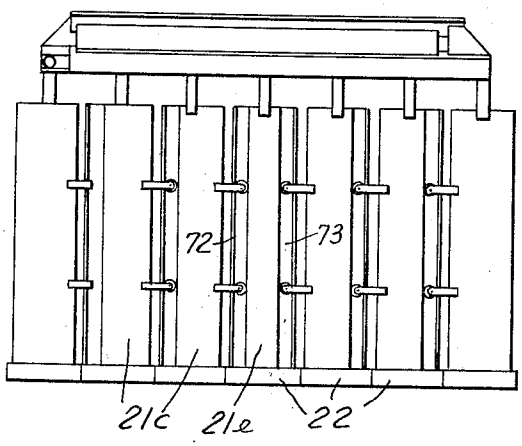


Fig. 14

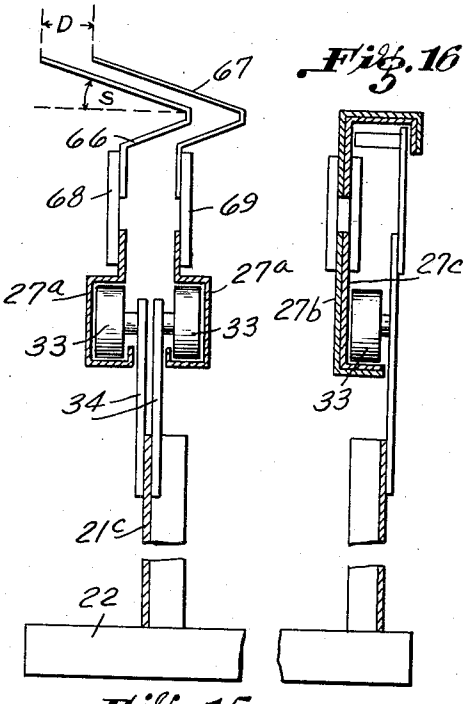


Fig. 16

Fig. 15

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United States Patent Office 2,888,182 Patented May 26, 1959

2,888,182

VARIABLE PITCH STAIRS

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Application April 2, 1957, Serial No. 650,163

13 Claims. (Cl. 228—48)

The present invention relates to variable pitch stairs and has for an object to provide a stair unit in which the pitch or inclination of the stair treads or steps may be adjusted to any desirable angle.

Another object of the invention is to provide a stair unit which will be adjustable as to pitch through an infinite number of successive angles whereby in one position, the steps or treads may be caused to assume a zero pitch angle all extending in a single horizontal plane, in which case the unit provides a platform, to another assumed position in which the inclination of the steps is steep providing a ladder-like arrangement. It is also desired to provide loading stairs adjustable to airplanes and other carriers of variable height.

It is a further object of the invention to provide a folding or collapsible stair unit of such flexibility that it may be accommodated in cramped areas and will lend itself to a variety of angular adjustments making it suitable for use in various constructional environments.

The invention has for a still further object to provide an improved stair unit involving treads or steps, balusters and stringers providing handrails which are so related and grouped into the stair unit that the treads will in any angular position of the parts always lie in a horizontal position and in which the balusters, which support the treads, will have anti-friction supports from the stringers, and in which means are provided between the adjacent baluster elements to unite and mutually guide the movements of the same so that such baluster units will be maintained at all times in a relation of parallelism although capable of moving substantially vertically relative to one another so that the rise of the steps may be altered conveniently and the inclination upstairs as a whole made to suit building constructions of a varied character.

The invention also contemplates improvement in certain mechanical detail in providing stringers composed of telescoping relatively movable parts in which are provided tracks for the movement of rollers which support the balusters, and in the novel construction of the balusters which provide tracks for rollers carried by brackets from adjacent balusters so that the parallel movement of the balusters may be facilitated and the relationship of the balusters at all times and in all positions maintained.

With the foregoing and other objects in view, the invention will be more fully described hereinafter and more particularly pointed out in the appended claims.

In the drawings, in which the same reference numerals indicate like parts throughout the several views:

Figure 1 is a side elevational view of a variable pitch stair unit constructed in accordance with the present invention and illustrated in a diagonal operative position,

Figure 2 is a similar view in which the members of the unit have been moved into a horizontal position in which the treads constitute a platform for workers,

Figure 3 is a fragmentary top plan view, with parts broken away, of the unit in the position of Figure 2,

Figure 4 is a fragmentary horizontal sectional view taken on an enlarged scale on the line 4—4 in Figure 2,

Figure 5 is a fragmentary isometric view of a stair tread and baluster according to one form of the invention,

Figure 6 is a horizontal sectional view taken on a magnified scale along the line of 6—6 of Figure 1,

Figure 7 is a vertical sectional view taken on an enlarged scale on the line 7—7 of Figure 2,

Figure 8 is a side elevational view of a modified form of the variable pitch stair unit,

Figure 9 is a similar view showing the parts in a subsequent position,

Figure 10 is a top plan view of the unit of Figures 8 and 9,

Figure 11 is a fragmentary horizontal sectional view taken on an enlarged scale on the line 11—11 in Figure 8,

Figure 12 is a vertical sectional view taken on an enlarged scale on the line 12—12 of Figure 8,

Figure 13 is a side elevational view of the further modified form of the invention showing the unit in an ascending scale,

Figure 14 is a similar view with the elements of the unit disposed horizontally,

Figure 15 is a vertical sectional view taken through the units of Figures 13, 14, on an enlarged scale and showing one form of stringer and handrails,

Figure 16 is a similar view showing a modified form of stringer arrangement,

Figure 17 is a fragmentary top plan view of the stair treads of Figures 13 and 14 with the balusters in top edge view, and

Figure 18 is an algebraic graph indicative of the mathematics of the invention.

Referring more particularly to the drawings and for the present to that form of the invention shown in Figures 1 to 7, inclusive, **20** designates stringers, **21** balusters or hangers and **22** treads or steps, which together generally compose the unit constituting the variable pitch stairs.

In general, the stringers **20** which also provide the handrails carry the balusters **21** which in turn support the treads or steps **22**.

Each stringer **20**, of which there are two, one at each side of the stairway, are preferably constituted of two telescopic members, more particularly illustrated in Figure 7. In this figure, **23** designates the base of the outer channel member, **24** the upper flange and **25** the lower flange thereof. A guard flange **26** extends downwardly from the free edge of the upper flange **24**.

The inner channel member is constituted of a base **27**, upper flange **28**, lower flange **29** and guard flange **30**, which extends downwardly from the free edge of the upper flange **28**. The respective base members and flanges fit closely together for free sliding movement in a longitudinal direction.

As appears more particularly from Figure 1, one of the channel members of each stringer will be pivoted, as at **31**, to a fixed support **32**, for instance to a floor or ceiling beam of a building. In the instance shown, it is the inner channel member that is pivoted at **31**. The fixed support **32** would normally be a wall, railing or post located at a distance above the floor.

As appears from Figure 7, the two channel members of each stringer provide internal tracks or guideways for rollers **33** or other anti-friction elements which are rotatably journaled in brackets **34** fixed to the upper portions of the balusters or hangers **21**. In this way, the

balusters 21 derive support from the stringers and at the same time the rollers 33 may freely rotate in the tracks or guideways incident to the angular movement of the stringers about the pivot 31 in assuming variable inclinations or pitches.

Referring more particularly to Figure 4, which illustrates a form of baluster, the same are each seen to comprise channel strips or beams in which 35 designates the base of a channel, and 36 and 37 flanges, which extend out at substantially right angles from opposite vertical edges of the channel base 35. Angle strips may be also affixed to the external surfaces of the bases 35, the angle strip bases being indicated at 38, they being welded, riveted or otherwise affixed to the bases 35 of the balusters. The flanges 39 of the angle strips are preferably substantially normal to the planes of the bases 35 and substantially parallel to the end flanges 36, they being spaced from such flanges so that between the flanges 36 and 39 substantially vertical guideways or tracks are provided in which are rotatably fitted with small clearance rollers 40 journaled upon brackets 41 having offset portions 42 therein and shanks 43 which are welded or riveted or otherwise fixed to the bases 35 of adjoining balusters. As will be clearly seen in Figure 4, the offsets 42 are for the purpose of enabling the brackets 41 to clear the flanges 36 and 37 of the adjoining balusters. It will thus be seen that at one side the balusters are provided with tracks, while at the other side of the same they carry the shanks of rollers which are rotatably and slidably fitted in the tracks or guideways of adjoining balusters. As appears from Figures 1 and 2, two rollers 40 for each baluster may suffice, these rollers being rather widely spaced apart, namely at the upper and lower portions of each baluster for the purpose of imparting stability and avoiding any rocking movement relatively of one baluster with respect to any other baluster. In other words, the rollers and their brackets will at all times preserve the preselected spacing of the balusters one from the other and will insure the preservation of parallelism therebetween while at the same time easing the relative movement of one baluster with respect to another.

Now referring more particularly to Figures 1 and 2, the end baluster 21^a at the end of the unit which is pivoted at 31 need not be equipped with any guideway but only with the brackets 41 and rollers 40.

As appears to best advantage in Figures 1 and 2, the upper edges 44 of the balusters are preferably cut off on an inclination so as to afford clearance for the relative movement of the stringers between the positions of Figures 1 and 2.

As also appears most clearly from Figures 1 and 2, the axes of the rollers 33 and 40 are preferably in alinement so that the thrust incident to the movement of the balusters up and down will also be alined in the direction of these axes. This arrangement will tend to prevent any rocking of the balusters or misalinement of the same.

Referring more particularly to Figure 5, in which a form of baluster is shown according to previous description, 45 designates a base flange on the baluster which may be riveted, welded or otherwise affixed to the tread or step 22.

As shown in Figure 3, there are two standards 46 arranged at the lower end of the stair unit. Cross sectionally these standards may conveniently be constructed as shown in Figure 6, in which 47 represents an end flange and 48 the base of a channel strip which is affixed to each standard 46, and which beside the base 48 is provided with spaced flanges 49 and 50 and an overhanging guard flange 51. The arrangement of these various parts is productive of a track or guideway 52 between the flanges 47, 49, and a track or guideway 53 between the flanges 49, 50, which latter guideway is partially overlapped by the guard flange 51.

As shown more particularly in Figures 1 and 2, the rollers 40 of the lower end balusters are disposed in the channels or tracks 52 of the standards 46. The other track or guideway 53 of each standard 46 receives rollers 54 on fixed supports 55, 56, which may be parts of the same support 32 to which the inner telescoping member of each stringer is pivoted at 31. These rollers 54 are for the purpose of guiding the standards 46 up and down vertically in a rectilinear path. The upper ends of the standards 46 may be connected to suitable counter weighting devices or they may be connected by flexible cable to a windlass driven by an electric or other motor as disclosed in my prior Patent 2,593,336 granted April 15, 1952, of which the present application constitutes certain improvements.

In operation, the standards 46 provide a convenient means by which through the motor or counter weighting arrangement the stairs may be easily lifted and lowered between the positions of Figures 1 and 2. As the standards 46 are thrust downwardly, the stringers will rotate about the pivots 31 and in so doing they will elongate, a condition permitted by the relative sliding of the telescopic members of which the stringers are composed.

Incident to this downward deflecting movement of the stringers, the rollers 33 will be proportionately shifted downwardly according to the position occupied in the unit. In accomplishing this movement the stringers will of course slide relatively to the rollers 33, which latter will facilitate this angular and slidable movement of the stringer members. At the same time the balusters will be moved down relatively to one another, being guided in this movement by the action of the rollers 40 in the tracks or guideways of the various balusters. The lower ends of the outer telescoping members of the stringers are pivoted, as at 57, directly to the standards 46, through which connection the movement of the standards up and down is communicated to the stringers and to the stair unit and whereby the stair unit may be moved upwardly to the horizontal platform position of Figure 2 or moved down to the inclined position of Figure 1 constituting a stairway or a staircase at a desired inclination or a pitch.

Referring more particularly to that form of the invention shown in Figures 8 to 12, inclusive, a simple unit is provided involving stringers 20^b, the balusters 21^b and the treads or steps 22^b. The balusters are channel form and have flanges 58 and 59. One of the adjoining flanges of each baluster may be provided with a lip 60 overlapped upon the adjoining flange 59 of the adjacent baluster. This overturned lip 60 provides a track, channel or guideway for the flange 59 so that the two adjoining balusters will be prevented from sidewise separation and at the same time be confined to move parallel to one another, for instance, between the positions of Figures 8 and 9 in true rectilinear paths. At their upper ends the balusters are punched out as indicated at 61 and the displaced metal is expanded or beaded, as indicated at 62. These portions 62, circular as shown in Figures 8 and 9, are snugly but slidably and rotatably received in overturned flanges 63 along the upper and lower edges of the stringer members 20^b. The parts 62 are in effect enlarged heads upon reduced diameter shanks and the flanges 63 of the stringers 20^b fit closely about the upper and lower portions of the reduced shanks so that the parts are interlocked and, in other words, the balusters cannot escape from the stringers yet the parts 62 may rotate in the guideways or tracks afforded by the flanges 63 of the stringers 20^b. In other words, the parts 62 may slide in the flanges 63 and rotate therein. Stated another way, the stringers 20^b in moving up and down between the positions of Figures 8 and 9 will slide upon the members 62 and also turn about such circular members 62. One or more apertures as 64 may be provided in an extending end of each stringer for the purpose of

connecting the stringers to some operative member or counterbalance for moving the same up and down. The other end 65 will be anchored pivotally to a suitable support. Also at this point 65, the member 62 will be rotatable but not slidable in the stringers. In other words, the left end baluster, viewing the unit in Figures 8 and 9, does not move up and down but the stringers 20b simply rotate upon the point 65 as a pivot. A permanent pivotal connection is made at 65 between this end baluster and the stringers so as to prevent accidental or casual dismemberment of the unit.

Referring more particularly to Figures 13 to 18, inclusive, it will be understood that this invention is an improvement over the subject matter of my prior Patent 2,593,336. It discloses stairs designed for use at any pitch between whatever limits are built into a unit. The drawings show a unit where either end may be raised or lowered, by any desired conventional means, to extend the stairs in either direction, and to any slope within its limits. Zero pitch, wherein the steps aline to form a continuous surface, is the mid point of this particular design. Figure 13 shows in side elevation the stairs opened out to not quite their full extent; Figure 14, also a side elevation, shows the unit collapsed to zero pitch.

In any case, the steps 22 are connected together by means of rollers 40 riding in tracks in the balusters 21c of preceding and/or following steps. Figure 17 shows this linkage in plan view.

The steps also hang from the stringers by means of the rollers 33 (or glides) which ride on tracks in the stringers, as previously described in connection with Figure 7. The stringers pivot on the terminal steps to adjust the pitch of the unit. The rise between the steps is always uniform.

Referring more particularly to Figure 18, the stringers divide any load W on the stairs into two components, one perpendicular and the other parallel to the stringers. The parallel component is carried by the step linkage and the perpendicular by the stringers which function as beams. The direction and value of these components will naturally depend on the stairs' pitch angle P.

Stringers may be one piece or telescopic. If one piece, they must be long enough to accommodate the unit when it is fully extended. Telescopic stringers are of two sections, each pivoted from opposite end step units. Two types are shown in Figures 15 and 16.

In Figure 15 two rollers 33 are provided and the stringers have two sections 27a providing separate tracks for these two rollers 33. Each section 27a slides parallel with the other.

In Figure 16 the two sections 27b and 27c slide within one another.

With the type according to Figure 15, the middle steps' balusters each have two rollers, one for the track of each section. Thus the middle steps hang from both sections at all times.

Stringers may also be placed in such position, as is done in Figure 15, that they may function as handrails 66, 67. Both types are shown as built-up shapes with webs 68, 69, connecting the tracks 27a and handrails 66, 67. The handrails 66, 67, are designed so that they nest. The space available for clearance between the side-by-side handrail shapes and the thickness of their material is determined by the distance D between them and the angle of their slope S, and is given by the product of large D and the sine of angle S.

As shown more particularly in Figures 13 and 17, the end baluster 21d is provided by brackets 70 carrying spaced lugs 71 which embrace the flange 36 on the following baluster 21c. The space between the lugs formed in effect a track for the flange 36. The rollers 40 are shown riding in channel shapes. These arrangements are representative; others are useable.

Referring more particularly to Figures 13, 14 and 17, as appears at the baluster 21e there may be two tracks or guideways 72 and 73 provided by certain of the balusters to receive rollers 40 and 40a which are carried by the adjoining balusters at opposite sides of the baluster 21e.

While the forms herein disclosed of the invention are the best known to me at the present time, the invention is susceptible of mechanical embodiment in many other forms and all such forms are within the contemplation of the invention provided the same come within the scope of the following claims.

What is claimed is:

1. A variable pitch stairs comprising a support, stringers pivoted at one end portion to the support for up and down swinging movement, balusters, means for pivotally and slidably connecting said balusters to the stringers and for freely suspending said balusters to gravitationally depend in vertical position, guide means between the balusters for preserving the vertical position and enabling the balusters to slide vertically relatively to one another, and treads carried by the balusters in constant horizontal position.

2. A variable pitch stairs as claimed in claim 1 in which the guide means comprises rollers on one baluster sliding in a guideway on an adjacent baluster.

3. A variable pitch stairs as claimed in claim 1 in which the guide means comprises overlapped flanges on the balusters.

4. A variable pitch stairs as claimed in claim 1 in which the stringers are comprised of telescoping members slidable upon one another.

5. A variable pitch stairs as claimed in claim 1 in which the stringers include tracks for receiving antifriction devices carrying the balusters.

6. A variable pitch stairs as claimed in claim 1 in which the stringers are composed of longitudinally slidable members having means at their respective ends to pivot on a fixed support and pivot to a raising and lowering member.

7. A variable pitch stairs as claimed in claim 1 in which rollers on the balusters travel in tracks on the stringers and other rollers on the balusters travel in guideways on adjacent balusters with the axes of the rollers of respective balusters being substantially in alinement.

8. A variable pitch stairs as claimed in claim 1 in which the balusters have punched out expanded projections slidably and rotatably fitted in tracks of the stringers.

9. A variable pitch stairs as claimed in claim 1 in which the said guide means on at least one of the balusters comprises spaced lugs to slidably receive a flange on an adjoining baluster.

10. A variable pitch stairs as claimed in claim 1 in which each stringer embodies spaced members having separate tracks for two rollers on each baluster.

11. A variable pitch stairs as claimed in claim 1 in which the first-named means comprises rollers on the balusters and in which each stringer embodies sections which slide within one another and together support said rollers.

12. A variable pitch stairs as claimed in claim 1 in which the stringers include sloping handrails nested together.

13. A variable pitch stairs comprising a support, stringers pivoted to the support for up and down swinging movement, steps, and means pivotally and slidably connecting the steps to the stringers and slidably connecting the steps to one another.

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