Oct. 21, 1952 C. D. DENISON 2,614,609

AMBULATORY RECIPROCATOR

Filed March 30, 1950 4 Sheets-Sheet 1

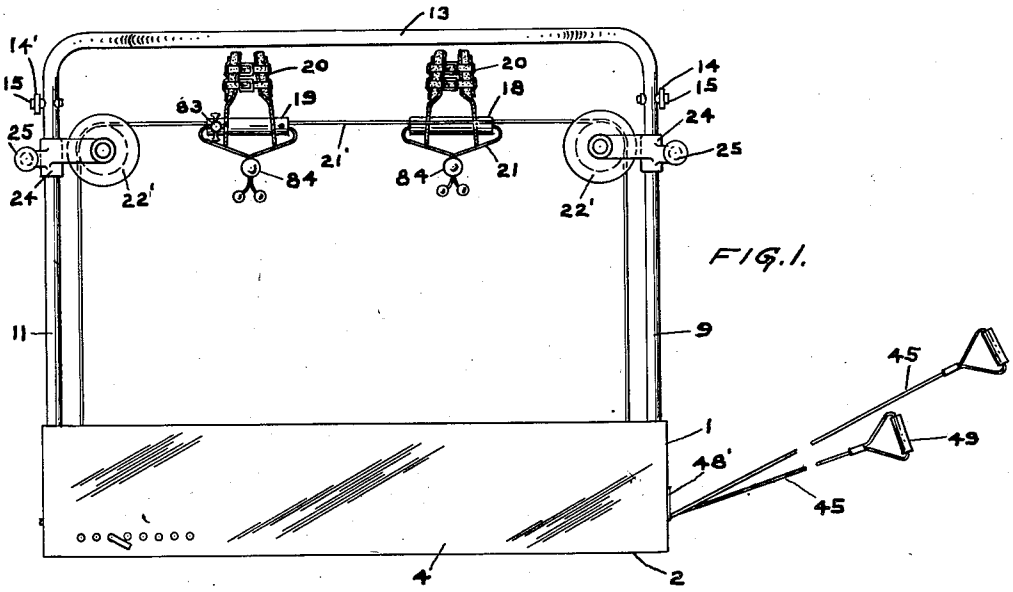


FIG. 1.

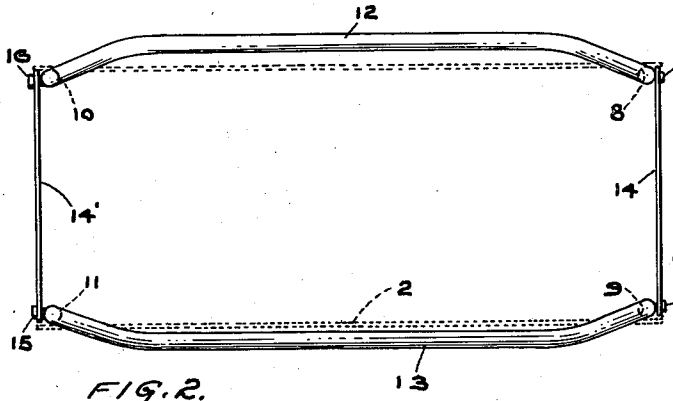


FIG. 2.

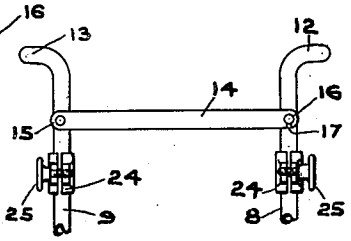


FIG. 3.

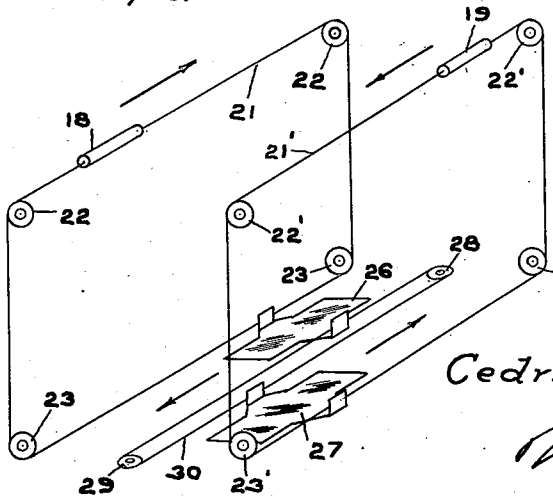


FIG. 4.

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AMBULATORY RECIPROCATOR

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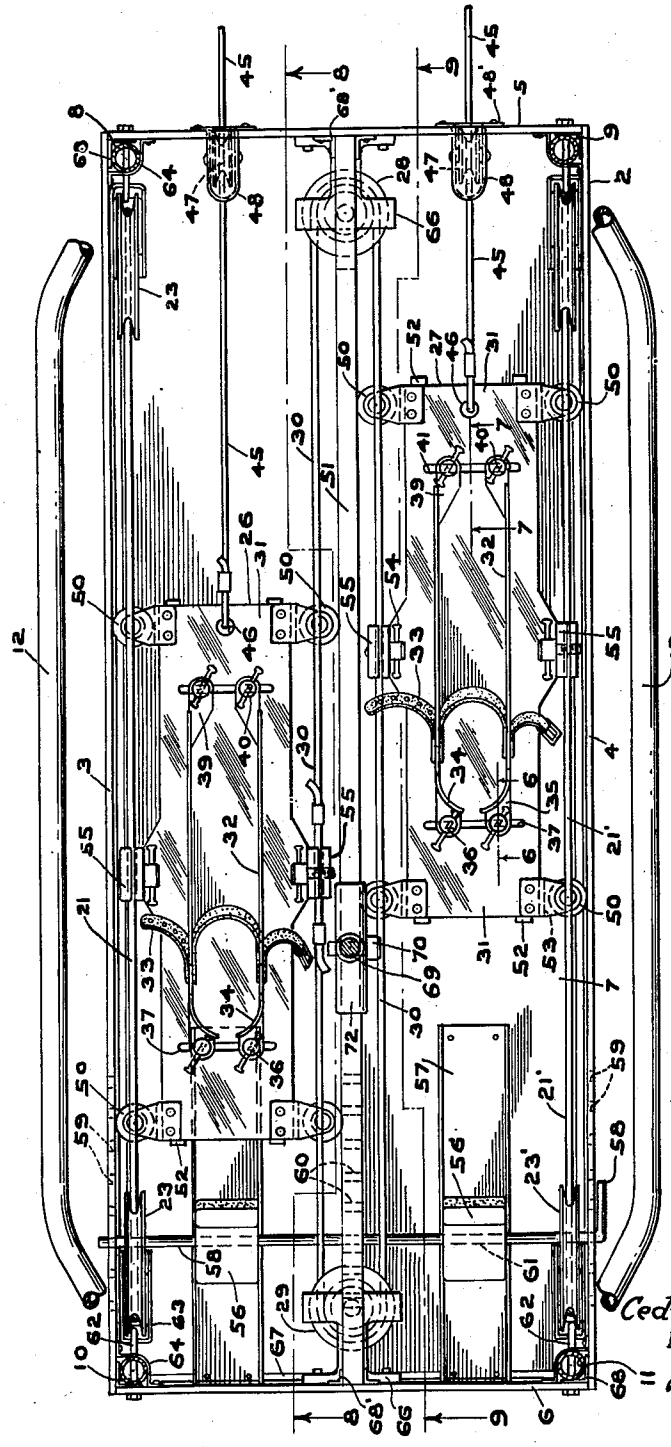


FIG. 5.

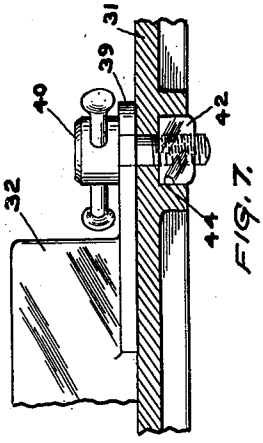


FIG. 7.

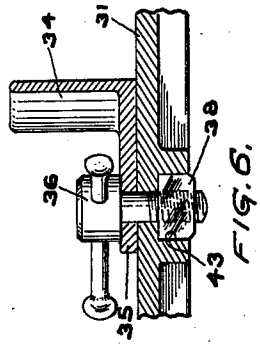


FIG. 6.

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AMBULATORY RECIPROCATOR

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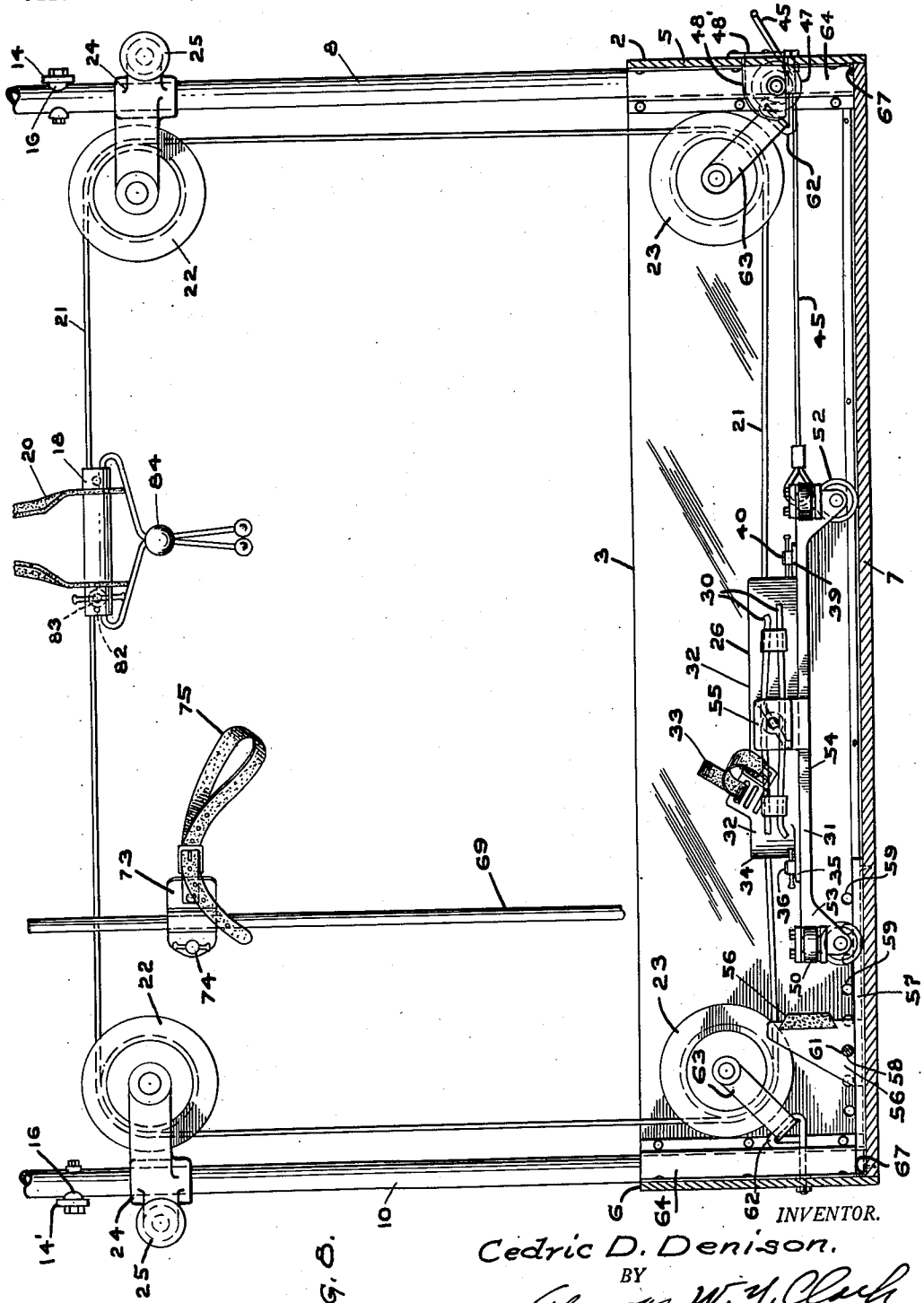


FIG. 8.

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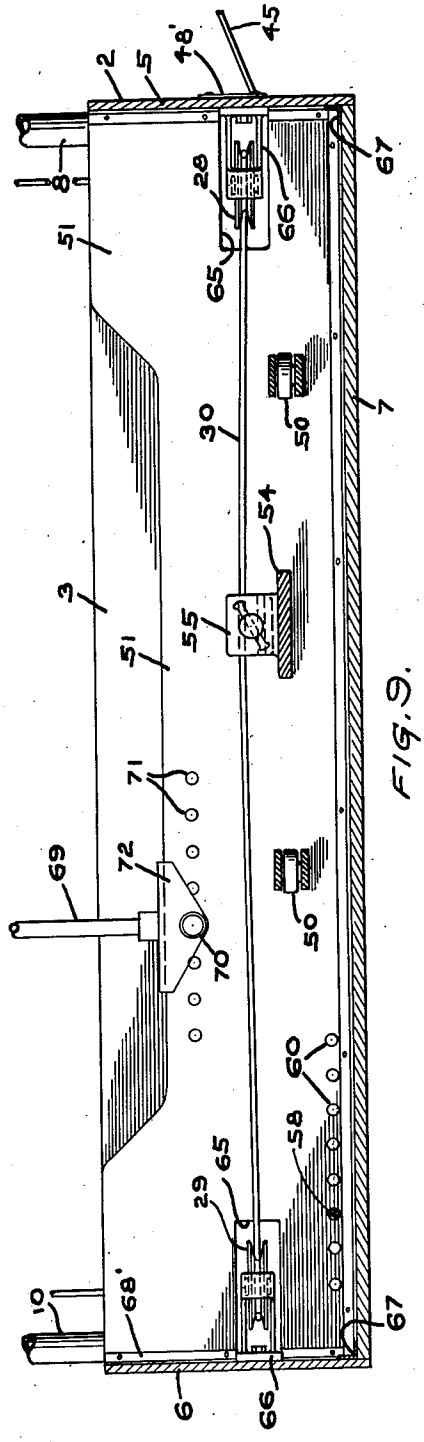


FIG. 9.

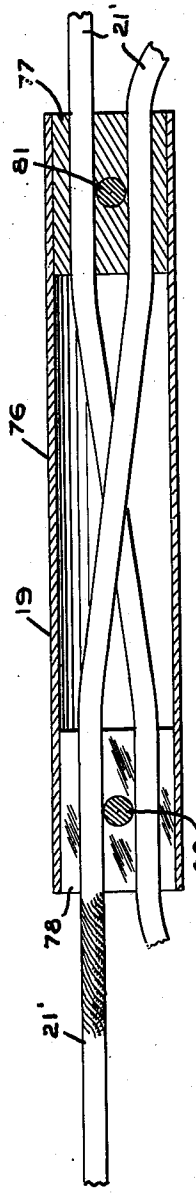


FIG. 10.

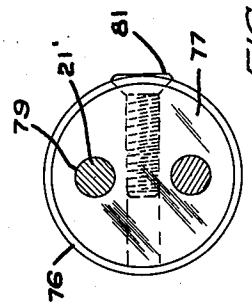


FIG. 12.

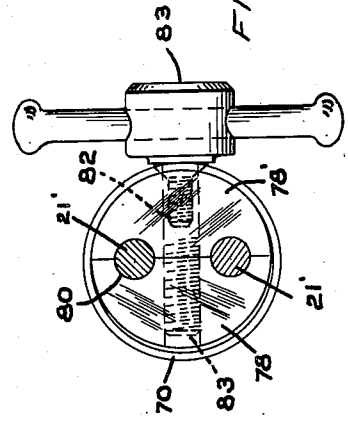


FIG. 11.

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AMBULATORY RECIPROCATOR

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Application March 30, 1950, Serial No. 152,815

13 Claims. (Cl. 155—23)

1

This invention relates to an ambulatory reciprocator adapted to simulate arm and leg movements in walking.

The apparatus is designed both to reestablish proper walking including muscular coordination and balance after illness or accident, and to teach walking coordination and balance to those who have never achieved normal walking ability. For example, in cerebral palsy it has been found that besides the difficulties in muscular coordination and balance, due to injury to the nervous system, some of the difficulty in walking results from never having learned proper walking habits, it being very difficult to learn such habits when special disabilities make standing and any type of self-locomotion uncertain. The ambulatory reciprocator meets this problem by providing support to the user, an obstacle-free practice course, and means for properly coordinating arm and leg movements. As the user becomes more proficient, a non-rigid support is provided which permits practice in the balance, weight shifting, sway and even foot lifting of normal walking, still without the obstacles of a normal walking course.

The device may also be used to strengthen weak muscles by exercise, as needed in infantile paralysis. Walking exercise is possible even when legs are in braces and cannot be bent. The length of movement of arms and legs can be adjusted to permit a gradual development to full stride when desired and means are provided whereby the walking movements can be introduced without the user furnishing the motive power for the device himself. The apparatus may be adjusted to accommodate different size users and is designed to operate easily so that normal strength is not required for self-operation and frequent practice is encouraged.

The means for coordinating arm and leg movements which is a main feature of this invention comprises a system of loops, one loop coordinating the left leg and left arm to move in opposite directions, a second loop coordinating the right leg and right arm to move in opposite directions and a third loop coordinating the left leg and arm movements with the right leg and arm movements, so that when the left leg is advanced, the right arm is also advanced and so forth in accordance with normal walking movements.

Other objects and features of the invention will be apparent from the following description and the accompanying drawings in which:

Figure 1 is a side elevation of an ambulatory reciprocator apparatus constructed in accordance with this invention.

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Figure 2 is a top plan view of the side rails and cross pieces, the base being dotted in.

Figure 3 is a fragmentary end elevation of certain of the parts of Figure 2 and of the upper pulley brackets.

Figure 4 is a diagrammatic perspective view of the system for coordinating arm and leg movements in accordance with this invention.

Figure 5 is an enlarged top plan view of the apparatus with the uprights and vertical loops broken away above the base.

Figure 6 is an enlarged partial sectional view taken along the lines 6—6 of Figure 5.

Figure 7 is an enlarged partial sectional view taken along the lines 7—7 of Figure 5.

Figure 8 is a partial sectional view taken along the lines 8—8 of Figure 5.

Figure 9 is a partial sectional view taken along the line 9—9 of Figure 5.

Figure 10 is an enlarged longitudinal sectional view of the right hand grip.

Figure 11 is an enlarged rear end view of the hand grip of Figure 10.

Figure 12 is an enlarged front end view of the hand grip of Figure 10.

As shown in Figures 1 and 5, the ambulatory training apparatus 1 comprises a rectangular base 2 including left and right side walls 3 and 4, forward wall 5, rear wall 6 and floor 7, the base and walls constituting parallel ways. In the corners of the base are mounted uprights 8 and 9 and in the rear corners uprights 10 and 11. The left hand uprights 8 and 10 and the right-hand uprights 9 and 11 are connected by side rails 12 and 13 respectively. As best seen in Figures 2 and 5, the side rails bow outwardly from their ends beyond the side walls of the base, in order to provide ample room for the user of the apparatus. The side walls should, of course, be at such a height as to insure the safety of the user of the apparatus and the base, of such width as to preclude any possibility of tipping the apparatus by falling against the rails.

As best seen in Figure 3 forward and rear cross pieces 14 and 14' are swingingly mounted upon bolts 14 on the uprights 9 and 11 and engage adjacent their free ends bolts 16 in recesses 17. To enter the apparatus a cross piece may be lifted upwardly out of engagement with its bolt 16 and then replaced. These cross pieces give strength and rigidity to the upper part of the apparatus.

The diagram of Figure 4 indicates the mode of operation of the apparatus. Left and right hand grips 18 and 19 are shown lying approximately in the same horizontal plane for movement generally forwardly and rearwardly in what will be called longitudinal reciprocation. The grips are spaced transversely to allow a user to stand therebetween. Wrist straps 20 are provided with the hand grips, in case the strength of the user's hand is not sufficient alone to maintain a hold on the grips, Figure 1.

The hand grips 18 and 19 are supported by ropes 21 and 21' which extend around left and right pairs of upper pulleys 22 and 22' at the level of the hand grips and left and right pairs of lower pulleys 23 and 23' at the floor level to form a pair of vertical loops. The upper pulleys 22 and 22' are carried by means of brackets 24, as best seen in Figures 1 and 8. These upper brackets are mounted on the uprights and are adjustable up and down therealong by means of clamping screws 25 as best shown in Figure 3. The level of the hand grips can thus be conveniently adjusted to varying heights according to the height of the user. The means for adjusting the effective lengths of ropes 21 and 21' to compensate for raising or lowering the upper pulleys 22 and 22' will be hereinafter described.

Again referring to Figure 4 it will be seen that corresponding to the left and right hand grips 18 and 19 are left and right foot skis 26 and 27 mounted for longitudinal reciprocation below the hand grips. It will be observed that the ropes 21 and 21' extend around the lower pulleys 23 and 23' and connect with the corresponding foot skis 26 and 27. Further it will be seen that the corresponding hand grip and foot ski are so attached to the ropes that when, for example, the right hand grip 19 is in a forward position, the right foot ski 27 is in its rear position, and as indicated by the arrows, when the right foot ski 27 is moved forwardly the right hand grip 19 will move rearwardly, as is normally the case with the corresponding leg and arm in walking. The same is true on the left side.

Two horizontal pulleys, a forward one 28 and a rear one 29 are mounted between the lower vertical pulleys 23 and 23'. A rope 30 extends around these pulleys to form a horizontal loop and it is engaged by the foot skis. As best seen in Figure 4, the foot skis engage the rope 30 so that when the left foot ski 26 is in its forward position the right foot ski 27 will be in its rear position, and reversely, as is the normal case in walking. As a result of the coordination of the foot skis by means of the horizontal rope 30 and pulleys 28 and 29, the hand grips are also coordinated so that when the right hand grip 19 moves rearwardly, the left hand grip 18 will move forwardly, as the arrows indicate. Thus the movement of the hand grip and foot skis may be made to correspond to the movement of arms and legs in normal walking.

Referring now to Figures 5 and 8, it will be seen that the foot skis include foot plates 31, sides 32 and straps 33 for confining the shoe of a user. The opposite sides 32 of each ski curve inwardly at the rear to provide back walls 34 for the heels of the shoes. A horizontal flange 35 extends rearwardly from the bottom of each back wall 34 and rests on one of the foot plates 31. A back clamping bolt 36 passes through each back flange 35 and through a transverse slot 37 in the foot plate, Figure 5, to engage a square nut 38 as best seen in Figure 6.

The forward ends of sides 32 have flanges 39 extending inwardly and resting on the foot plates 31. Front clamping bolts 40 pass through the flanges 39 and transverse slots 41 in the foot plates, Figure 5, to engage square nuts 42, as shown in Figure 7. As will be readily understood, the square nuts 38 and 42 ride in channels 43 and 44 beneath the slots 37 and 41, the nuts 38 and 42 being prevented from turning by the channel walls as shown in Figures 6 and 7.

The front end of each foot plate 31 has a pull rope 45 in a hole 46, Figure 5, which may be used to operate the apparatus as will be hereinafter described. The ropes 45 pass through vertical slots in the forward wall 5 of the base of the apparatus. Pulleys 47 are mounted on the forward wall 5 by means of hood brackets 48, extending into the apparatus and having outturned flanges 48' on either side of the slot bolted on the outside of the forward wall. The pulleys guide the pull ropes through the slots with little friction. As shown in Figure 1, the ropes may have at their outer ends handles 49 for pulling the ropes.

As best seen in Figure 5, at the forward and rear ends of the foot plates 31, at the side edges, are mounted horizontal rollers 50. The outer horizontal rollers ride on the side walls 3 and 4 and the inner horizontal rollers ride on a central partition 51, Figures 5 and 9. Referring to Figure 8, vertical rollers 52 are carried by flanges 53 depending from the side edges of the foot plates 31 at the front and rear, and roll on the floor 7 of the base. Thus the foot skis can be reciprocated without an undesirably great energy expenditure. Also it will be noted that the skis can be lifted off the floor somewhat without interfering with the operation of the apparatus. This might be desirable, particularly for users who already possessed walking habits and might naturally tend to lift their feet.

The side edges of each ski project outwardly in the middle to form side wings 54 which carry upstanding rope clamps 55, Figures 5, 8 and 9, for attaching the skis to the ropes 21, 21' and 30 at any desired position therealong. It will be seen in Figures 5 and 8 that the inner rope clamp 55 of the left ski 26 serves to retain both ends of the horizontal rope 30. These clamps 55 are similar in operation to that shown in Figure 11, but they are rectangular with the rope or ropes passing through a long dimension of the clamp.

As a further adjustment for the skis, stops 56 are provided at the rear thereof to limit the rearward travel of the skis. These stops are confined transversely in floor channels 57 to positions in line with the centers of the rear edges of the foot plates of the skis, but are slidable longitudinally to adjust the length of ski movement, Figure 5. A rod 58 is inserted through openings 59 in side walls 3 and 4 one of the openings 60 in the center partition 51 and through openings 61 in the stops to lock the stops in position.

The lower vertical pulleys 23 and 23' can be seen in Figure 8 to be held by means of bolts 62 attached to the U-brackets 63 of the pulleys. The bolts pass through the curved strips 64 forming sockets with the walls 3, 4, 5, 6 and through the uprights contained in the sockets, anchoring them therein. The bolts are fastened to the forward and rear walls 5 and 6, Figures 5 and 8. Figure 9 shows the horizontal pulleys 28 and 29 mounted in slots 65 in the center partition 51 by means of brackets 66. Right angle brackets 67 are employed to fasten the floor to the end

walls 5 and 6 as shown in Figures 8 and 9, and brackets 68 connect the side and end walls as shown in Figure 5, and brackets 68' connect the end walls and center partition 51.

A hip stabilizer shown in Figures 8 and 9, in part, may be mounted on the center partition 51 and adjusted therealong by means of a bolt 70 in one of openings 71 in the partition or it may be removed from the apparatus, depending on the needs of the user.

This stabilizer includes a rod 69 mounted in base 72, of suitable strength, Figure 9, and a plate 73 slidable on the rod and adapted to be clamped at any suitable level by clamp 74, Figure 8. A belt 75 is attached to the plate and is intended to position the hips and stabilize them where this is desirable.

The construction of the right hand grip 19 is shown in Figures 10, 11 and 12, the left hand grip 18 is similarly constructed. The hand grip comprises a hollow cylinder 76 having in its forward end a cylindrical block 77 fitting snugly therein and in its rear end two half-cylinder blocks 78 and 78' fitting loosely into the cylinder 76. The block 77 has two holes 79 vertically spaced through which the rope 21' passes, Figure 12. The half blocks 78, 78' have vertically spaced arc grooves 80 of radius less than that of the rope, Figure 11. A screw 81 retains block 77 in the cylinder 76 and a pair of screws 82 hold the right half block 78' to the cylinder 76. Tightening clamp screw 83 serves to pull the left half of block 78 toward the right half 78' to pinch the rope. Retainers 84 are provided to hold the ends of the ropes as shown in Figures 1 and 8.

The rope ends are crossed within the cylinder 76 so that the hand grip tends to maintain a horizontal orientation, as shown in Figure 10.

In self-operation of the apparatus, the pull ropes 45 may be unfastened to provide free movement of the skis. Before the user enters the apparatus the stops 56 may be removed to furnish additional foot room and the sides 32 of the skis moved to their most open position with the straps 33 loose or removed from one side. The cross piece 14' is lifted to admit the user and replaced and, the skis being approximately alongside each other, the user's feet are placed between the sides of the skis, the straps fastened and the sides clamped in proper position by means of clamping bolts 36 and 40. The slots 37 and 41 are of such length as to permit braces to be included between the sides. The stops 56 may then be placed at the position allowing the desired travel of the skis and hand grips, and fixed in place by means of rod 58 inserted through openings 59, 60 and 61.

If desired, the hip stabilizer 69 may be fixed on the central partition 51 in the proper position by means of bolt 70 through one of the openings 71. The belt 75 is then properly adjusted to insure flexion and extension of the hip joints and associated muscles and in cooperation with the foot skis the desired position of rotation and abduction of feet and legs, as well as to provide support.

The hand grips 18 and 19 may then be adjusted to the proper level by loosening the tightening screws 63 on the grips and slackening the ropes for upward adjustment and by raising or lowering the pulleys 22 and 22' to the desired height. The ropes are then taken in and clamped by means of clamp screws 83. To adjust the position of the hand grips to correspond to the alongside position of the skis, and thereabove, clamps 55 on the skis are loosened, the grips

brought into proper position, and the clamps tightened again. The wrist straps 20 may be fastened when desired, or removed.

The apparatus is set into operation simply by pushing forward on one foot ski, the right for example, the left foot ski then moving rearwardly due to the horizontal loop of rope 30. The left hand grip 18 moves forwardly and the right hand grip 19 moves rearwardly due to the vertical loops or ropes 21 and 21'. The left foot ski traveling rearwardly strikes its stop 56 at the rear edge of the foot plate 31 and the right foot ski and hand grips being interlocked or coordinated with the left foot ski, also stop. This rear left food ski is then moved forwardly and the right automatically moves rearwardly and the hand grip corresponding to each ski moves in the opposite direction thereto in accordance with the leg and arm movements in walking and so on alternately pushing forward one foot ski and then the other.

Particularly when the hip stabilizer is omitted it is possible to practice the balance and sway of normal walking since the hand grips provide a non-rigid support. This effect can be heightened further by loosening the vertical loops slightly.

When it is desired to operate the device by means of the pull ropes 45, these ropes are left attached and the operator may sit in a chair in front of the apparatus grasping the handles 49. It will be noted that since the foot skis are interlocked or coordinated, an opposition between the pull of one rope and gradual release of the other rope exists which permits an even operation of the apparatus at any rate which may be desired, it being impossible to pull one foot ski forward without allowing the other to move rearwardly.

It will be apparent that many modifications may be made in the apparatus described above in detail without departing from the invention defined in the following claims.

What is claimed as new and is desired to be secured by Letters Patent is:

1. An ambulatory reciprocator comprising a first loop and means to support the same for alternate linear movement in a vertical plane for coordinating the left leg and left arm to move in opposite directions, a second loop and means to support the same for alternate linear movement in a vertical plane parallel to the first loop for coordinating the right leg and right arm to move in opposite directions, a hand grip connected to the upper part and a foot ski connected to the lower part of each loop and a third loop connected to and coordinating the movements of the first two loops to coordinate the left leg and arm movements with the right leg and arm movements, whereby the right arm advances when the left leg is advanced and the right leg and left arm move rearwardly, and the reverse alternately to simulate normal walking movements.

2. In an apparatus for ambulatory training, left and right transversely spaced hand grips adapted for longitudinal reciprocation, spaced left and right foot skis corresponding respectively to the left and right grips, and adapted for longitudinal reciprocation, loops and means to support the same in parallel, vertical planes for alternate linear movements connected to and coordinating the right hand grip and foot ski to move in opposite directions and the left hand grip and foot ski to move in opposite directions,

and a horizontal loop connected to and coordinating the movements of the first two loops to coordinate the hand grips to move in opposite directions and the foot skis to move in alternate opposite directions, the loops together coordinating movements of the hand grips and foot skis to simulate normal leg and arm movements in walking.

3. An ambulatory reciprocator comprising left and right hand grips, a pair of vertical cable loops having upper and lower horizontal cable portions, said upper portions carrying said hand grips, pulleys guiding said cable loops, right and left foot skis connected to said lower horizontal cable portions and a horizontal cable loop connected to the vertical cable loops coordinating the left and right foot skis to move in opposite directions, the horizontal and vertical cable loops together coordinating the movements of the hand grips and foot skis to simulate arm and leg movements in walking.

4. An ambulatory reciprocator comprising longitudinally movable left and right hand grips and left and right foot skis, a pair of horizontally spaced vertical loops and means to support the same in parallel planes, the loops having upper horizontal portions carrying the hand grips and opposite lower horizontal portions connected to the foot skis, stops for the skis to adjust the length of movement thereof, and a horizontal loop having opposite portions connected to the foot skis, whereby the hand grips and foot skis are constrained to motion in accordance with normal walking movements of arms and legs.

5. An ambulatory reciprocator comprising longitudinally movable left and right hand grips and left and right foot skis, a pair of vertical loops and means to support the same in parallel planes, providing upper horizontally extending loop portions carrying the hand grips and opposite lower horizontally extending loop portions connected to the foot skis, a base having ways therein to guide the foot skis in substantially rectilinear parallel paths, rollers connected to the foot skis and riding on the base in the movement of the skis, and a horizontal loop and means to support the same to provide opposite loop portions connected to the foot skis, the horizontal and vertical loops coordinating the foot skis and hand grips to move in accordance with normal walking movements of legs and arms.

6. The reciprocator of claim 5 including pull ropes connected with said foot skis to be pulled alternately to produce movements of the hand grips and foot skis corresponding to arm and leg movements in normal walking.

7. An ambulatory reciprocator comprising longitudinally movable left and right hand grips and left and right foot skis, a pair of vertical loops and means to support the same in parallel planes providing upper horizontally extending portions connected with the hand grips and opposite lower horizontally extending portions connected with the foot skis, a floor and side walls for guiding the foot skis, horizontal and vertical rollers connected with the foot skis and riding on the floor and side walls, stops for the skis to adjust the length of movement thereof, a horizontal loop and means to support the same to provide opposite portions connecting the foot skis, the horizontal and vertical loops coordinating the foot skis and hand grips to move in accordance with normal walking movements of legs and arms.

8. An ambulatory reciprocator comprising left and right hand grips and left and right foot skis, a pair of vertical cable loops, a pair of upper pulleys in substantially the same horizontal plane and a pair of lower pulleys in substantially the same horizontal plane carrying each of the loops, the hand grips being connected to the substantially horizontal portion of each cable loop between the upper pulleys and the foot skis being connected to the substantially horizontal portion of each cable loop between the lower pulleys, the upper pulleys being vertically adjustable to raise and lower the level of the hand grips, a base having ways therein to guide the foot skis in substantially rectilinear parallel paths, rollers connected with the foot skis and riding in said ways, and a horizontal cable loop and means to support the same to provide opposite portions connected to the foot skis to coordinate the left foot ski and hand grip and the right foot ski and hand grip to move in accordance with normal walking movements of arms and legs.

9. An ambulatory reciprocator comprising a base having a floor and side walls, and a vertical partition between the side walls, right and left foot skis, rollers connected with said foot skis for riding on the floor, side walls and vertical partition, horizontally disposed pulleys in said vertical partition, a horizontal cable loop carried by said pulleys having a longitudinal portion on each side of the partition and connecting with each of the foot skis by one of the longitudinal portions of the horizontal cable loop, right and left hand grips, right and left vertical loops and means to support the same in parallel planes, the loops connecting respectively the right foot ski and hand grip and the left foot ski and hand grip, the horizontal and vertical cable loops coordinating the movements of the foot skis and hand grips to correspond to the movements of legs and arms in walking.

10. An ambulatory reciprocator comprising a base having a floor and side walls, and a vertical partition between the side walls, right and left foot skis, horizontal and vertical rollers connected with said foot skis for riding on the floor, side walls and partition, a pair of longitudinally spaced horizontal pulleys in said vertical partition, a horizontal cable loop carried by said pulleys having a longitudinal loop portion extending along the partition on each side and connecting with each of the foot skis by one of the longitudinal loop portions, right and left hand grips, right and left pairs of uprights adjacent the side walls of the base, a pulley slidably mounted on each upright, right and left vertical cable loops extending around the right and left pairs of pulleys respectively and each loop having an upper portion connecting with one of the hand grips and a lower portion connecting with one of the foot skis to coordinate the movements of the hand grips and foot skis to simulate walking.

11. An ambulatory reciprocator comprising a base having a floor and side walls, and a vertical partition between the side walls, right and left foot skis, horizontal and vertical rollers connected with said foot skis for riding on the floor, side walls and partition, a pair of spaced, horizontally disposed pulleys in said vertical partition, a horizontal loop carried by said pulleys having portions of the loop extending along each side of the partition and being connected to the foot skis to move skis in opposite directions along the partition, right and left hand grips, right and left

upper pulley pairs in substantially the same horizontal plane, right and left lower pulley pairs in substantially the same horizontal plane, a right vertical loop passing around the right upper pulley pair and connecting with the right hand grip between the right upper pair and passing around the right lower pulley pair and connecting with the right foot ski therebetween, a left vertical loop passing around the left upper pulley pair and connecting with the left hand grip therebetween and passing around the left lower pulley pair and connecting with the left foot ski therebetween, whereby the hand grips and foot skis are free to reciprocate in a substantially horizontal plane and are coordinated in their movement to simulate the arm and leg movements of walking.

12. An ambulatory reciprocator comprising left and right hand grips and left and right foot skis, a pair of vertical loops and means to support the same in parallel planes, one of said loops being connected to each of the foot skis and a horizontal loop and means to support the same, said horizontal loop being connected to the foot skis and interlocking the vertical loops and the left hand grip and foot ski with the right hand grip and foot ski, and pull ropes connected to the foot skis, the horizontal loop coordinating the movement of the foot skis whereby smooth motion may be imparted to the foot skis and hand grips by the pull ropes in accordance with leg and arm movements in walking.

13. An ambulatory reciprocator apparatus comprising left and right pairs of upper and lower pulleys, the left and right pairs of upper pulleys and the left and right pairs of lower

pulleys lying in vertically spaced substantially horizontal planes, right and left vertical loops passing around the right and left pulleys, right and left upper loop portions supported by the right and left upper pulley pairs and extending substantially horizontally, right and left lower loop portions supported by the right and left lower pulley pairs and extending substantially horizontally, right and left hand grips connected to said right and left upper loop portions, right and left foot skis connected to the right and left lower loop portions, a third loop connected to the foot skis and means to support the said third loop, the third loop interlocking the right and left foot skis and hand grips to simulate walking movements of legs and arms, the upper loop portions providing a semi-rigid support for the hand grips whereby the balance and sway of walking may be experienced in the use of the apparatus.

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