May 6, 1969 K. GARDNER ET AL 3,442,532

PORTABLE INVALID WHEELCHAIRS

Filed May 1, 1967 Sheet 1 of 4

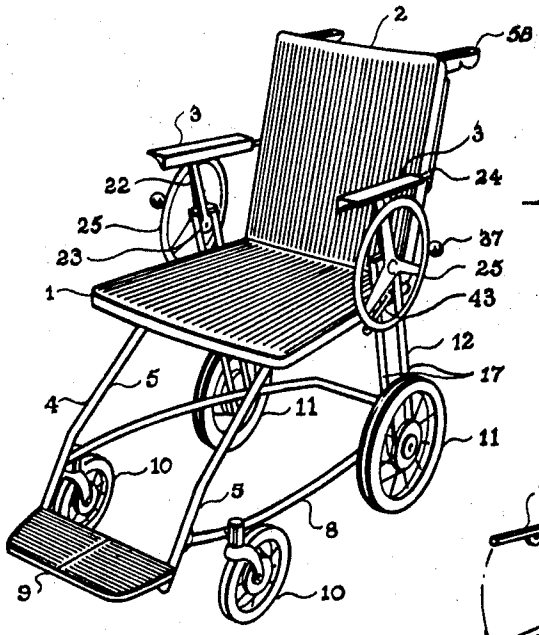


FIG. 1

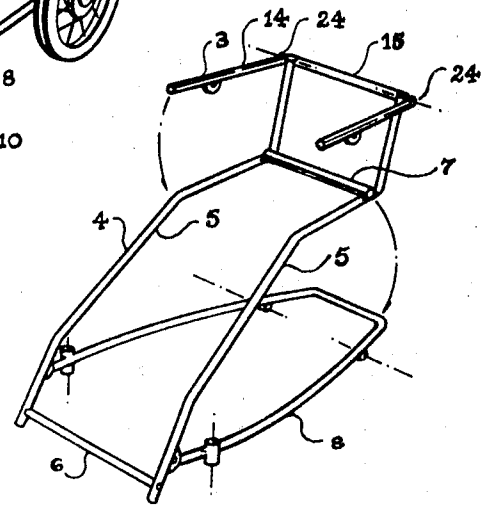


FIG. 2

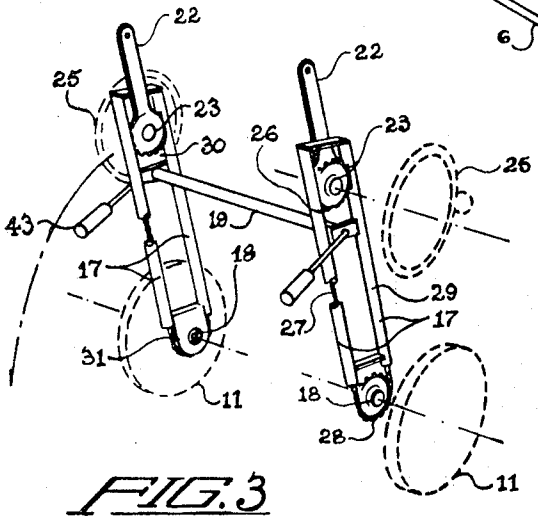


FIG. 3

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May 6, 1969 K. GARDNER ET AL 3,442,532

PORTABLE INVALID WHEELCHAIRS

Filed May 1, 1967 Sheet 2 of 4

FIG 4

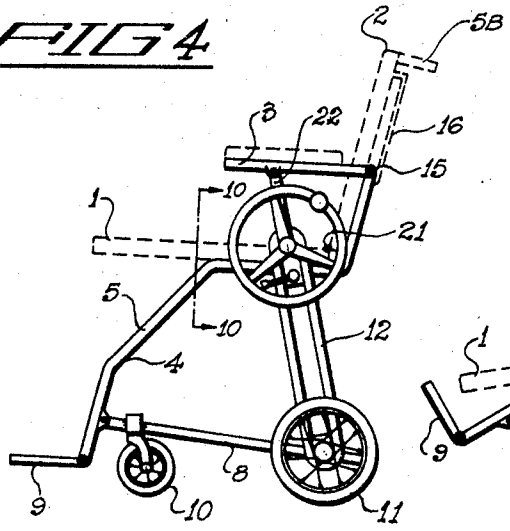


FIG 5

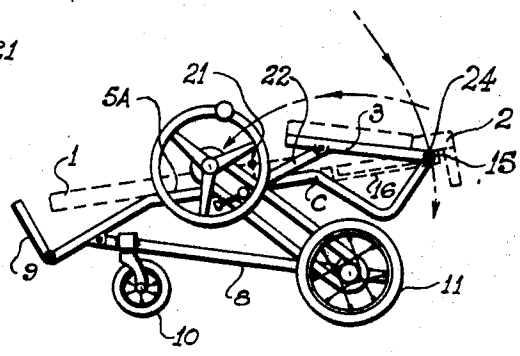
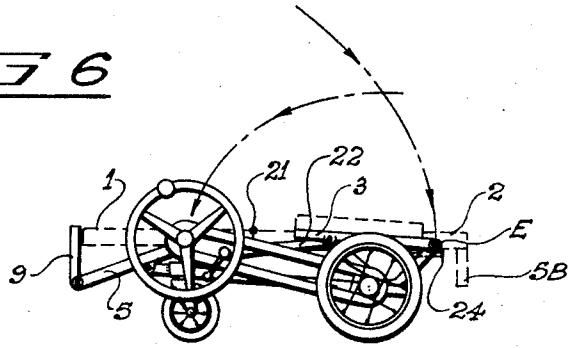


FIG 6



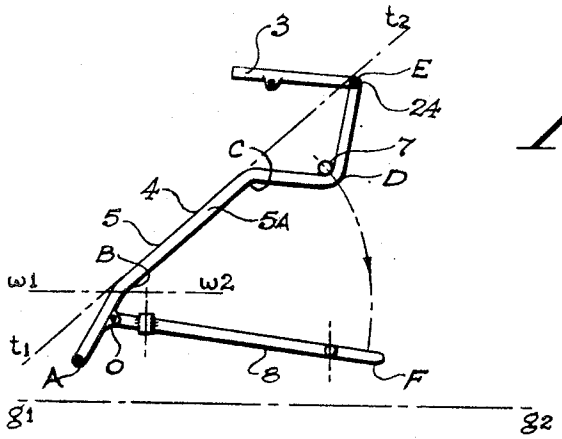
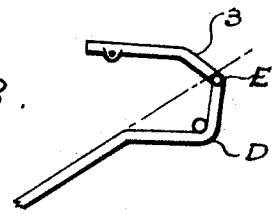


FIG 7

FIG 8



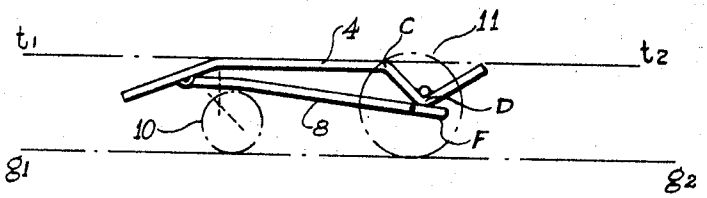
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May 6, 1969 K. GARDNER ET AL 3,442,532

PORTABLE INVALID WHEELCHAIRS

Filed May 1, 1967 Sheet 3 of 4

FIG. 9



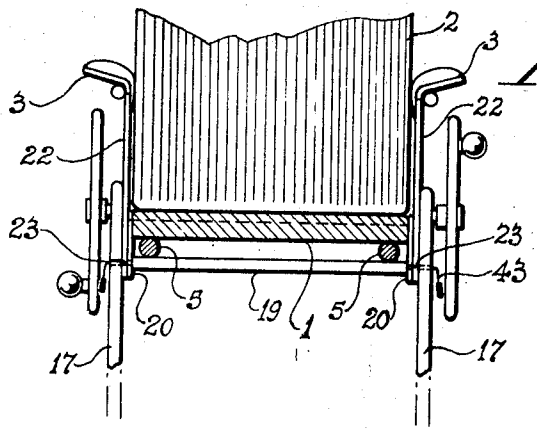


FIG. 10

FIG. 11

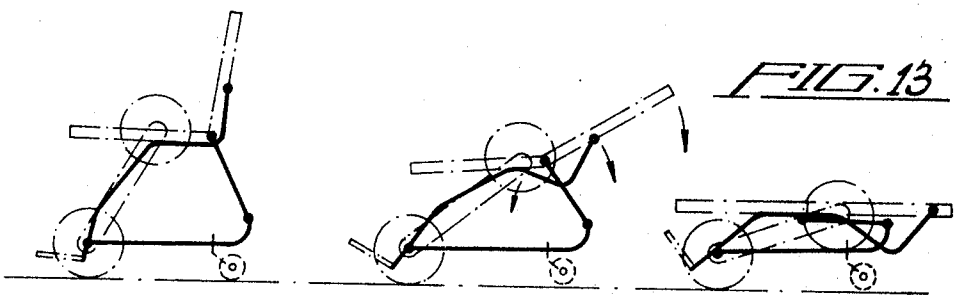


FIG. 13

FIG. 12

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PORTABLE INVALID WHEELCHAIRS

Filed May 1, 1967 Sheet 4 of 4

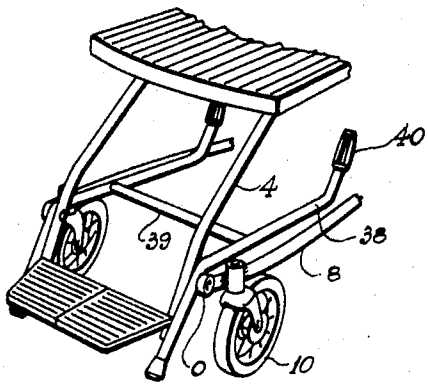


FIG. 14

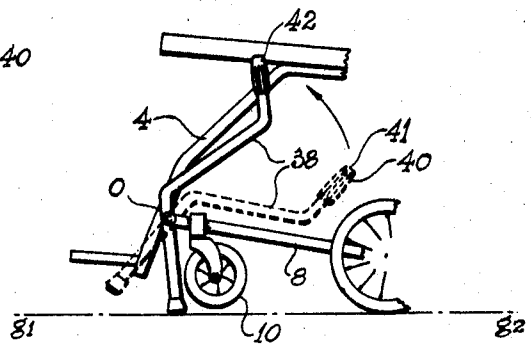


FIG. 15

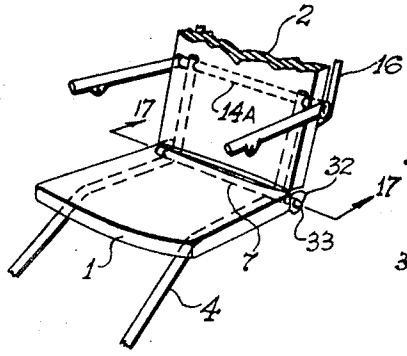


FIG. 16

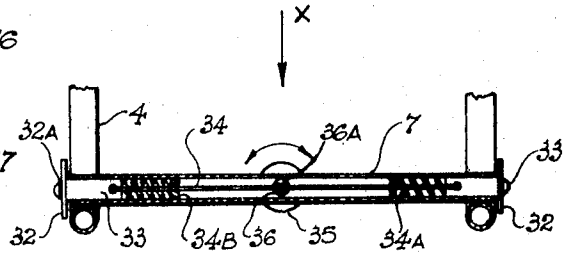


FIG. 17

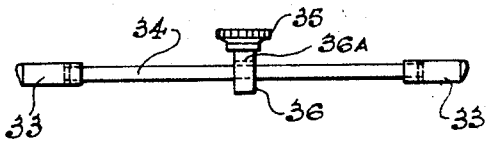


FIG. 18

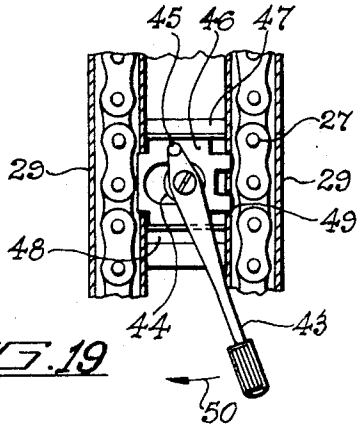


FIG. 19

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PORTABLE INVALID WHEELCHAIRS

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Filed May 1, 1967, Ser. No. 635,237
Claims priority, application Great Britain, May 2, 1966, 19,200/66
Int. Cl. B62m *1/14;* A61g *5/00*
U.S. Cl. 280—250 10 Claims

ABSTRACT OF THE DISCLOSURE

A collapsible wheelchair in which relatively small ground wheels are connected by chains to handwheels to permit driving. The wheelchair is formed by upper and lower mutually pivoted frames that are each unitary and permit vertical collapsing.

The present invention relates to vehicles travelling upon horizontal and inclined substantially smooth planes. More specifically the invention relates to invalid wheelchairs with particular emphasis on their improved capability to negotiate successfully in domestic and public environments both indoors and out. Furthermore the invention includes improvements in foldability and portability.

A study of wheelchair designs over the last hundred years has revealed the discarding of numerous configurations and the gradual evolution of a foldable wheelchair which was influenced largely by the advent of the automobile as an indispensable means of transportation. For many years now, almost all wheelchairs have been of one basic configuration. They comprise two large diameter main wheels and two smaller castoring wheels, a frame which folds across the main axle line and a seating means comprising a flexible material slung laterally between the two side frame structures. Manual propulsion is achieved by the spasmodic gripping and releasing propelling rims which are concentrically mounted upon the large diameter wheels.

Most wheelchairs serve as wheeled vehicles for both indoor and outdoor use. Because of this dual purpose, they are by no means ideal for either. We believe that by our analysis of the problem a new configuration has been found which makes the wheelchair more suitable for its many contemporary roles. The standard propulsion method currently achieved by the large diameter rims, although as simple mechanically as one could hope to design, is not necessarily the ideal solution. In view of technological progress over the last twenty or thirty years, simplicity is no longer the criteria. An examination of wheelchairs in the English magazine "Design" of August 1962 was made by Nurse Raynor. In this article the very fundamentals of the design, namely the seating and the method of propulsion were questioned. These two fundamentals are interrelated.

Because of the large propelling wheels on conventional wheelchairs, the only practical way for compact collapsing is to bring the two side structures together laterally. In such collapsing, the seat is laterally folded. This is made possible by the use of a flexible slung fabric seat. Such a seat is considered the least desirable by all professional people concerned, even for able bodied individuals. Notable references can be found in the publications "Anatomical Physiological and Anthropometric Principles in the Design of Office Chairs and Tables" and "Measurements for Confortable Sitting" and the article in "Design" of August 1962 by Nurse Clare Raynor. A few manufacturers provide a firm, hinged or removable upholstered seat portion in an attempt to overcome the objection cited. In other cases the owner improvises with varying degrees of success. To our knowledge, however, the back remains as a flexible slung fabric support on the majority of conventional wheelchairs.

The classical means of propulsion i.e. by directly driving the main wheels manually, is highly unsatisfactory for the following reasons:

(a) The occupant's knuckles are easily barked when negotiating confined spaces such as doorways.

(b) Dirt adhering to the tires is transferred to the occupant's hands.

(c) A reciprocating discontinuous drive is unavoidable, making progress on the level for any distance extremely laborious, and the slightest incline almost insurmountable.

(d) The position of the rim forces the occupant to take an unnatural posture which hampers circulatory, respiratory, and digestive functions.

(e) The large diameter wheels control the frame configuration, the seating configuration and dictate the method of collapsing.

(f) A custom seating design (frequently necessary having regard to deformities and the like in the user) becomes a major modification of the frame and is again dictated by the large wheel diameter.

(g) The footrest area is condensed if the frame is folded laterally and its design is restricted accordingly.

(h) The large wheels have a rearward overhang which hampers manoeuverability.

(k) A separate brake required for each side of the chair since a cross linkage would prevent folding.

(l) The large diameter of the rear driven wheels dictate closer proximity to the front wheels in terms of ground point contact than is the case with the herein disclosed chair, and consequent relative instability.

The current method of propulsion demands large diameter wheels and laterally folding arrangements (i.e. a structure in which the two sides come together normal to the direction of wheelchair travel) which imposes severe restrictions on the seating and overall design.

An objective of the invention is therefore to provide a wheelchair configuration capable of meeting the following parameters without the loss of the conventional wheelchair's versatility, serviceability and safety, manoeuverability, reliability or convenience. These parameters are as follows:

(a) Width not exceeding 25".

(b) A substantial weight and collapsed volume reduction.

(c) Manoeuverability and stability as good or better than conventional wheelchairs including the elimination of the rearward overhang.

(d) A propulsion system wherein the occupant is not required to exert excessive force in negotiating normal inclines associated with the average outdoor environment.

(e) A continuous rather than a spasmodic form of propulsion, having therapeutic value.

(f) A means of providing rigid or semi-rigid seating designed within the recommendations of the medical profession and freedom within the design for modifications of the seating to suit individual requirements without interfering with the fundamental configuration of the chair's structure.

(g) To provide a means for propulsion that will not injure or soil the occupant's hands and one to be broad enough in its concept to serve a wide variety of disabilities.

(h) Considerably greater stability against overturning due to the longer wheel base made possible by the use of relatively small diameter front and back wheel-pairs.

Some further important novel features of the present invention reside in the provision of a chair which is collapsible vertically downward in contrast to laterally, and includes a seat and a back which move from the usual angular relationship into a final, horizontal, co-planar, coterminous relationship with an approximately equal overhang, (for the seat-back combination) beyond the pair of front and back wheels, with the ends of the seat-back combination in the collapsed position constituting substantially the outside chair-length, in virtue of which arrangements, upholstering of the back and/or seat is rendered possible, while impractical with laterally folding chairs; and all the foregoing in combination with a chair which, when collapsed is only some 12 inches high to the upper plane of the collapsed back and seat, so that the chair may be pulled by the user-occupant after him following his transfer from the chair to the driver's seat of a Volkwagen or the like, onto the passenger seat beside him, the invention also importantly, featuring upper and lower mutually pivoted frames each of which is unitary, and does not change its profile as between the in-use and out-of-use positions, so that it is as strong and rigid when collapsed as it is when extended. As a result, the chair is not liable to become loose and weak with repeated opening and collapsing due to having a multiplicity of pivoted joints, which of course is of the very essence in such chairs. In addition, the chair can be moved by the user between open and collapsed positions with one hand only. Further it will not tend to "roll-away" during transfer of the patient due to the novel parking brake means disclosed. It can easily be folded and then rolled under beds or the like, and lends itself readily to shipping and hospital stacking.

With the foregoing in view, and such other object, purposes or advantages as may become apparent from consideration of this disclosure and specification, the present invention consists of the inventive concept embodied in the method, process, construction, arrangement of parts, or new use of the same, as herein particularly exemplified in one or more specific embodiments of such concept, reference being had to the accompanying figures in which:

FIGURE 1 is a perspective view of our wheel chair in its upright or operating position.

FIGURE 2 is a perspective view of the two fundamental frame components showing their respective relationships.

FIGURE 3 is a perspective view of the stay frame and propulsion sub-assembly.

FIGURE 4 is the side elevation of the wheelchair in its upright or operating position.

FIGURE 5 is the elevation of the wheelchair in its partially collapsed condition.

FIGURE 6 is the elevation of the wheelchair in its fully collapsed condition.

FIGURE 7 is a side elevation showing the basic frame elements in the distended mode.

FIGURE 8 is a fragmentary side elevation showing an alternative configuration for the arm rest.

FIGURE 9 is a side elevation showing the basic frame elements in the collapsed state.

FIGURE 10 is a sectional view taken on line **10—10** on FIGURE 4.

FIGURE 11 is a diagrammatic side elevation of an alternative wheel chair configuration having the driving wheels at the front of the chair.

FIGURE 12 is a diagrammatic side elevation showing the alternative wheel chair configuration in a partially collapsed position.

FIGURE 13 is a diagrammatic side elevation showing the alternative wheel chair configuration in the fully collapsed position.

FIGURE 14 is a fragmented perspective showing the jacking method of braking.

FIGURE 15 is a partial side elevation showing the jacking method of braking.

FIGURE 16 is a fragmented perspective illustrating the latching means for maintaining the chair in the extended position.

FIGURE 17 is a section taken on line **17—17** of FIGURE 16 showing details of the latching mechanism.

FIGURE 18 is a detail of FIGURE 17 viewed on arrow X.

FIGURE 19 is a cut-away elevation of the chain-locking method of braking.

In the drawings, like characters of reference designate similar parts in the several figures.

Description of construction

With reference to FIGURES 1 and 2, our wheelchair comprises a seat **1**, a back rest **2**, a pair of arm supports **3**, an upper frame collectively designated **4** comprising principally the side members **5**, a lower cross brace **6** and an upper cross brace **7** (immediately against the rear seat edge in the position of FIGURE 4), a lower frame collectively designated **8**, a foot rest assembly **9** spanning the lower end of the upper frame **4**, a pair of castoring wheels **10** attached to the lower frame **8** near the front end thereof, a pair of driven wheels **11** located near the rearward end of the lower frame **8** and a pair of propulsion assemblies generally designated **12** located in the area below the arm supports **3**.

The design of the frame is governed by the requirement for collapsibility into the smallest practical package. We have imposed a longitudinal limit to this package as being substantially the sum of the back-to-front seat depth plus the back rest height, when the rear and lower edges thereof respectively are contiguous, (see FIGURE 6). This requirement has largely dictated the concept of collapsibility used.

It will be seen in FIGURE 7 that frame members **5** have a characteristic profile which is described by the interrelationship of points designed A, B, C, D and E.

The starting point in the design of the frame is length CD. This has to be adequate in length to support the seat, but no longer than is necessary since in the collapsed condition excessive length increases the collapsed package height as shown in FIGURE 9.

The anthropometrics must then be considered in terms of the arm rest position relative to the seat and thus the length DE is established. The angle CDE is also determined by anthropometric considerations. Professional recommendations are that this should be slightly greater than the right angle, for example, 95°.

The collapsed package, FIGURE 6, shows that the seat **1** and the back rest **2**, fall into a common horizontal plane, the side edges of the seat being supported by the runs **5A** of frame members **5**, between points BC, and the back rest side edges at point C and E. It therefore follows that the angle BCD on FIGURE 7 is established by projecting a line *t1–t2* through points E and C downwardly and forwardly towards the footrest area. At the upper corners of back rest **2**, a pair of handles **5B** is provided, and at this point it should be noted that braces **6** and **7** are welded solidly to the side members **5**.

If desired the run DE may be shortened as in FIGURE 8 to provide a curved arm rest **3** of the same effective height as to the support portion thereof.

The arm supports **3** are preferably integrated into a single U tube assembly **14**, FIGURE 2 which is pivotally mounted upon the uppermost extremities of frame members **5**. The transverse portion **15** of the arm rest assembly **14** supports and guides the back rest **2**. To prevent the back rest **2** in FIGURE 4 from falling forward, a pair of elongated open guideways **16** are secured to the rearward face of the back rest, **2**, as shown in FIGURES 4 and 5, trapping member **15** in juxtaposition with said back rest but permitting sliding relationship therewith.

A reference line *w1–w2* on FIGURE 7 drawn horizontally through point B and consequently parallel to a ground reference plane *g1–g2*, shows that the slope of plane *t1–t2* (through points BC and E) is inclined to the

horizontal ground reference at an angle CB*w*2. It is desirable that point D on frame 4 should overlie and be supported upon point F of the lower frame 8. It therefore follows that the arc through which point D passes in the collapsing movement must be that of angle CB*w*2. This then governs the selection of pivot point O on frame 4 (by which frames 4 and 8 are rotatably connected) between points A and B, the angle of bend B, namely angle ABC, and the inclination of frame 8 relative to the ground plane *g*1–*g*2. It will be noted that this rearward inclination of frame 8 is compatible with about an eleven or twelve inch diameter driven wheel 11 and an eight inch diameter castor 10. See FIGURE 9.

When the chair is extended, occupant-containing position, the frames 4 and 8 are held in rigid relationship by strut means in the form of a pair of stay frames which are actually elongated gear cases collectively designated 17, and best illustrated in FIGURE 3. These pivot at their lower ends 18 upon and about the axles of wheels 11. A tubular tie bar 19 maintains them in parallel relationship and extends transversely beneath the seat 1 between points C and D of frame 4, FIGURE 7.

Tie bar 19 is attached to seat 1 by a pair of flat brackets 20 which extend downwardly therefrom (being secured to the seat edges) and through which said tie bar 19 freely extends as shown in FIGURE 10, such that there is a sliding clearance for frame members 5 between the under side of the seat 1 and the upper side of tie bar 19. The back of the seat 1 is hinged to the lower corners of the back rest 2 at 21 as shown in FIGURE 4. It will therefore be apparent that as the chair collapses, the seat and back rest assembly are drawn downwardly and forwardly over the profile of frame 5. Shortly after the hinge point 21 passes over point C (FIGURES 5 and 7) of the frame 5, the back 2 and seat 1 fall into a common plane, overlying portion B, C and E which reaches the horizontal in the final or fully collapsed position best illustrated in FIGURE 6. This action is the essence of compact folding since the upper edge of the back rest 2 in this position is in closest possible proximity to point E of frame 5 and prevents a substantial space-consuming overhang beyond point E.

Arm supports 3 are pivotally connected to linkages 22 (FIGURES 5 and 6) which in turn pivot at their lower ends about points 23 (as best shown in FIGURE 10)—and the linkages 22 are herein considered as part of the complete arm rest assemblies 14. The rear ends of the arm supports 3 are pivotally connected at 24 which are coincident with points E on frame members 5 (see FIGURE 7). Thus, as the frame is collapsed the arm supports 3 and the linkages 22 combine to draw the arm supports into line with the seat and back upholstery as the tie bar 19 (FIGURE 10) moves away from the point E on frame 4. This process is illustrated by reading FIGURES 4, 5 and 6 in sequence. To lock the chair in the collapsed position (FIGURE 6) the operator may apply downward hand pressure to the arm supports 3 and thereby force them to over-toggle in their relationship to linkages 22.

The chair is latched in the extended (occupying) position by means of a pair of flat, rearwardly extending tongues 32 (FIGURE 16) attached to each rear corner of seat 1. A single aperture (32A) in each tongue becomes aligned with the axis on arrow 17—17, of upper brace 7 when the chair is fully extended. Within and projecting from the ends of brace 7 (FIGURE 17) is a pair of plungers 33 both outwardly spring biased and joned by a flexible tape 34 which is substantially held in tension by the bias of the springs 34A bearing against the fixed, apertured, stop-washers 34B. When the said plungers project through tongues 32, the chair seat 1 is prevented from sliding forward or rearward with respect to frame 4. An actuating knob 35 located centrally on brace 7 is connected to a stub-shaft 36 having a transverse open slot 36A therein through which tape 34 passes. A partial turn of knob 35 winds tape 34 around stub-shaft 36 thus drawing both plungers 33 inwards and withdrawing them from engagement with tongues 32 thus allowing the chair to fold.

The driving means (best illustrated in FIGURES 1 and 3) comprises a pair of handwheels 25 each having an integral sprocket 26 and a chain 27 within each of gear cases or struts 17, connecting said sprocket 26 to a lower sprocket 28 attached to a driven wheel 11. The stay frames 17 each comprise essentially a pair of tubes 29 welded to upper and lower mounting plates 30 and 31 through which the chain drive passes in order to provide a clean safe protective guard for said chain. Incidentally, the handwheels 25 may readily be lowered from the location shown and positioned lower down, so that they do not project upwardly in the collapsed position as indicated in FIGURE 6. Even as shown however, they do not interfere with stackability as already referred to, because each super-posed chair would be laid upon the one below in reverse relationship.

Attached to each propelling handwheel rim, or to a spoke thereof, is a knob 37 (FIGURE 1). Thus, the operator may either use a rim type of propulsion similar to the present conventional wheelchair, or he may to advantage maintain a constant drive by using the knob as a crank. Over long distances or on ramps the knob drive is superior to the intermittent rim type drive. For small manoeuvers, the rims may be found more convenient. For frail patients, a mechanical advantage may be simply achieved by the selection of a larger sprocket 28 relative to sprocket 26.

The braking of the chair in the sense of reducing speed or bringing the chair to a stop is accomplished by applying hand pressure to the rotating rims 25, this being similar to the present practice on conventional wheelchairs. Locking the chair in a fixed stationary position, however may be accomplished in one of two ways, the first being illustrated in FIGURES 14 and 15 and referred to as the jacking method and the second FIGURES 3, 10 and 19 and referred to as the chain-locking method.

In the jacking method, a pair of brake levers 38 (FIGURES 14 and 15) may be introduced between frames 4 and 8 (being commonly pivoted at points). Said levers are preferably joined by a tie bar 39. One end of each lever has a hand grip 40 and the opposite end, a rubber ferrule. When the brake is off the lever handgrip is in the lower position 41 (FIGURE 15) and the lower end of the lever is clear of the ground. When the lever is raised to position 42 its lower end makes contact with the ground *g*1–*g*2 and lifts the castors 10 slightly clear of the ground. In the fully raised position the lever passes over dead-centre and provides a stiff leg lock in this position against any suitable and obvious abutments (not shown). Thus the chair becomes very stable for entry or exit of the occupant.

The alternative chair-locking braking means is best shown in FIGURE 19 which is a fragmented elevation through a portion of a stay frame 12. A lever 43 is attached to each end of a rod 44 which is coaxial with tubular tie bar 19 (FIGURE 3). The upper end 45 of lever 43 is pivotally connected to a dog 46 and said dog being horizontally slidable between a pair of guides 47 and 48 which span the space between stay frame tubes 29. Projecting teeth 49 on the dog may be brought into engagement with adjacent links of drive chain 27 when the lever 43 is moved in the direction of arrow 50. This effectively locks the chain and thus also the drive wheels. The lever 43 on either side of the chair locks both wheels 11 simultaneously providing connecting rod 44 is common to both levers.

In general a great advantage is achieved by the small wheel configuration over conventional large wheel models by the elimination of a rearward overhang which is out of the range of vision of the rider. Our wheelchair, therefore, describes a substantially smaller turning circle and is therefore more manoeuverable in confined areas.

In general also it should be noted that although front castors and rear driven wheels is the preferred arrange-

ment, the reverse is practical and within the general concept of our invention as illustrated in FIGURES 11 through 13. The driven wheels when located at the rear should preferably be as close to the vertical centreline of gravity of the accupant as possible consistant with adequate stability. The reason for this is that the main mass of the occupant tends to pivot rather than swing in an arc when negotiating turns. It will easily be perceived by reference to FIGURES 11 through 13 that on cambered roads especially, the occupant's mass when close to the castors will cause a sideways veering of the chair which is virtually eliminated by placing the drive wheels to the back.

What is claimed is:

1. A downwardly collapsible wheelchair, including a seat and back rest, characterised by upper and lower frames mutually pivotally connected near the base of said chair in the vicinity of the ends of said frames, said lower frame carrying a pair of driven wheels which are of small diameter relative to conventional wheelchair driven wheels, and a pair of castors, whereby to provide a longer wheel-base and greater stability than conventional wheelchairs, means spaced from said driven wheels for operating the same, said upper frame including a pair of side-members of which the upper corresponding portions of each are in permanent fixed relationship conforming substantially to the angular relationship of said seat and back rests of said chair when in seating position, and means for maintaining said chair in normal occupant's seating position against unwanted collapse.

2. The chair according to claim **1** which includes means for causing said seat and back rest to assume a co-planar, substantially horizontal, and contiguous relationship in the collapsed position of said chair.

3. The chair according to claim **2** in which said seat and back rest overlie said upper portion of said upper frame, and in which said upper frame, in the collapsed position of said chair, rests upon said lower frame at the location remote from that of their pivoted connection.

4. The chair according to claim **1** in which said means for maintaining this chair in normal occupant seating position against unwanted collapse includes strut means pivoted in the vicinity of said driven wheels, and extending between said lower and upper frames, remote from their locus of pivoted connection, the upper ends of said strut means being operatively associated with said upper frame in the vicinity thereof which extends between the front and rear edges of said seat.

5. The chair according to claim **4** in which said means for maintaining said chair in normal occupant seating position includes foldable arm rest assemblies comprising arm rests extending forwardly from said back rest, and link means pivotally connected in between said rests and said strut means, the rear ends of said rests being slidably associated with said back rest so as to move toward the upper ends of said back rest while said link means move in a locking-toggle acute angular relationship downwardly with the strut ends of said arm rest into an obtuse angular relationship, during the collapsing of said chair, while said seat moves forwardly, and said back rest moves forwardly and downwardly, as from the leading lower edge thereof into horizontal coplaner relationship with said seat, and over said upper frame.

6. The chair according to claim **4** which includes a pair of occupant operated hand wheels, and in which said strut means constitute elongated gear cases, gear means within said cases, said hand wheels being operatively connected with said gear means for propelling said chair.

7. The chair according to claim **1** in which said means for maintaining the same in normal occupant seating position includes transversely extending locking means located in the vicinity of the junction of said seat and back rest.

8. The chair according to claim **1** in which said upper frame includes a pair of side members the profile of each of which, as viewed in side elevation, is seen to comprise lower portions inclining upwardly from the front of the chair towards the back, relatively horizontal portions which, in seating position, conform to the plane of, and lie contiguous to said seat adjacent the edges thereof, and upper portions which, in said seating position, conform substantially to the plane of and lie contiguous to said back rest adjacent the edges thereof, said portions of said side members being permanently fixed in their mutual relationship, said seat and back rest being mutually hinged for movement between an angular seating and back supporting position, and a horizontal co-planar position, at a lower level when said chair is collapsed, at least a substantial length of said lower portions of said side members lying parallel with and below said seat and back when the same are in horizontal position, and means for locking said seat and back rest in seating and back supporting relationship.

9. The chair according to claim **8** which includes strut means pivotally connected at the lower end thereof to said lower frame in the axial vicinity of said driven wheels, said strut means maintaining said upper frame in normal seat supporting position, said seat resting upon said seat supporting portion, and arm rest assemblies, said arm rest assemblies including arm rests in slidable relationship to said back rest, and link means pivotally connected between said arm rests and said strut means, movable between lock-toggle acute angular relationship in the seating and back-supporting position of said seat and back rest and unlocked obtuse angular relationship when said seat and back rest are in co-planar collapsed relationship.

10. The chair according to claim **1** which includes jack-braking lever means in the form of at least one angulated bar pivotally connected to said chair in the vicinity of the front lower portion thereof and rotatable between an out-of-use position in which the lower ends of said bar is clear of the ground and a brake locking stiff-leg position in which said lower end is in ground pressing contact such as to lift said castors clear of the ground.

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