

[54] **ELECTRICALLY DRIVABLE WHEELCHAIR** 3,023,825 3/1962 Rabjohn..... 180/65 R X
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Hirota, Zushi, both of Japan 3,770,070 11/1973 Smith..... 254/86 R
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 254/86 R; 180/65 R
 [51] Int. Cl. B60s 9/20
 [58] Field of Search .. 180/11, 12, 13, 65 R, DIG. 3,
 180/14 R, 15, 16; 280/5.3, 5.2, 5.32;
 297/DIG. 4; 254/86 R

[57] **ABSTRACT**
 In a wheelchair for disabled persons having side wheels with hand rims, an electric driving unit comprising: a main body including an electric motor; a jack portion having a member moved by a jackscrew driven by the electric motor; and driving wheels driven by the electric motor through a speed-reduction device is pivotally connected to a rear part of the wheelchair through a supporting lever and spring means, whereby the wheelchair can be driven by the electric motor when the driving wheel is brought down to contact the ground surface particularly in climbing and descending a step such as a curb of a sidewalk.

[56] **References Cited**
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8 Claims, 9 Drawing Figures

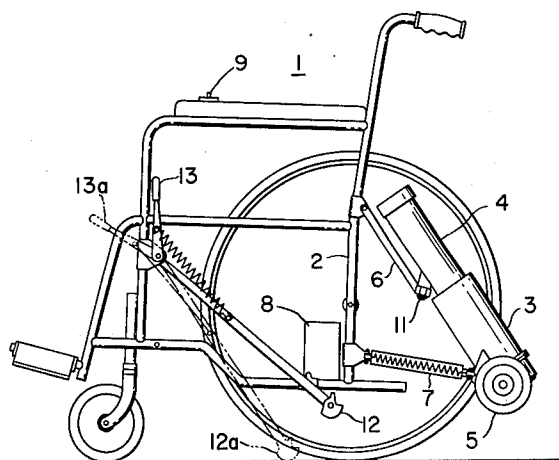


FIG. 1

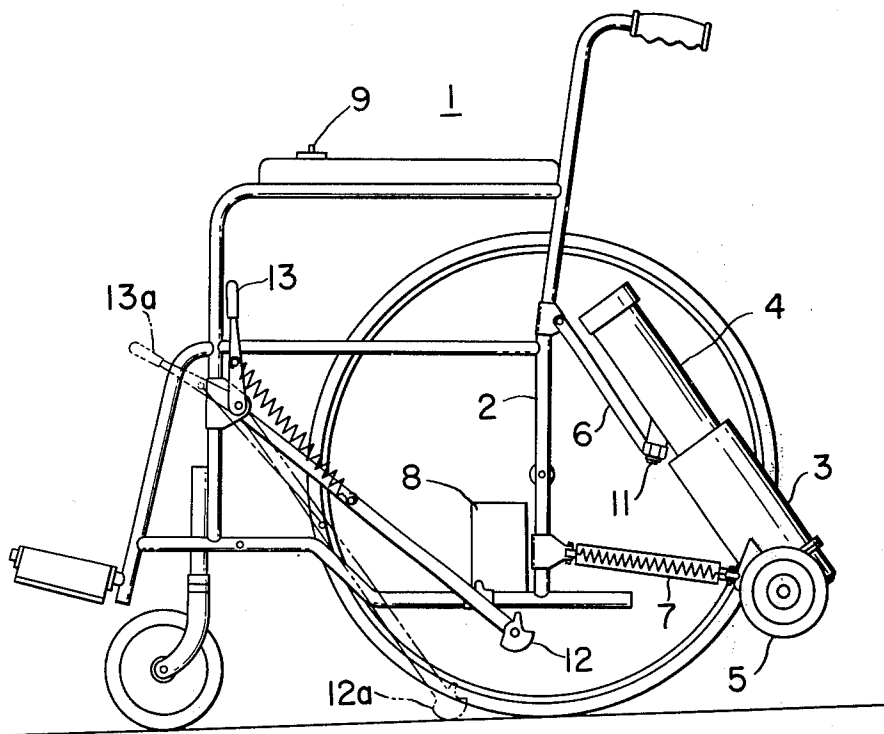


FIG. 2 (a)

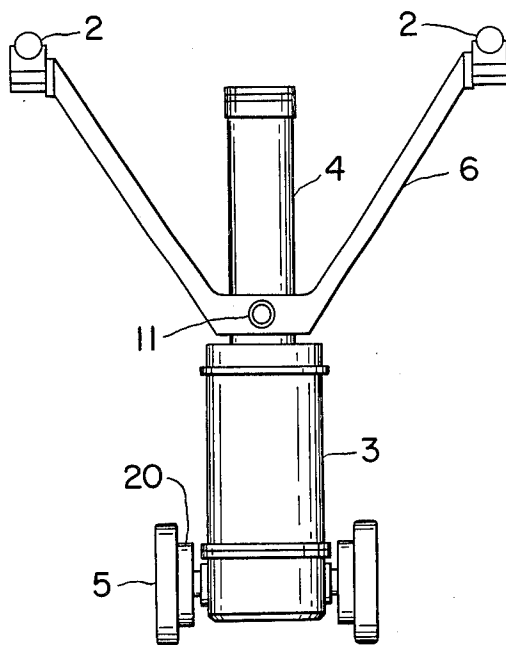


FIG. 2 (b)

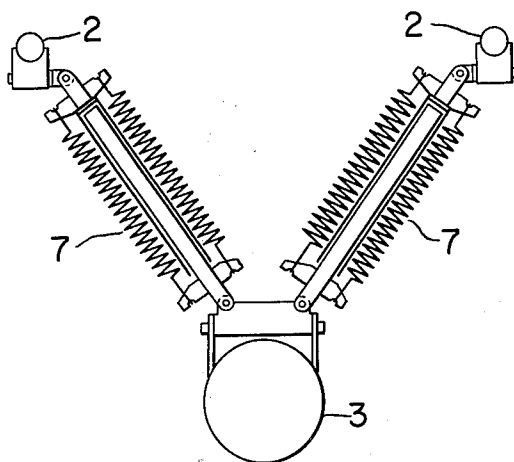


FIG. 4

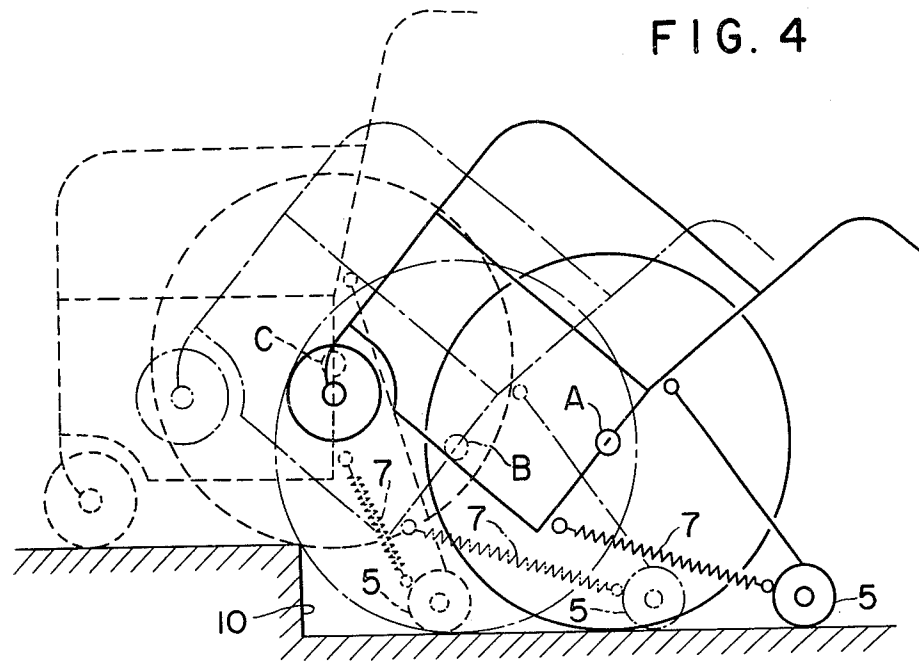


FIG. 5

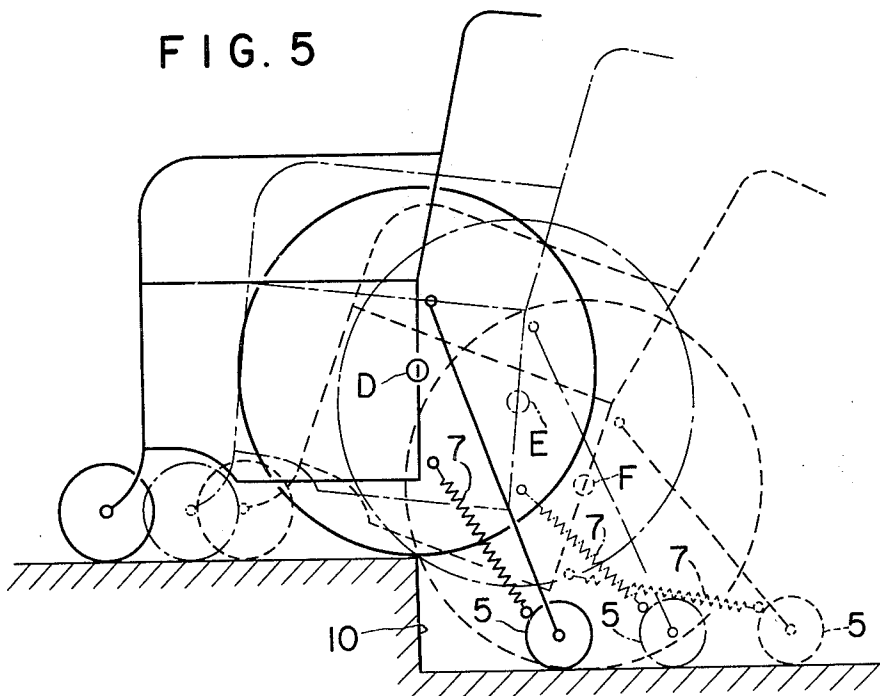


FIG. 7

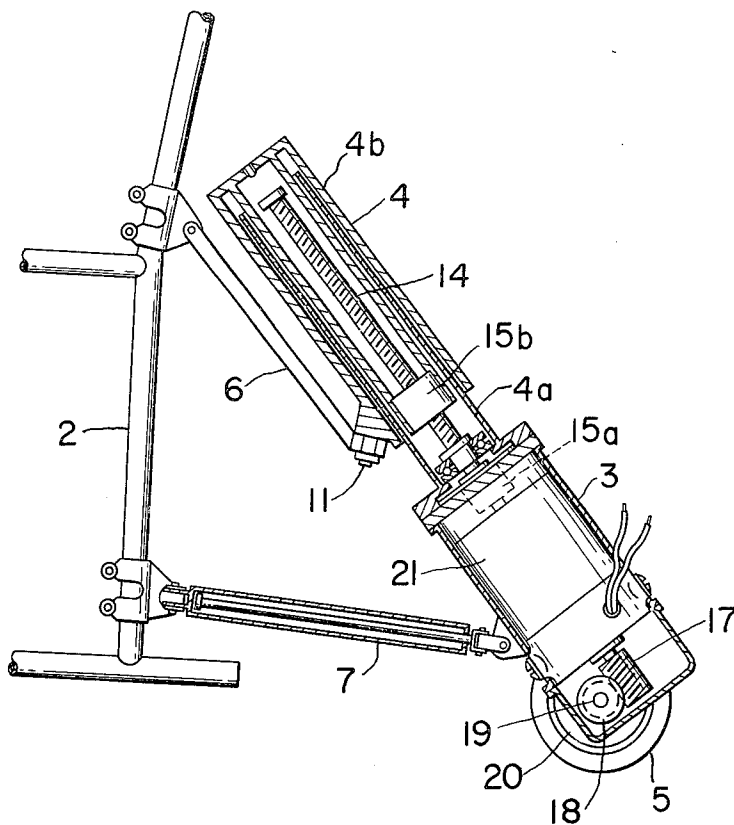
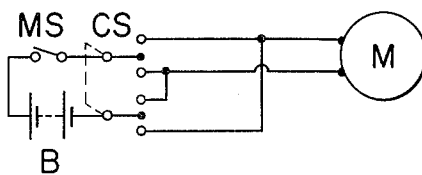


FIG. 8



ELECTRICALLY DRIVABLE WHEELCHAIR

BACKGROUND OF THE INVENTION

This invention relates generally to wheelchairs for disabled persons, and more particularly to a type thereof provided with an electric power drive so that it is driven to climb or descend a step as a curb (or kerb) of a sidewalk.

Ordinarily, a wheelchair for a disabled person comprises a chassis, a pair of side wheels of a comparatively large diameter with hand rims attached thereto, respectively, for manually driving the wheelchair, and one or more of front wheels of a comparatively small diameter. Although a wheelchair of this kind can operate satisfactorily to some extent, being maneuvered in forward and reverse running and steering to change direction by manually operating the hand rims, a serious difficulty is encountered when an attempt is made to climb or descend a step such as that of a sidewalk or the like.

Of course, the disabled person may strive hard and succeed in bringing the front wheels to ride onto the step by tilting the entire wheelchair backwardly and advancing it slightly forwardly, but it is almost impossible to lift the side wheels upwardly over the step by manually rotating the hand rims, and even if it is possible, a great effort must be exerted for a certain period of time. Furthermore, there is a high probability of severe impact loads being frequently applied not only to the wheels and structure of the wheelchair, but also to the body of the disabled person, when either of the front wheels and the rear wheels collide against the flank of the step or when the wheels failing to climb the step drop back onto the surface of the ground, thus giving rise to damage or breakage of the wheelchair.

SUMMARY OF THE INVENTION

With the above described difficulty accompanying the conventional wheelchairs in view, a primary object of the present invention is to provide a wheelchair for disabled persons, which can be driven by an electric motor when it is desired, so that the climbing or descending of the wheelchair over a step is facilitated.

Another object of the invention is to provide an electrically drivable wheelchair which may also be driven manually as in the ordinary case so that delicate maneuvers of the wheelchair are thereby made possible.

These and other objects have been achieved by the present invention, according to which, briefly summarized, there is provided an electrically drivable wheelchair of a type having a chassis, a pair of side wheels with hand rims attached thereto, and at least one front wheel, wherein there is provided the improvement comprising an electric driving means including a main body and a jack portion, the main body including an electric motor operatively connected with a wheel for driving the wheelchair, the jack portion including a jackscrew also driven by the electric motor, and means for supporting the electric driving means apart from a rear part of the chassis in a manner such that the driving wheel can be lifted from the ground when the jack portion of the electric driving means is contracted by the operation of the electric motor.

Preferably, the above-mentioned supporting means comprises a V-shaped lever having two ends pivotally connected to a rear part of the chassis and a central portion pivotally coupled to the jack portion of the

electric driving means through a king pin, and spring means connecting the main body of the electric driving means to the rear part of the chassis.

Preferably, a tilting means manually operable may be further provided in the wheelchair for lifting the front wheel upward from the ground level and driving forward the same over a limited distance.

The nature, principle, and utility of the present invention will be more clearly understood from the following detailed description of the invention when read in conjunction with the accompanying drawings wherein like parts are designated by like reference numerals.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a left side elevation showing the outline of an electrically drivable wheelchair according to the present invention;

FIG. 2(a) is a front view showing the construction of an electrical power device which is adapted for driving the wheelchair of this invention;

FIG. 2(b) is a plan view showing a spring mechanism used for securing the lower part of the electric power device to the wheelchair;

FIG. 3 is a left side elevation of the wheelchair in a state wherein it is being electrically driven on a level road;

FIG. 4 is a diagrammatic left side elevation showing progressive operational states of the wheelchair of this invention in climbing a curb (or kerb) of a sidewalk;

FIG. 5 is a similar diagrammatic left side elevation showing progressive operational states of the wheelchair in descending the curb (or kerb);

FIG. 6 is a left side elevation of the wheelchair showing still another operation thereof wherein the wheelchair is inclined backwardly before it climbs a curb or the like with the aid of an auxiliary mechanism;

FIG. 7 is a left elevation, partly in section, showing details of construction of the electric power device for driving the wheelchair and parts associated therewith; and

FIG. 8 is a circuit diagram showing an example of electrical connection between an electric motor and a switch used for electrically driving the wheelchair.

DETAILED DESCRIPTION

Referring now to FIGS. 1, 7, and 8, there is indicated an example of a wheelchair generally designated by numeral 1 and provided with an electric power drive movably attached to suitable rear members 2 of the chassis through V-shaped lever 6 and two spring means 7. The electric power drive comprises a hollow main body 3 containing an electric motor 21, a jack 4 including a jackscrew 14 coupled to the electric motor 21, and a driving wheel 5 rotatably mounted on the lower end of the main body 3 to be driven by the electric motor 21.

The main body 3 may be of any suitable configuration having an inner space encasing the electric motor 21, the shaft thereof extending upwardly and downwardly. The jack 4 comprises a stationary member 4a rigidly coupled to the upper end of the main body 3, a movable member 4b having a portion turnably coupled to the central portion of the V-shaped lever 6 through a king pin 11, and the jackscrew 14, the lower end of which is coupled through a free-running mechanism 15a to the upper end of the driving shaft of the electric

motor 21 so that the jackscrew 14 is rotated around its longitudinal axis by the electric motor 21.

Another free-running mechanism 15b including a nut (not shown) engaging with the jackscrew 14 is interposed between the movable member 4b and the jackscrew 14, so that when the jackscrew is rotated in one direction, thereby extending the movable member 4b of the jack 4 to the uppermost position, the coupling between the nut and the movable member 4b is released by the free-running mechanism 15b, and the jackscrew 14 is rotated in a free-running state together with the nut.

Likewise, when the jackscrew 14 is rotated in the opposite direction, thereby shifting the movable member 4b of the jack 4 to the lowermost position, the coupling between the jackscrew 14 and the motor shaft is released by the free-running mechanism 15a.

The main body 3 is further provided with a chamber, into which the downwardly extending portion of the motor shaft is extended. A worm 17 is mounted on the end portion of the shaft, and a worm wheel 18 engaging therewith is mounted on the shaft 19 for driving the wheel 5 via a free-wheel 20.

Since the two ends of the V-shaped lever 6 are pivotally connected to the rear members 2 of the chassis, and the forward ends and the rearward ends of two spring means 7 are pivotally connected to the rear members 2 and the main body 3 of the electric power drive, respectively, full extension of the jack 4 causes the main body 3 of the electric power drive to be lowered until the driving wheel 5 is brought into contact with the ground surface. Furthermore, the rotation of the electric motor 21 in the direction to extend the jack 4 causes the driving wheel 5 to rotate through the worm 17 and worm wheel 18 in a direction driving the wheelchair forward, and the advancing speed of the wheelchair, that is the forward rotating speed of the driving wheel 5, is selected to match the extending speed of the jack 4 such that the wheelchair can easily override a step of a sidewalk or the like. It is a characteristic feature of the invention that the ratio between the two speeds can be easily preset to a suitable value.

For supplying an electric power to the electric motor 21, and for controlling the operation of the electric motor 21 in normal rotation, stop, and in reverse rotation, a battery 8 and a three-position control switch 9 are provided in the wheel chair.

In addition to the electric power drive and the supporting means, the wheelchair 1 is further provided with a manually operable tilting mechanism comprising at least one tiltable lever 12 and a manually operable handle 13, both pivotally connected with a forward member of the chassis, and a tension spring 16 stretched between a position a on the handle 13 and another position b on the tilting lever 12, whereby the tilting lever 12 is lifted in a snapping manner when the handle 13 is raised into a vertical position past a dead-center point as shown in FIG. 1, while the lever 12 is lowered also in the snapping manner when the handle 13 is lowered into a somewhat horizontal position 13a, as indicated by two-dot chain lines in FIG. 1.

For operating the wheelchair of the above description in a state driven by the electric power drive on a level road as shown in FIG. 3, the tilting lever 12 is lifted upward by elevating the handle 13 vertically, and then the control switch 9 is brought into the "forward" operating position. Thus the electric motor 21 starts to

rotate in the normal direction thereby extending the jack 4 and rotating the driving wheel 5 in the direction for forward driving of the wheelchair. The spring means 7 are now extended, and the driving wheel 5 is lowered until it contacts the surface of the road thereby to start driving the wheelchair. In this state, the jack 4 is fully extended, and the free-running mechanism 15b releases the coupling, thereby leaving the jackscrew 14 in the freerunning condition.

When the control switch 9 is shifted to the "stop" position, the rotation of the electric motor 21 is stopped, and the wheelchair is kept in the stopped position with all members held in the state shown in FIG. 3.

When the switch 9 is placed in the "reverse" position, the jackscrew is rotated in the reverse direction thereby contracting the jack 4. The electric power drive is now lifted upwardly and ultimately held at a position, as indicated in FIG. 1, where the driving wheel 5 is separated from the surface of the ground by a predetermined distance. When the mechanism assumes this state wherein the jack 4 is fully contracted, the free-running mechanism 15a releases the coupling between the jackscrew 14 and the motor shaft.

Furthermore, at the time when the switch 9 has just been placed in the reverse position while the driving wheel 5 is still contacting the road surface, the electric motor 21 is started to rotate in the reverse direction as described hereinbefore, and the driving wheel 5 is caused to rotate in the reverse direction, thereby tending to drive the wheelchair rearward. This tendency, however, is prevented because of the interposition of the free-wheel 20 between the worm-wheel shaft 19 and the driving wheel 5, and also by the fact that the driving wheel 5 is lifted instantaneously from the surface of the ground.

When it is desired to change the direction of travel while the wheelchair is being driven by the electric power drive as described hereinbefore with reference to FIG. 3, the rotation of the appropriate one of the large side wheels is braked manually by holding the hand rim attached thereto.

In FIG. 4, there is indicated diagrammatically the operation of the wheelchair for upwardly overriding a step 10 of, for instance, a curb of a sidewalk. In the diagram, the positions of the center of the hand-operated side wheels at different instants are indicated sequentially at A, B, and C, respectively. In this case, although the wheelchair is driven by the electric power drive, the power drive device is once elevated from the lowered state shown in FIG. 3 to the elevated position shown in FIG. 1. Then the entire wheelchair is tilted backward by, for instance, the disabled person tilting his body backward, so that the front wheel is elevated from the surface of the road, and the wheelchair is supported on the road by the side wheels the center of which is now at the point A and by the driving wheel 5 of the power drive which may, but not necessarily, be brought into contact with the road surface 1 (hereinafter designated as the state A).

At this moment, the handle 13 of the auxiliary tilting mechanism is manually lowered to the position 13a, whereupon the tilting lever 12 descends in a snapping manner to the position 12a as aforementioned, so that the lower tip of the tilting lever 12 contacts the surface of the ground. Then, the wheelchair is moved rearward manually by operating the hand rims of the side wheels for a distance sufficient to bring the tilting lever 12 to

tilt from the vertical position slightly backwardly as shown in FIG. 6, so that the wheelchair is further tilted backward, and the front wheel is thereby further elevated.

In the case where the driving wheel 5 is not yet contacting with the ground surface, the electric switch 9 is again operated thereby to lower the electric power drive downward until the driving wheel 5 contacts the ground surface. Simultaneous, the handle 13 is operated thereby to lift the tilting lever 12 upwardly, and the wheelchair is advanced manually until forward parts of the side wheels contact the edge of the step 10 and the centers of the side wheels are brought to the position B with the front wheel being held above the step as shown in FIG. 4.

With the wheelchair in this state, the electric switch 9 is operated again to the forward position to operate the electric motor 21 in the normal direction, so that the jack 4 is further extended and the driving wheel 5 is thereby driven forwardly. Thus, the wheelchair is driven over the step thereby bringing the center of the side wheels to the position C. At this stage of the operation, the wheelchair is brought back to the horizontal state because the center of the gravity of the wheelchair is forwardly of the contact position between the edge of the step 10 and the side wheels, and the front wheel is caused to contact the top surface of the step 10.

It is of course possible to aid the above described electric-power drive of the wheelchair by manually rotating the hand rims, and in this manner the wheelchair can surmount a step higher than the above described step 10.

The electrically drivable wheelchair can descend a step as described below with reference to FIG. 5.

The wheelchair is first moved rearward until the centers of the side wheels are brought to a position D approximately above the front edge of the step 10. At this position, the jack 4 is again operated to the fully extended state until the driving wheel 5 descends to contact the surface of the ground below the step 10. Then the motor 21 is operated reversely to contract the jack 4 while a braking force is applied by hand to the hand rims, so that the side wheels are gradually lowered over the step 10, the centers thereof being moved through a position E to a position F at which the side wheels are fully contacting the ground surface below the step 10. The front wheel is then lowered with or without the use of the auxiliary tilting lever 12 from the step 10, whereupon the descending operation of the wheelchair is completed.

The advantageous features of the electrically operable wheelchair according to the present invention may be listed as follows.

1. When the wheelchair is not in the electrically operable state, the driving wheel 5 is lifted above the ground level, whereby the wheelchair can be operated as an ordinary manually operated wheelchair, and its feature of easy maneuver is in no way hampered by the provision of the electric power drive.

2. Since the driving wheel is provided on the rear side of the wheelchair, the wheelchair can be driven electrically as described thus allowing the wheelchair to run at a higher speed. Furthermore, the provision of the driving wheel prevents the wheelchair from being upset rearward, and the wheelchair can be maintained safely

in the state wherein the front wheel is placed above the step.

3. Since the jackscrew and the driving wheel are rotated by a single electric motor 21. The ratio between the driving speed of the wheel 5 and the extending speed of the jack 4 can be preset to a suitable value, and also an electric power drive of small size and light weight can thereby be realized. Furthermore, since the road driving and ascending and descending of a step can be attained by the operation of an electric switch having forward, stop, and reverse positions, the control of the wheelchair can be substantially simplified.

4. When the wheelchair is driven electrically, the running speed thereof can be regulated by simultaneously operating the side wheels. Furthermore, the running direction of the wheelchair can be changed without using a steering handle or the like, but simply applying a braking force to either one of the side wheels, and the direction of the wheelchair can be easily changed with the aid of a king pin.

5. In addition, the electric power driven can be easily installed on substantially any type of conventional wheelchair.

Although the present invention has been described with reference to a preferred example thereof, it will be apparent to those skilled in the art that various alterations and modifications can be carried out without departing from the scope of the present invention. For instance, the free wheel 20 provided between the worm-wheel shaft 19 and the driving wheel 5 may be constructed in the form of a simple hub including a non-reversible ratchet wheel, or the two free-running mechanisms 15a and 15b may be replaced by a single mechanism which can release the nut member upon activation by two stop members.

What we claim is:

1. In a wheelchair of the type having a chassis, a pair of side wheels with hand rims, and at least one front wheel, the improved combination thereof with an electric driving means comprising a main body including an electric motor, a jack portion including free-running mechanisms and a jackscrew coupled to said electric motor, and driving wheels also coupled to said electric motor, said electric driving means being attached extensibly and contractably to a rear part on the wheelchair through supporting means and spring means.

2. A wheelchair as set forth in claim 1 wherein said means for supporting said electric driving means comprises a V-shaped lever two ends of which are pivotally connected to the rear part of said chassis, and the central part of which is pivotally coupled to a movable part of said jack portion through a king pin.

3. A wheelchair as set forth in claim 1 wherein two spring means are used, each having forward and rear ends pivotally connected to a rear part of the wheelchair and the main body of the electric driving means, respectively.

4. A wheelchair as set forth in claim 1 wherein there are further provided auxiliary tilting means comprising a control handle and a tilting lever, an end of each of said control handle and tilting lever being pivotally connected to a forward part of the chassis through a commonly provided pivot pin, and a spring member extended between suitable positions on the said control handle and tilting lever.

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5. A wheelchair as set forth in claim 1 wherein a worm-wheel device is interposed between said electric motor and said drive wheels.

6. A wheelchair as set forth in claim 5 wherein a free wheel device is further provided between the worm-wheel device and the driving wheels.

7. A wheelchair as set forth in claim 2 wherein said jack portion further comprises a stationary member rig-

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idly coupled with the main body, and a member which is moved upon rotation of said jackscrew and coupled with said V-shaped lever through said king pin.

8. A wheelchair as set forth in claim 7 wherein said free-running mechanisms release the coupling between the movable member and the electric motor when the movable member reaches the extremities of its stroke.

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