Personal Transport for Disabled People

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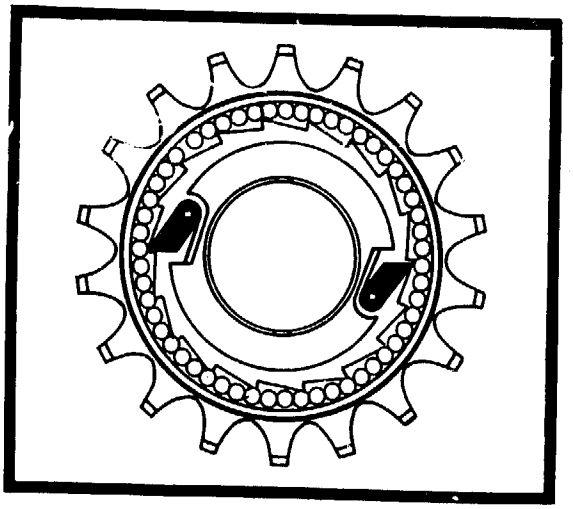

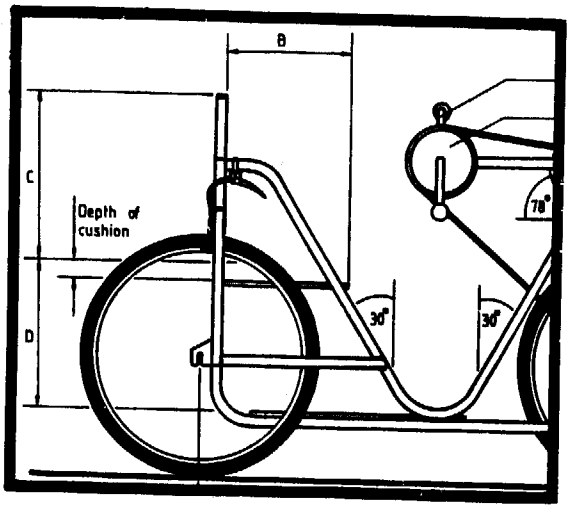

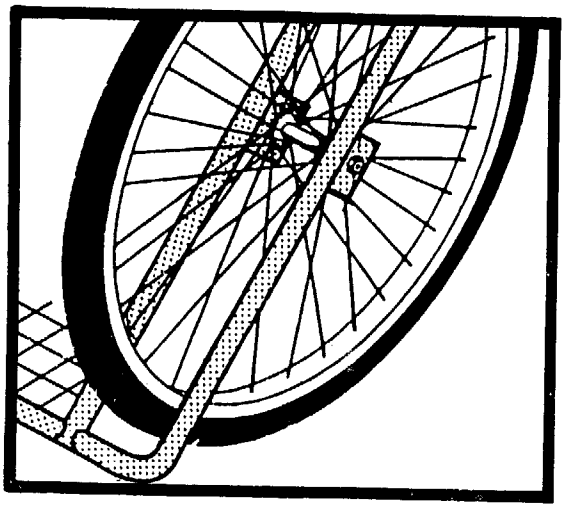

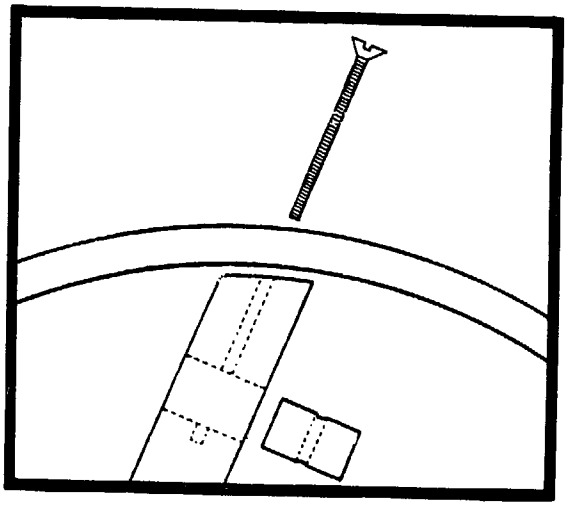

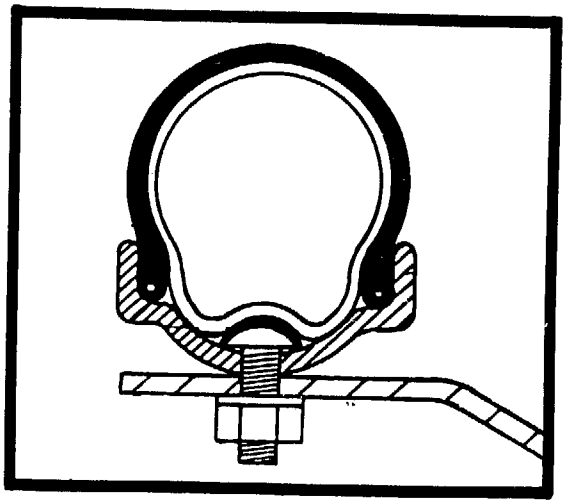

DESIGN & MANUFACTURE

Appropriate Health Resources and Technologies Action Group Ltd.

PERSONAL TRANSPORT FOR DISABLED PEOPLE DESIGN & MANUFACTURE

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Foreword

Following a struggle for liberation one country was recently left with a large number of young men suffering from amputations. In response to this a national programme of rehabilitation was developed, but it soon became apparent that for every amputee, there were in the community a number of others with severe disability from illnesses such as polio and also accidents.

Those with these severe disabilities are to be found scattered in their hundreds of thousands through the villages and slums of developing countries. For most of them much of the day will be spent looking at four walls and perhaps in some position on a verandah of the house.

By finding a means of improving their mobility their life expectations can be greatly improved and for many the burden of their support, which falls on the family, diminished.

I well remember visiting the workshop of the late Bill Eaves and seeing beggars who had been almost immobilized, relying on charity, happily operating simple tricycles with their hands. They were now coming to the workshop for a day's work.

Much thought and care has gone into this book on trolleys, wheelchairs and tricycles, to try and make them available to the many whose lives could be so changed by such simple equipment. The authors hope that many more workshops throughout the developing world will be encouraged to produce this equipment and to develop further local initiatives which will provide the mobility disabled people so urgently need if they are to be enabled to take as full a part as possible in the life of their local community.

Those involved in AHRTAG appreciate that this book is only one step in the process of making this low-cost, locally made and locally repaired equipment widely available. We hope to hear from those involved the problems that they run into, the improvements that they have been able to make and how successful they have been in getting this equipment to those who need it so desperately.

David Morley,
Professor of Tropical Child Health,
University of London,
Chairperson of AHRTAG.

Acknowledgements

This book has been produced with the support of the Swedish International Development Authority (SIDA) to whom we are grateful for their encouragement.

We are indebted to many centres and workshops around the world who supplied us with resource material. Particularly we extend our thanks to centres who field tested the designs and provided constructive criticisms: Baren Das, ISOM, India; Antony Samy, WORTH Trust, India; Daniel Wanjohi, CITC, Kenya; Majid Bakari, Malindi Workshops, Malawi; David Ward, Hlekweni Friends Rural Service, Zimbabwe.

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Contents

Section 5: Technical information

Introduction

Purpose of the Manual

This Manual provides technical information and advice on the design and manufacture of trolleys, wheelchairs, and tricycles for disabled people, and describes methods for manufacturing and marketing these aids.

The technical information in the Manual is presented as a range of options, enabling the reader to choose a suitable design for manufacture, or to adapt existing products. The information can also be used to produce new designs which are low-cost. The Manual aims to encourage the manufacture of aids on a small scale and the use of simple but efficient batch production methods to aid this process.

It is essential that disabled people should be consulted at all stages in the production of wheelchairs and tricycles. They should be involved at policy making, planning, and production levels.

Only by this process can it be ensured that disabled people receive the most appropriate equipment they need in a manner suitable to their requirements.

Local manufacture of transport aids

Physically disabled people who cannot walk need some form of personal transport. Without it they often cannot do basic daily tasks in the community.

Most manufactured wheelchairs and hand-propelled tricycles come from the industrialised world. They were developed for use on smooth surfaces. On uneven or soft ground, such aids are unsuitable. They are also expensive to buy and look after, and difficult to repair, because they are usually complicated. In areas where people need aids most there are often no spare parts, nor the facilities to make them.

Locally manufactured transport aids can be functional and effective but cheap and simple. Local manufacture has several advantages:

- it allows the design to suit the local resources and geography, and the needs of the user
- it allows the introduction of improvements and the development of new designs
- it costs less, so that you can provide more aids
- it produces local employment
- it uses existing skills and develops new ones.

Use of the Manual

You can use the information in the Manual in a number of ways:

(iii) You can choose a design from the ones given in the Manual:

- trolleys – section 2
- wheelchairs – section 3
- tricycles – section 4

The pictures/illustrations of each design give the general appearance of the aid. The side, back and top views show some basic dimensions, proportions and construction details. They also show some specific dimensions which you will need to adapt the equipment to the size of users. Section 5 describes various methods of making components – wheels, castors, etc.

(ii) You can change particular designs shown in the Manual to suit local conditions and manufacture. This may demand different materials or manufacturing methods.

(iii) You can combine different ideas from the manual to produce an aid which suits local conditions.

(iv) You can develop an entirely new design. Section 1 provides some basic information for developing new designs, if the ones shown in the Manual are unsuitable.

Before you choose or design an aid consider thoroughly the cost, performance, manufacturing facilities, etc. The first part of Section 1 describes the major points for consideration.

Section One:

Design, Manufacture & Marketing

This section provides information on some of the methods used to design, manufacture and market simple, but efficient transport aids. It gives advice on how you can successfully manufacture and market the designs and can encourage the development of local skills.

Design

Choosing a suitable aid

Before choosing a design or developing a new one, it is important to consider thoroughly the following:

- Cost limitations
  Many disabled people do not have much money to spend so the aid should be as cheap as possible. Hospitals or other institutions may want a sophisticated aid which will be more expensive. It is important to balance the cost, performance and appearance needs of the people who will buy locally produced aids.

- Performance and durability
  The condition of local roads and paths may have an effect on the design of an aid. If local paths are rough, the aid will need large wheels and good ground clearance. This may demand the choice of a wheelchair or the adaptation of a trolley design so that large wheels can be fitted. It is unlikely, however, that any wheeled transport aid would be suitable for use in very hilly areas or on very rough surfaces. The surface of local roads and paths will also influence the strength of the aid. If the aid is not strong enough, it will have a limited useful life, particularly if there are no repair facilities.

- The needs of the user
  The aid will be used for a variety of activities – work, play, carrying goods, etc. and it should satisfy all the user's needs. For example, tricycles are more suitable for outdoor use and other aids for both indoors and outdoors. A trolley may be more suitable than a wheelchair for a child who needs to talk and play with other children at ground level. If a person needs to carry tools, etc. It may be necessary to fit a basket to the aid.

  Disabled people should not spend too much time in a wheelchair because sitting too long in one position can cause sores. Those who can walk a little should use a walking stick or crutches or a trolley to give as much exercise as possible to active muscles. It is important to change position as often as possible. Wheelchairs should have space for carrying walking aids.

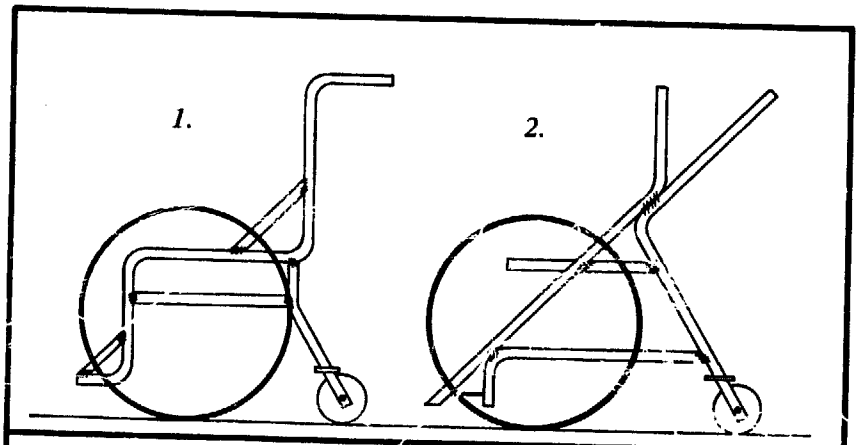
- Availability of materials and components
  The local availability and cost of materials, tools and components needs careful consideration to keep manufacturing costs down and make maintenance easy.

In many countries steel is a suitable construction material because it is cheap, or because wood is scarce. In other places, however, wood and carpentry skills are the basis of most small-scale manufacture. When choosing or designing an aid decide which engineering parts can be made locally, and consider the availability of imported parts. Many aids are based on bicycle technology. Bicycle parts are widely, but not always, available. Using locally made parts may reduce costs, and will also reduce dependency on outside suppliers.

After careful consideration of this information you can now choose a design from the Manual or develop a new design.

Design methods

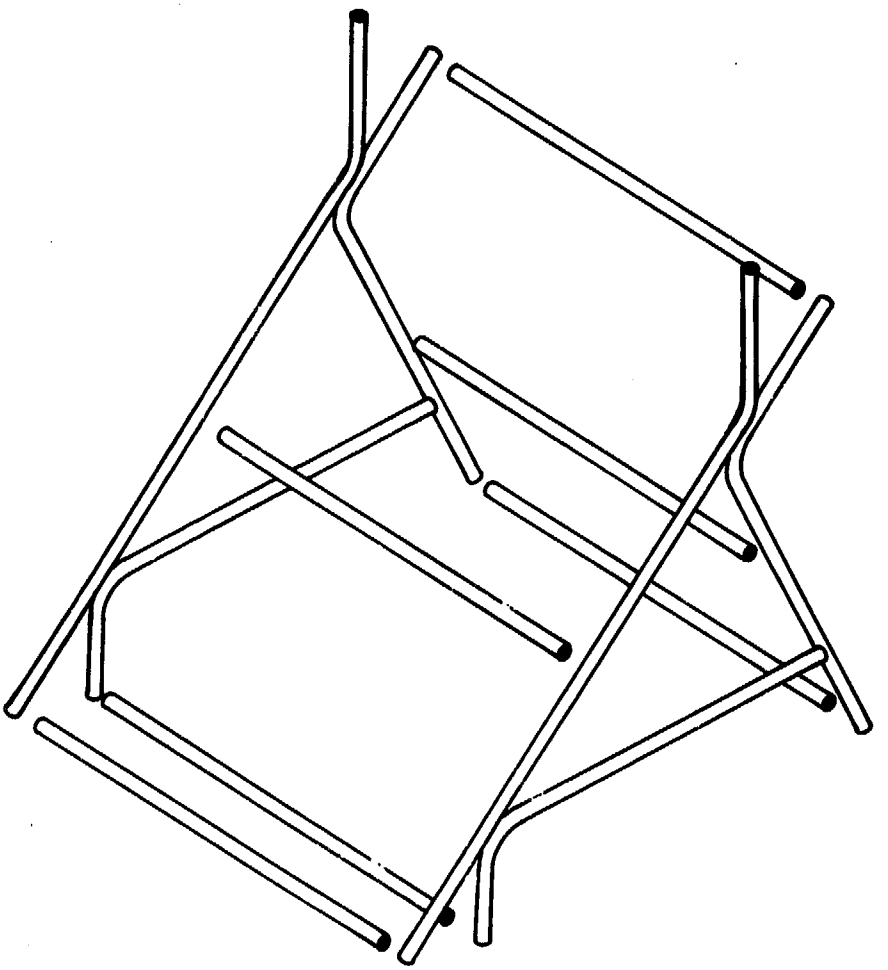
Complicated aids are often difficult to manufacture and use a lot of material. They are, therefore, expensive to produce. The development of simple designs can reduce manufacturing complexity and the amount of material required. This makes the product easier to maintain and more attractive to the customer. The two side views of wheelchair frames shown below illustrate this point. The frames are made of the same material – tubular steel – and use the same manufacturing processes – cutting, bending, and welding. However, design 1 has more parts, and needs more bending and welding operations. It is therefore more difficult and more expensive to produce than design 2. Simple solutions are often more difficult to develop than complicated ones. However, the time spent making a design as simple as possible can reduce the cost of the aid.



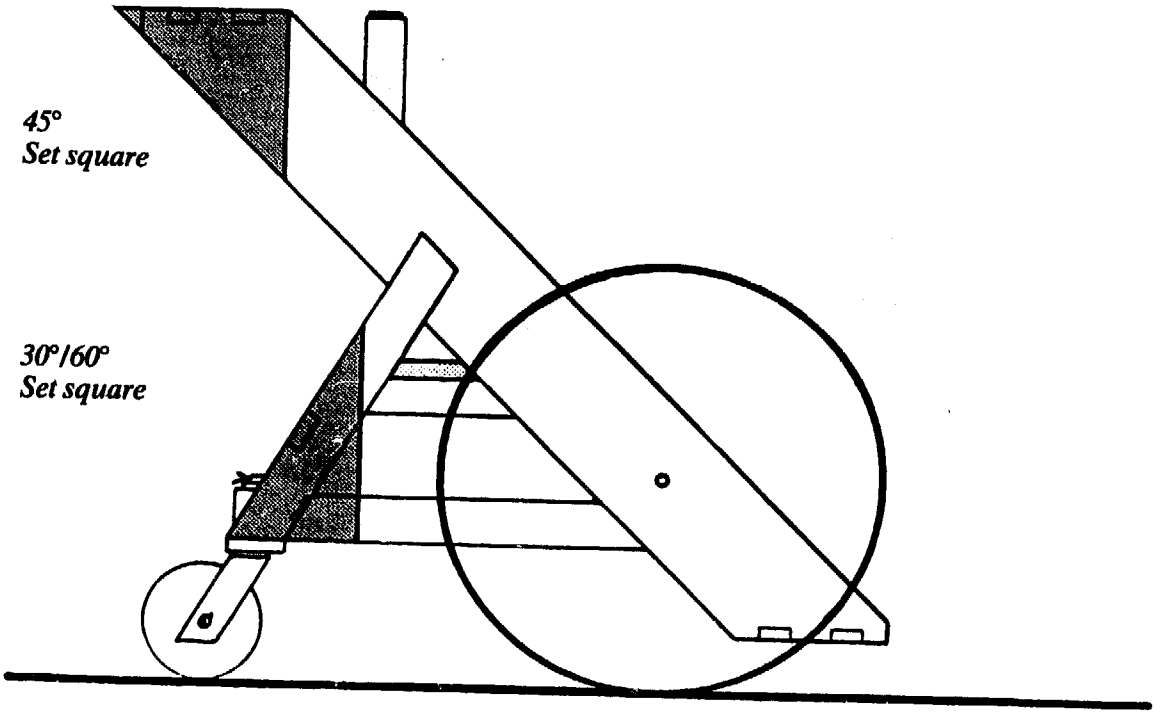
	Design 1	*Design 2*
No. of parts	5	4
No. of bends	5	3
No. of welds	7	5

It can be very helpful to standardise material sizes. This will help you to reduce costs and manufacturing problems through improved stock control and production planning. For example, several of the aids in this Manual have tubular steel frames designed to use **one size of tube only**. It is important to standardise on materials which are easy to find. The tube recommended is 25mm diameter with a wall thickness of 1.6mm. However, it is not essential to use this particular size. For example, if 30mm diameter tube is widely available, use the 30mm tube as the standard material. It is important however, that the material chosen is strong but not too heavy.

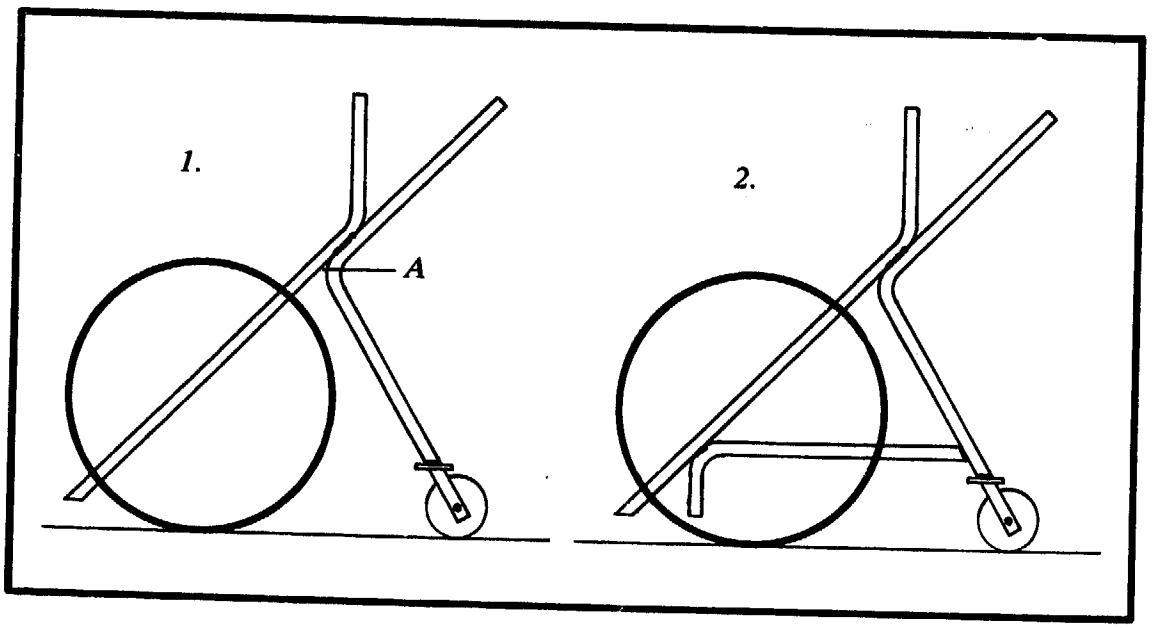
One of the most complicated activities in any manufacturing process is checking and positioning the parts before joining them. This is particularly important when welding steel parts, as mistakes are often expensive to correct. The tubular steel wheelchairs and tricycles in the Manual are made of two separate side frames joined together by straight tubes. In the example below, the two side frames are designed to be exactly the same. The connecting tubes are all the same length. This makes sure that the two side frames are in line with each other. This method is suitable for producing aids in wood or steel.



If you use simple angles (e.g. 30°, 45°, 90°) for the frame members and joints, you can mark out and position the parts with simple geometric aids, such as 'set-squares'.



It is important to consider the strength of the design. For example, design 1, shown below would eventually break at point A, because the two main frame tubes are not connected. The addition of another tube (design 2) increases the strength of the frame without greatly increasing complexity or weight.



Dimensions

The aids illustrated in the Manual show critical dimensions which will remain the same for different sizes of people. However, other dimensions which are indicated in the drawings as A,B,C,D, etc show where alterations must be made to those dimensions to suit the varying sizes of local people. This does not mean matching the size of each aid to an individual's measurements. If the aids are to be manufactured in quantity it will be necessary to base dimensions on groups of people of different ages and sizes to produce a limited range of equipment in batches.

The sections of the Manual on trolleys, wheelchairs, and tricycles each include a drawing which shows how to measure a person to obtain the dimensions needed to draw up your plans.

Producing a prototype

Once you have produced a detailed design, make sure that it meets all the requirements given on pages 6–7, especially the cost. If it does, then make a prototype of the aid which you can test and, if necessary, adapt. The production of this prototype is one of the most difficult stages of product development. You must turn an idea or drawing into a working full-sized example of the design. There are two basic methods of doing this:

(i) You can make a scale drawing of the aid, which shows the exact size and shape of every part. The scale drawing can be half full size, one quarter full size, etc. The drawings in the Manual which show the **side, back** and **top** views of each design show the way to set out a scale drawing.

(ii) You can draw the design for the aid, full size, on paper or the floor or the wall of a workshop. This method has the advantage that you can see the size and approximate appearance of the aid before you make it. Depending on the complexity of the design, drawings of **side, back** and **top** views may be necessary. If, for example, you are making a tubular steel design, the side frame governs most of the critical dimensions. Then only a side view will be necessary. This method allows you to check parts against a full size drawing before assembly.

You may need to adapt some details of the design – exact location of wheels, position of seat, etc, as you build the prototype. However, it is most important that you make the basic frame correctly. All the frame members must be the correct size and join at the proper angles.

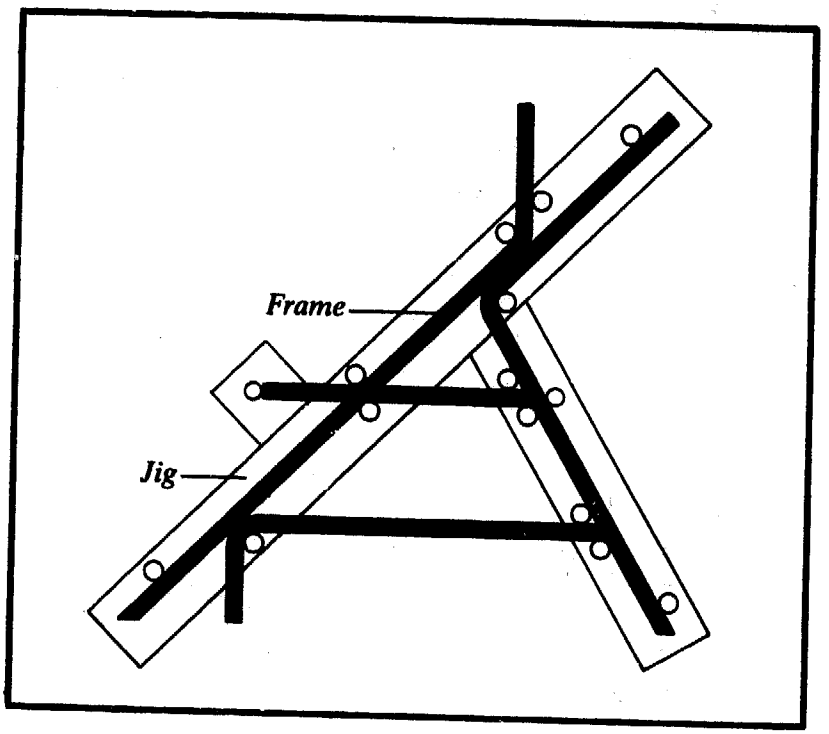
Once you have built the prototype, it is important to test it thoroughly and consider: cost, performance, user's needs, durability, etc. You can solve minor problems at this stage by changing the prototype. Larger problems may demand the additional cost of another prototype. However, it is extremely important to correct all such problems at this stage of product development.

Manufacture

Manufacturing methods

There is a close relationship between the design of a product and the methods used to make it. If you develop or choose a simple design, and choose the materials carefully, you can keep production time and complexity to a minimum. There are several simple manufacturing aids which help this process, and assist the production of a quality product:

A **jig** holds a part or number of parts in a fixed position during a manufacturing operation. Welding jigs are particularly useful for lining up and locating frame parts while you join them together. Jigs can be simple and cheap. They reduce the time taken to line-up parts, and prevent twisting during welding. They also help to find wrongly made parts since these will not fit into the jig properly. The illustration below shows how a jig positions the parts of a steel wheelchair side frame.



A **template** is a pattern used to mark out and check the shape of a part. You can make simple templates from sheet metal, wood or cardboard. They are particularly useful for marking out the shape of more complicated parts, joints in wood, and the correct position of holes. You can also use them to check that steel tube parts are bent to the correct shape.

When you make a number of identical aids, production time is reduced by making batches of each part. You can then check each part against a template as you make it. This improves product quality.

It is very important to make jigs and templates accurately, particularly when it is necessary to mark out holes and joints by template. Before the production of the first batch of aids using these tools, use them to make one aid to check that they are correct. Otherwise you may ruin the whole batch.

Marketing

To sell aids, it may be necessary to advertise: e.g. through posters, leaflets and newspaper advertising. You could invite a newspaper to write an article about what you are making to get some free publicity. It may also be possible to place one example of the product in a shop which is prepared to accept orders.

Locally produced aids are as good as, and often better than, imported ones, but people often think that they are inferior. Such people may be under pressure to buy locally-made aids if these are well made, well finished and attractive. A good advertisement for locally produced aids is provided by disabled people themselves. If they are satisfied with your product they will recommend it to others.

Many disabled people do not have much money to spend on transport aids. Financial help will be needed to provide aids for those who need them. Some Governments have schemes to provide financial help to disabled people. It is worthwhile finding out if they include help in providing transport aids.

Other organisations and groups who may contribute to the paying for an aid are:

- the community in which the person lives
- religious groups
- hospitals, which often have access to funds for this purpose
- service organisations, such as Lions, Rotary, etc
- other local and international voluntary agencies.

It is worthwhile encouraging these organisations to help in providing aids. It is also important to have a well-finished product to show them when asking for their financial help. They will not want to be associated with a poorly made and unattractive product.

Section Two:

Trolleys

Introduction

Trolleys are the cheapest type of wheeled aid. They are suitable for:

- disabled children who like to be close to the ground to play and talk with other children
- adults who, for mobility or social reasons, prefer a seating position close to the ground.

This section gives design information on:

- four wheeled wooden trolley
- wooden trolley with castor wheel
- steel framed trolley

Measuring for a trolley

A. Height of the backrest

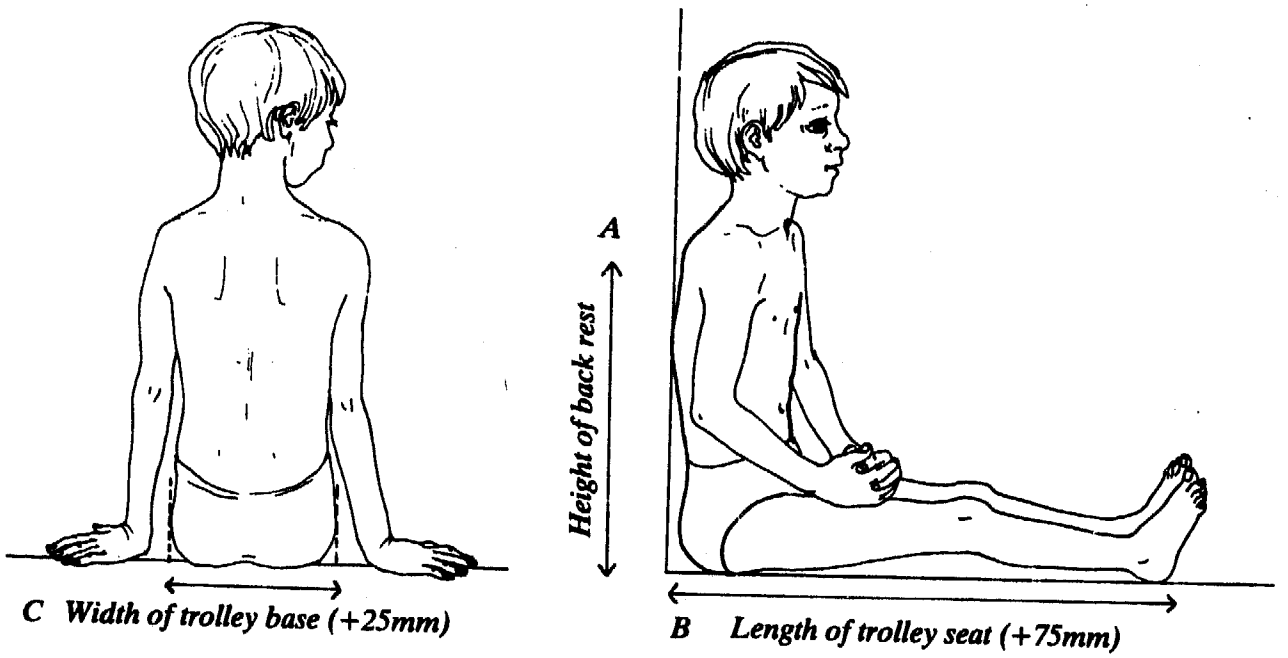
Ask a therapist about the most suitable height for the backrest.
Sit the person on the ground.
Measure from the ground to the correct point on their back.
If you are going to use cushions, make both measurements a little longer to allow for the thickness of the cushions.

B. Length of trolley seat

This is the most critical dimension.
Sit the person on the ground with their back supported in an upright position if possible.
Measure from the back of the person to the end of their heels.
Add about 75mm to this length.

C. Width of trolley base

Measure the person across the widest part of the hips while he/she is sitting down. Then add 25mm to the measurement to obtain the width of the seat.



Design A: four wheeled wooden trolley

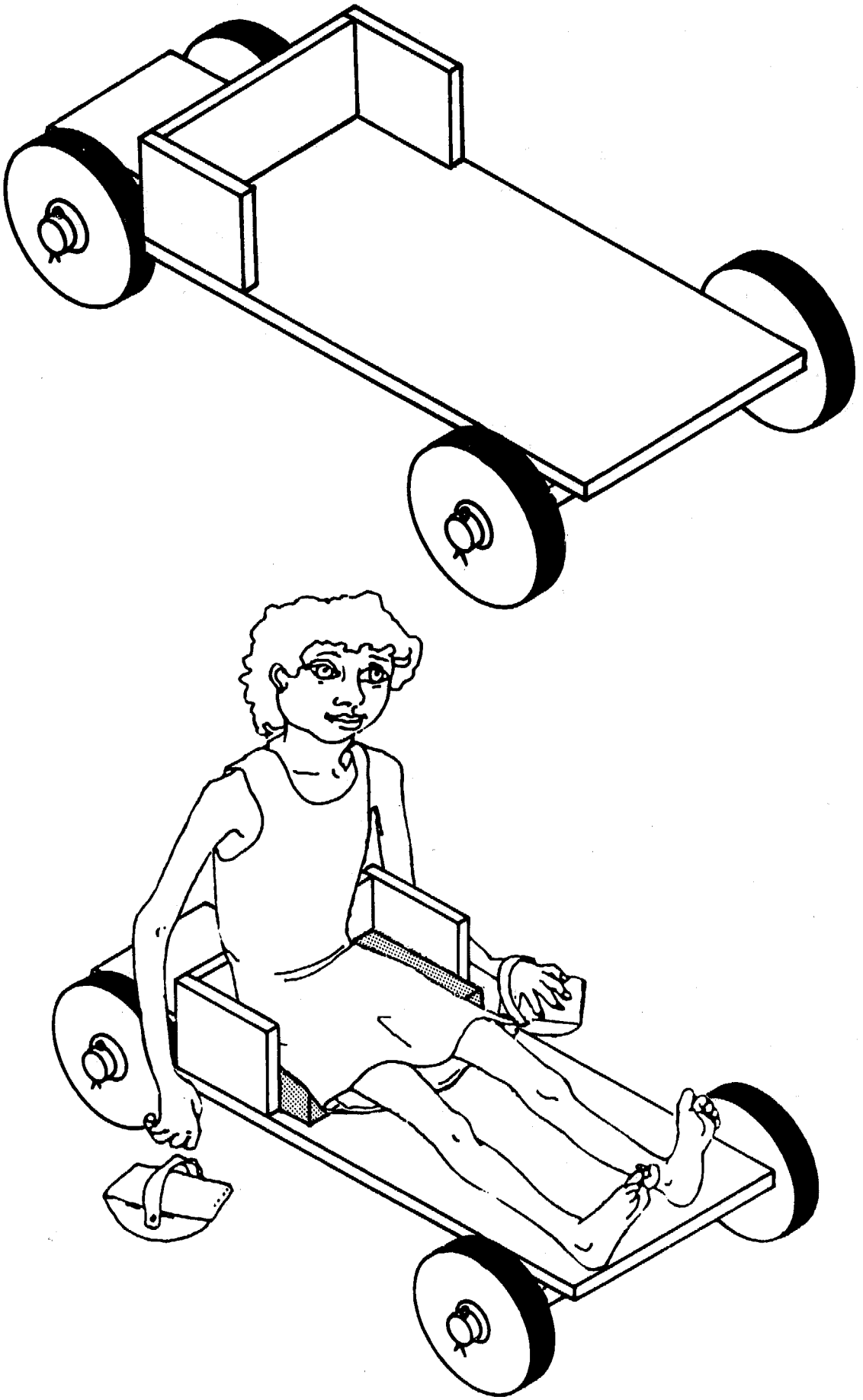
This trolley is made of wood and is the cheapest, simplest design shown. The user propels and steers the trolley with a pair of sticks or pads held in the hands. The wheels run on wooden axles.

- Pages 55–57 show the wheels you can use with this trolley.
- A seat cushion (pages 72–73, Section 5) makes the trolley more comfortable.

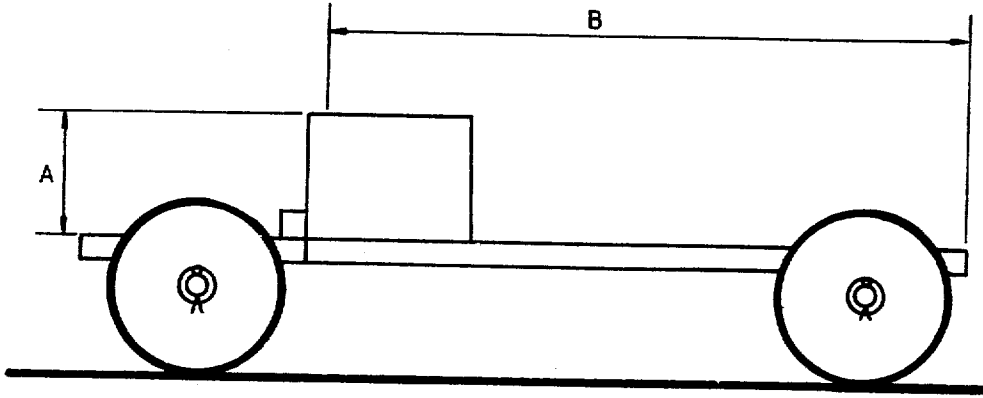
Some adaptations to the basic design are possible.
You can:

- fit a rope so that an able-bodied person can pull the trolley
- make a higher backrest
- provide steering by pivoting the front axle on a wooden pin or bolt.

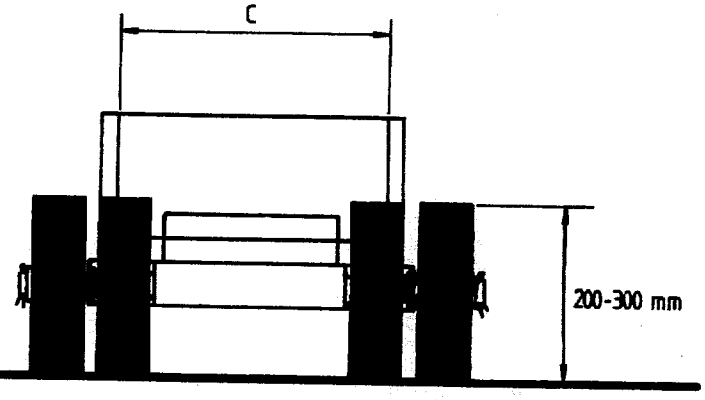
Four wheeled wooden trolley

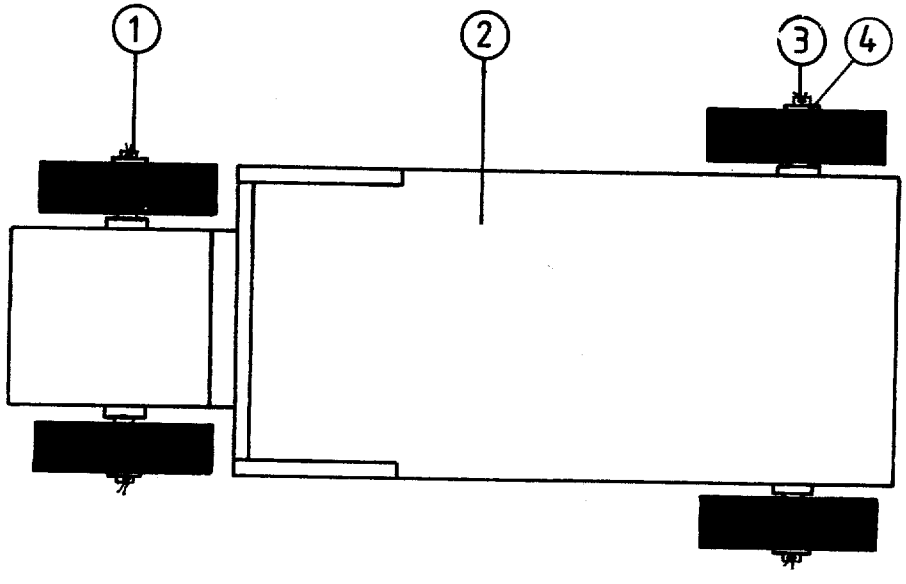


View from side



View from back



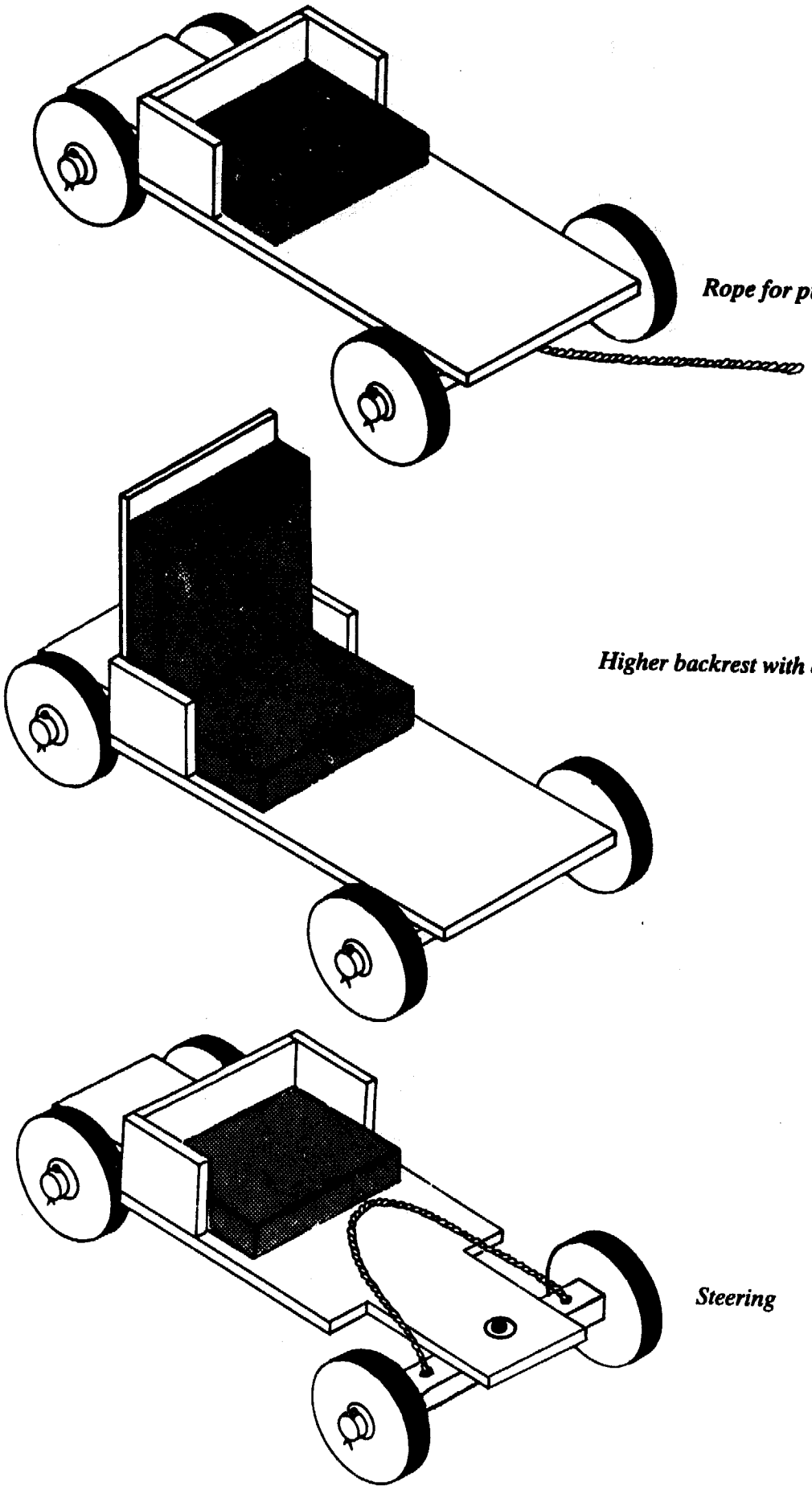


View from above

Part Nº	Material
1	Wooden axle
2	Wooden body
3	Steel split pin
4	Steel washer

FOUR WHEELED WOODEN TROLLEY

Adaptations to the four wheeled wooden trolley



Design B: wooden trolley with castor wheel

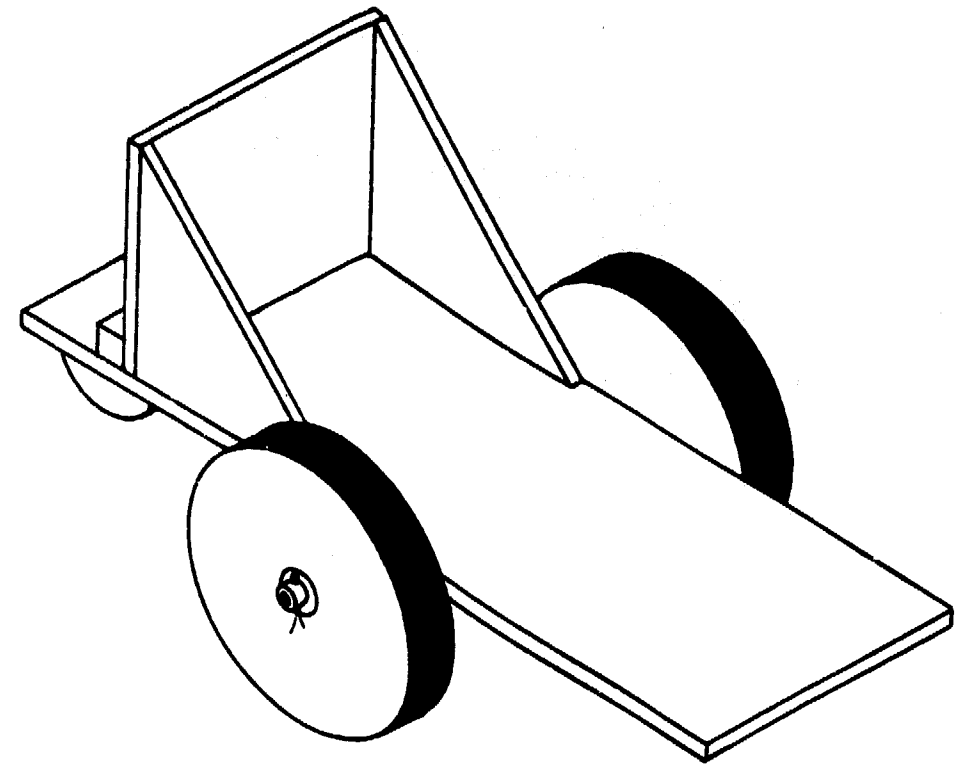
This trolley is made of wood and has a castor wheel which makes it easy to steer. The user propels and steers the trolley by pushing on the wheels. The position of the axle allows the user to tip the trolley forward and slide on or off at floor level. When the user is sitting in the trolley it does not tip.

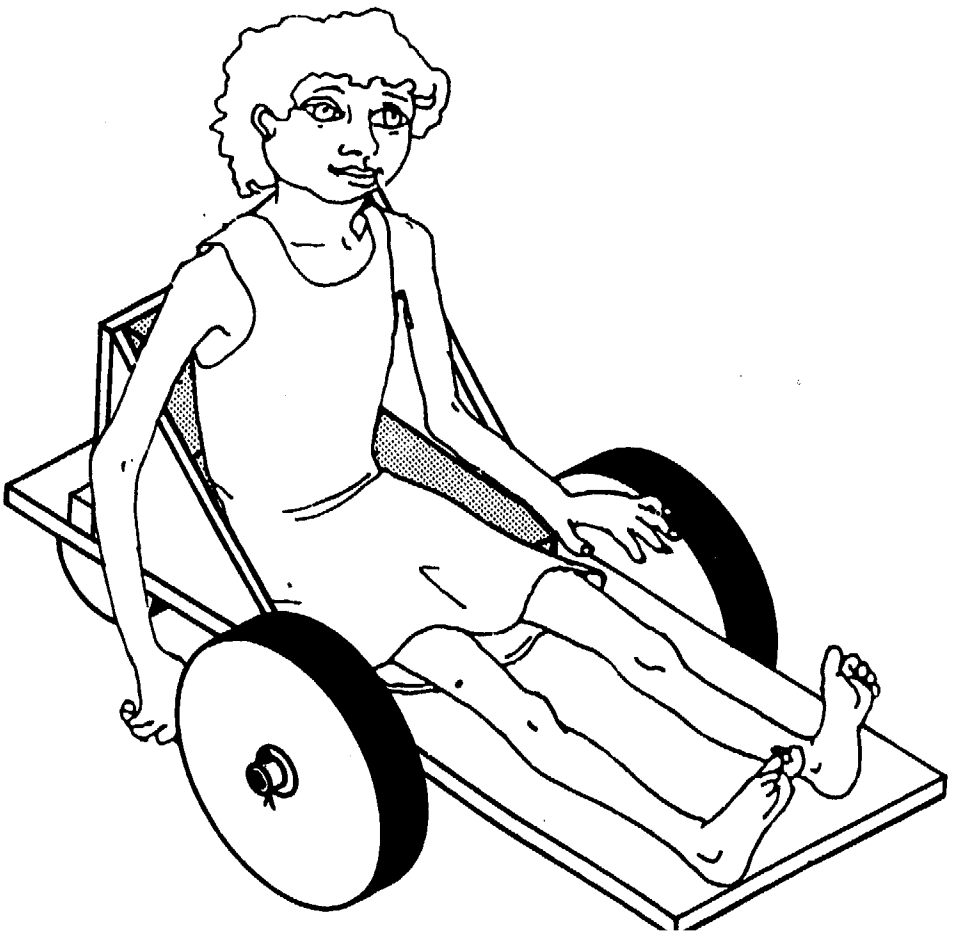
- Pages 55–57 show the wheels you can use with this trolley.
- Pages 67–68 show a castor wheel. The castor wheel pivots in the wooden block at the back of the trolley.
- Seat and back cushions (pages 72–73, Section 5) make the trolley more comfortable.

Some adaptations to the basic design are possible.
You can:

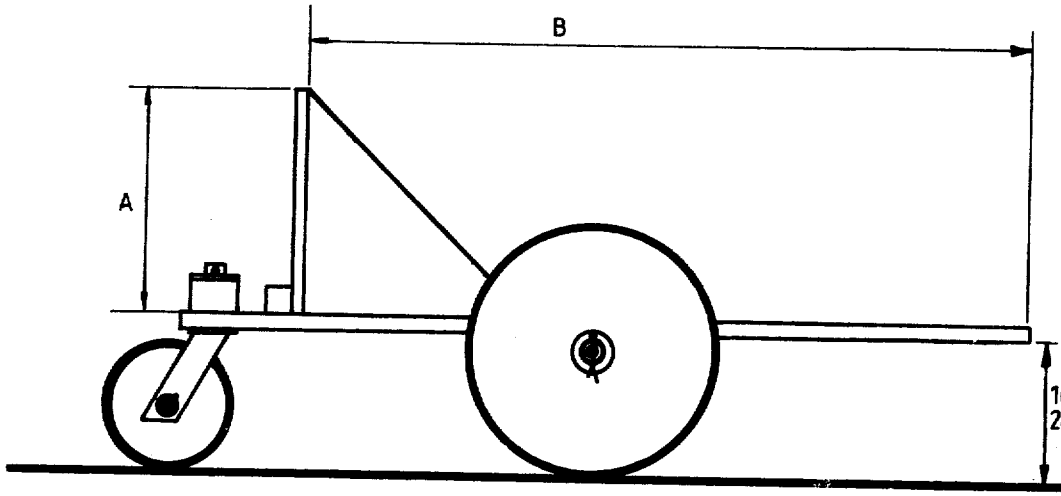
- fit a rope, as shown in design A, so that an able bodied person can pull the trolley
- add propulsion rings to the wheels, as shown in design C.

Wooden trolley with castor wheel

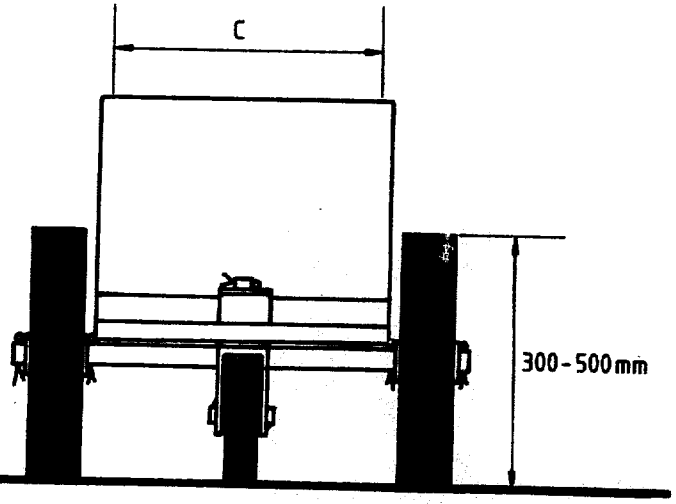


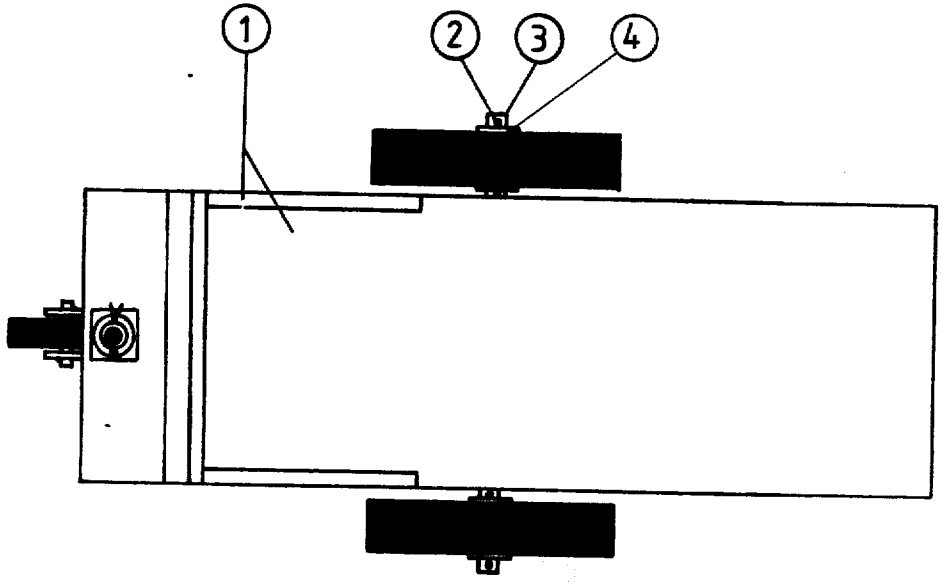


View from side



View from back





View from above

Part No	Material
1	Wooden body
2	Steel split pin
3	Steel tube axle
4	Steel washer

WOODEN TROLLEY WITH CASTOR WHEEL

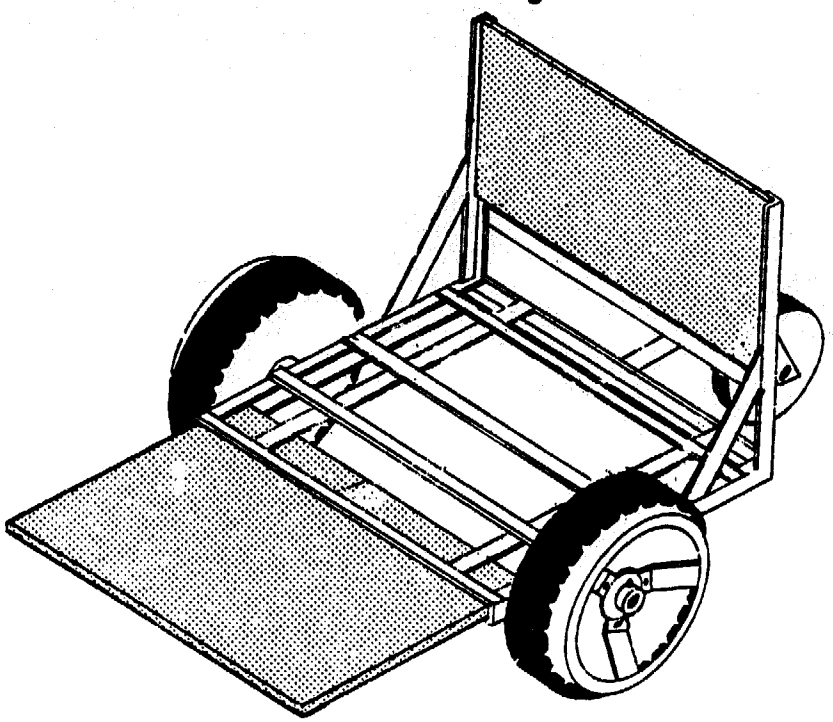
Design C: steel-framed trolley

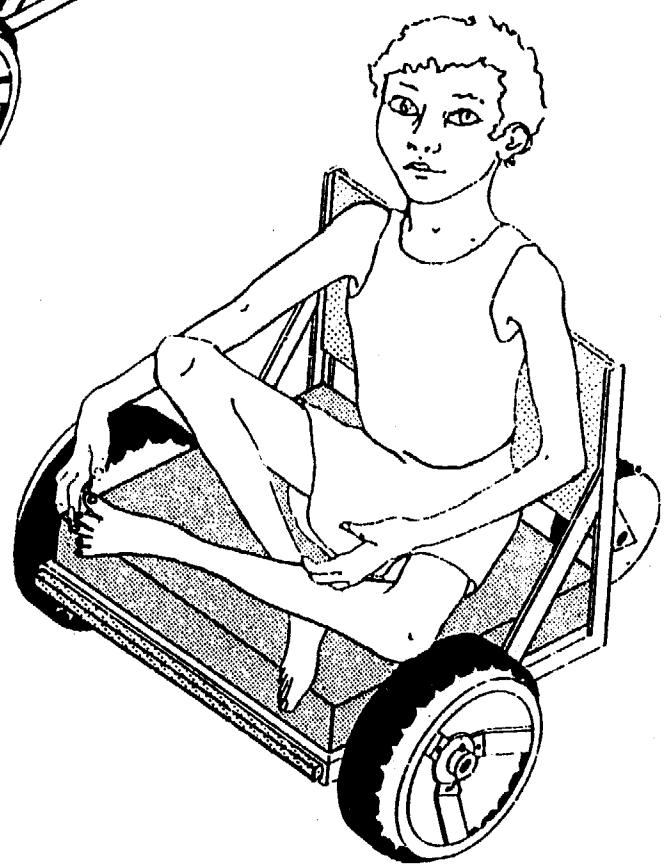
The frame of this trolley is made from steel angle, strip and tube joined by welding. The trolley has a castor wheel which makes it easy to steer. The user propels and steers the trolley by pushing on the propulsion rings fitted to the wheels. The wooden seat base shortens or lengthens to allow the user to sit with legs crossed or straight. With the seat base lengthened the user can tip the trolley forwards in the same way as design B. Because the trolley has an open steel frame the user can take it into a shower or over a latrine after lengthening the wooden base.

- Pages 55–57 show the wheels you can use with this trolley.
- Pages 67–68 show a castor wheel. The castor wheel pivots in a wooden bearing fitted inside the steel tube at the back of the trolley.
- A seat cushion (pages 72–73, Section 5) is essential for this trolley. A back cushion makes it more comfortable.

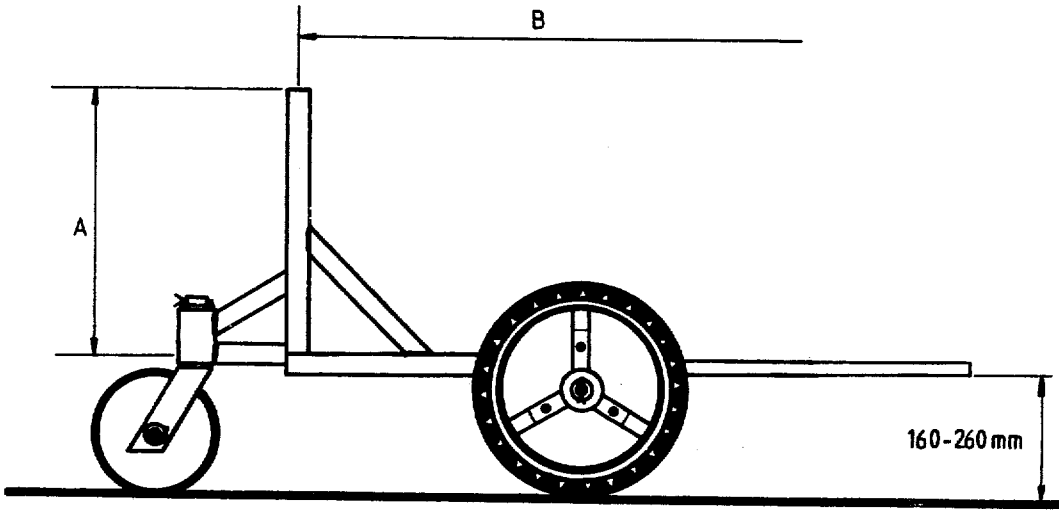
The propulsion rings help to prevent the user's hands getting dirty or infected. They are not, however, essential. If they are not fitted, the user propels the trolley by pushing on the wheels, as in design B.

Steel framed trolley

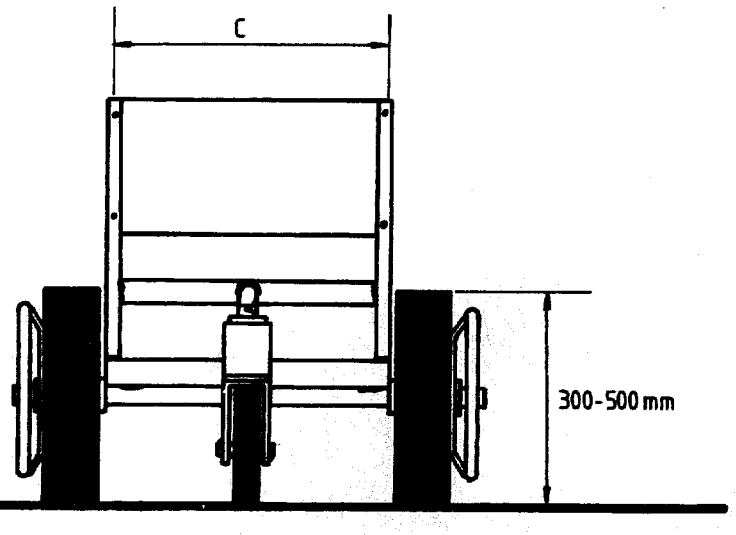


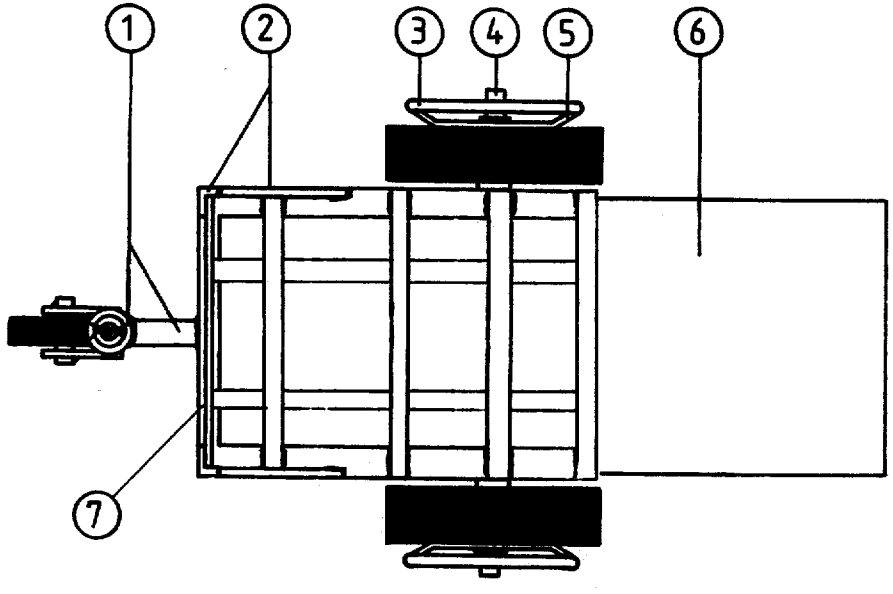


View from side



View from back





View from above

Part Nº	Material
1	Steel tube
2	Steel strip/angle
3	Steel rod
4	Steel tube axle
5	Steel strip
6	Wooden base
7	Wooden back rest

STEEL-FRAMED TROLLEY

Section Three:

Wheelchairs

Introduction

Wheelchairs are generally more expensive than trolleys but are more efficient. They allow the user to travel further.

The wheelchair designs shown here are suitable for outdoor use. They can all be propelled by the user. Each design, however has a pushing bar at the back which allows an able-bodied person to push the wheelchair if necessary.

There are two main points for consideration in wheelchair design:

- design of the frame
- choice of the wheels and design of the wheel mounting

Information on wheels and wheel mountings is given in Section 5.

This section gives information on:

- general points of wheelchair design
- a simple wheelchair frame using standard wooden chair
- a wooden wheelchair frame
- a tubular steel wheelchair frame
- adaptation to basic designs

Measuring for a wheelchair

Seat the person in a chair with a straight back.

A. The width of the seat

Measure the person across the widest part of the hips while he/she is sitting down. Then add 25mm to this measurement to obtain the width of the seat.

B. The depth of the seat

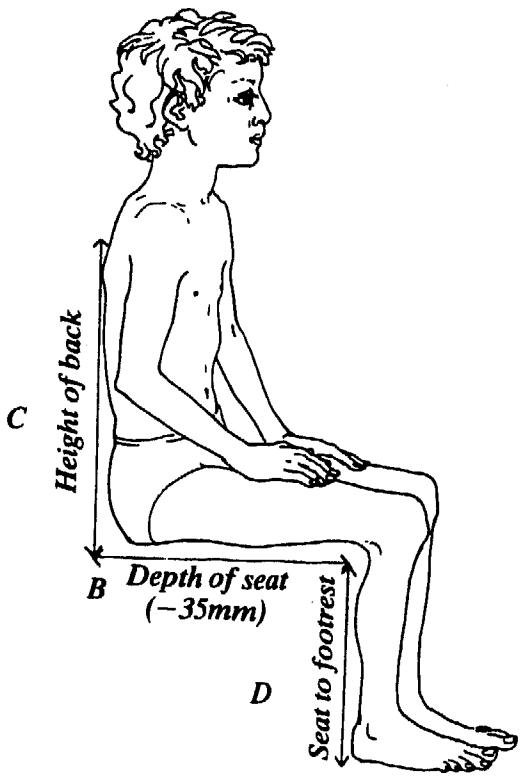
Measure the person from the back of the seat to the back of the knees. Take off about 35mm from this measurement, to obtain the depth of the seat. This is so that the seat does not come right up to the back of the knees, which can be uncomfortable and cause pressure sores.

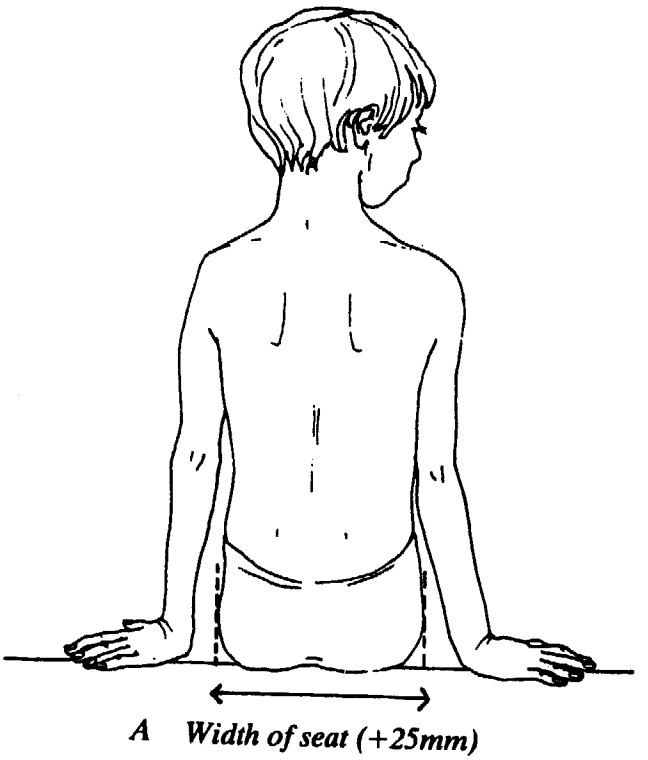
C. The height of the back

Measure from the base of the seat to the middle of the shoulder blades.

D. The seat to foot rest

Measure from under the knees to the bottom of the heels.





General wheelchair design

Wheelchair design

Wheelchairs have three or four wheels. The designs shown on the following pages all have two large driving wheels at the front and one castor wheel at the rear. Three wheeled chairs are more suitable because with large front wheels the user can propel the wheelchair over rough ground without help. If castor wheels are used at the front, help may be necessary to move over even small obstructions. This seriously limits the use of the wheelchair. If a single rear castor falls into a pot hole, the user can tip the wheelchair slightly forwards. The castor then lifts clear of the hole. The careful positioning of the footrest prevents the wheelchair tipping too far.

This section includes information on folding footrests. These can assist the user to get in and out of the wheelchair without difficulty.

Wheelchair propulsion

There are two ways the user can propel a wheelchair:

- by pushing on propulsion rings fitted to the outside of the front wheels
- by pushing directly on the tyres of the front wheels.

Propulsion rings increase the cost of the wheelchair but allow the user to control the aid more efficiently. They also prevent the user getting infected by the dirt which is picked up on the tyres.

Information on making and fitting propulsion rings is given in Section 5.

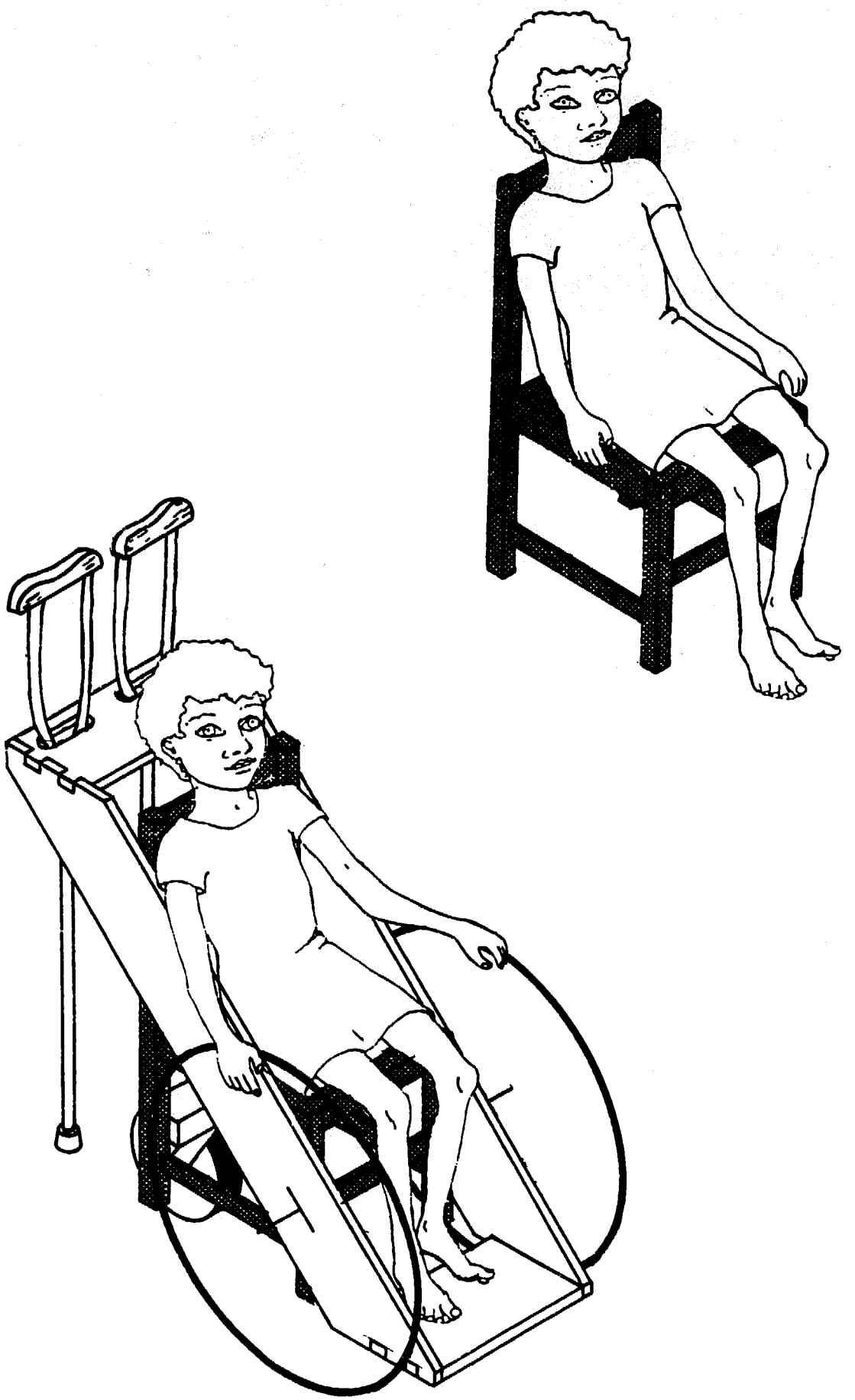
Design A: Wheelchair frame using a wooden chair

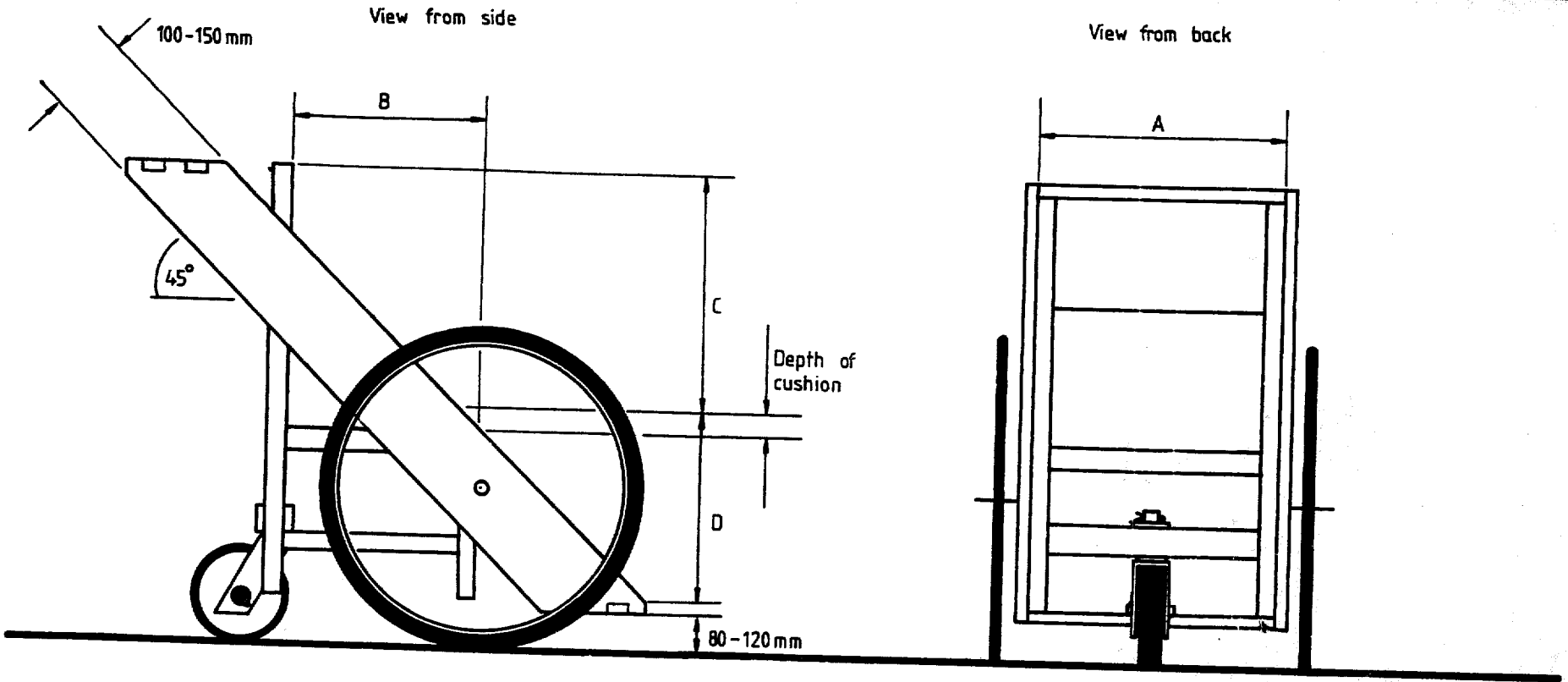
This wheelchair is made of wood and is the simplest design shown. The design is based on a standard wooden chair with an outer frame added. The frame provides a pushing bar and locations for the wheels and footrest. The user can carry a pair of crutches or a walking stick on the wheelchair. Carpenters who make furniture should be able to produce this wheelchair.

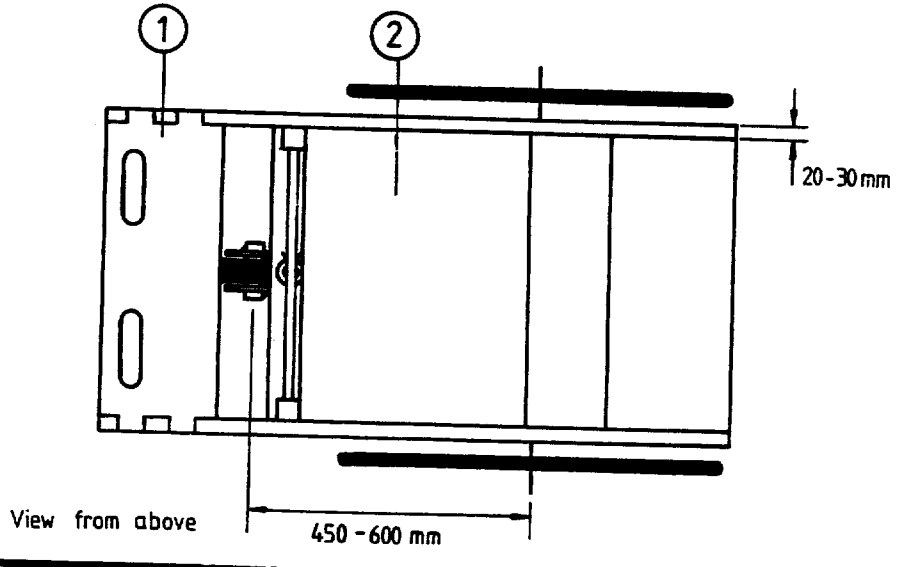
The chair must be the same width at front and back so that the two front wheels are in line.

- Pages 58–60 and 62–67 show the wheels and wheel mountings that you can use with this frame.
- Pages 67–68 show a castor wheel. The castor wheel pivots in the wooden block at the back of the frame.
- Pages 69–71 show methods of preventing punctures in the front tyres.
- Seat and back cushions (pages 72–73) make the wheelchair more comfortable.
- Parking brakes are shown on pages 75–77.

Wheelchair with wooden chair frame







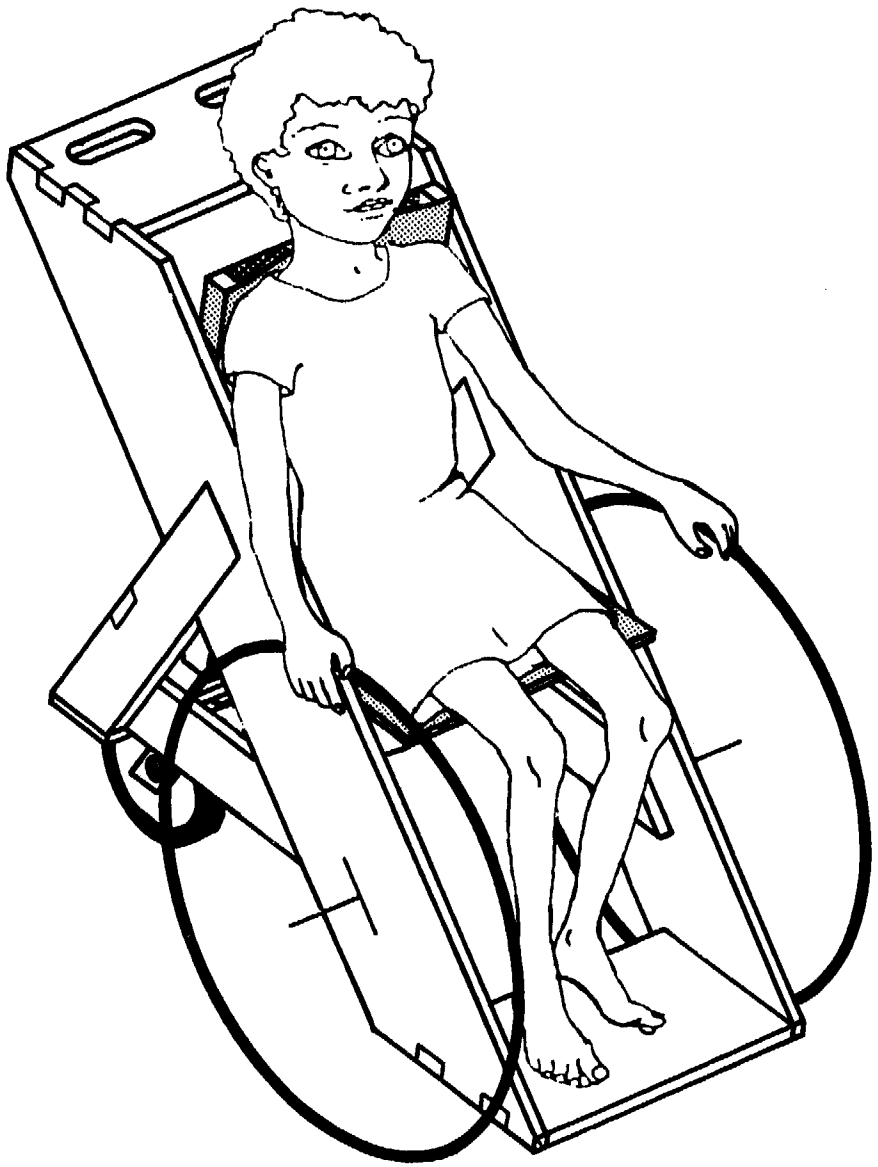
Part №	Material
1	Wooden frame
2	Wooden chair

WHEELCHAIR WITH WOODEN CHAIR FRAME

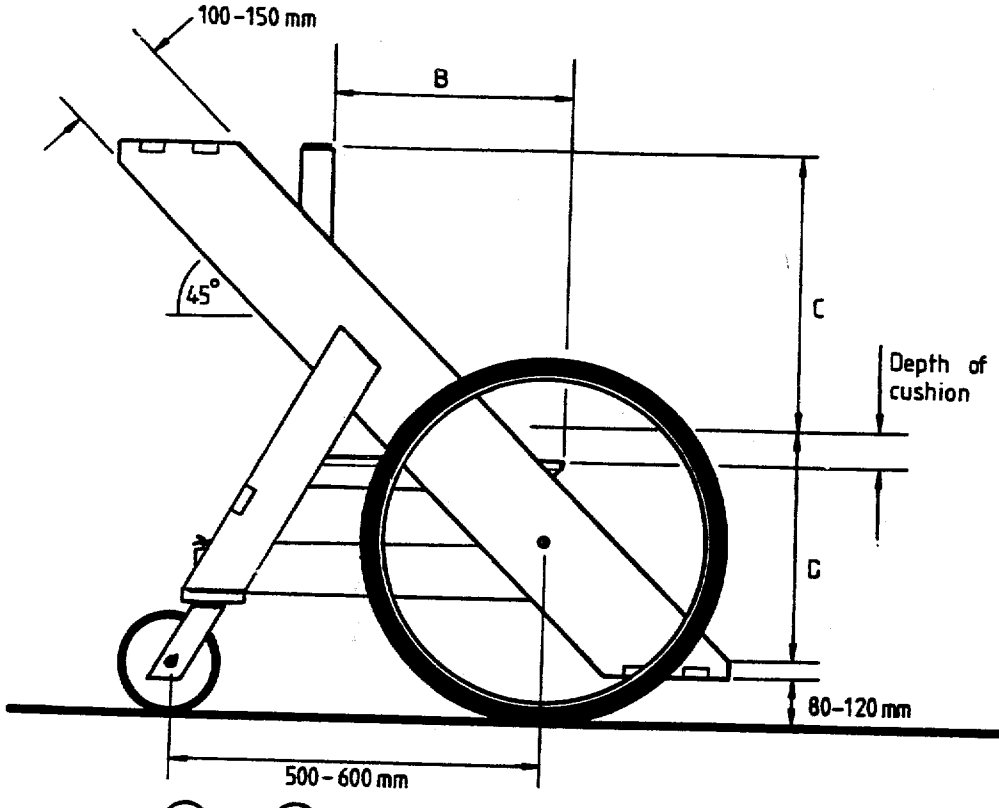
Design B: wooden wheelchair frame

This wheelchair frame is made from wood and has a canvas seat-back. The user can carry a pair of crutches or a walking stick on the wheelchair.

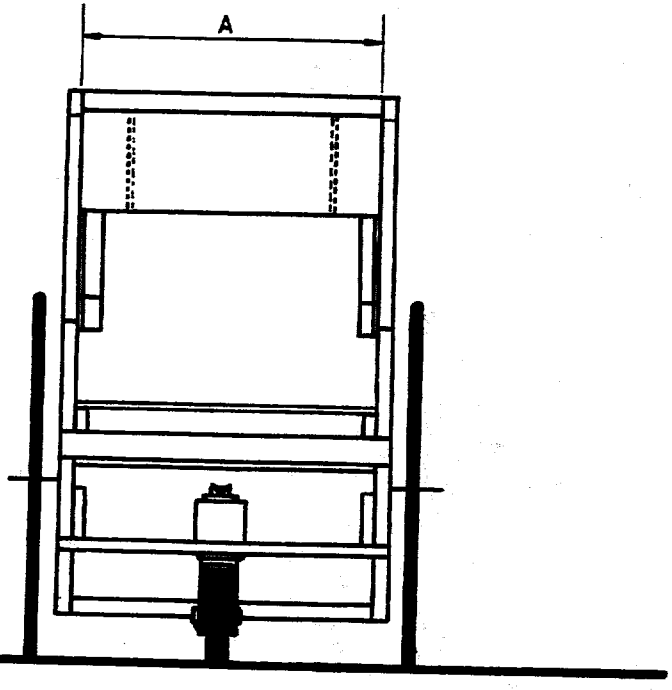
- Pages 58–60 and 62–67 show the wheels and wheel mountings that you can use with this frame.
- Pages 67–68 show a castor wheel. The castor wheel pivots in the wooden block at the back of the frame.
- Pages 69–71 show methods of preventing punctures in the front tyres.
- You can use any of the seat bases shown on page 73.
- A seat cushion (pages 72–73, Section 5) makes the wheelchair more comfortable.
- Parking brakes are shown on pages 75–77.

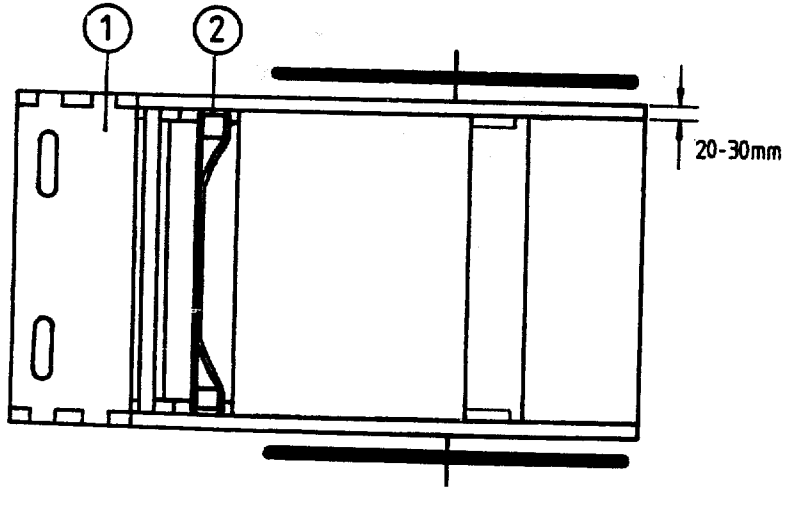


View from side



View from back





View from above

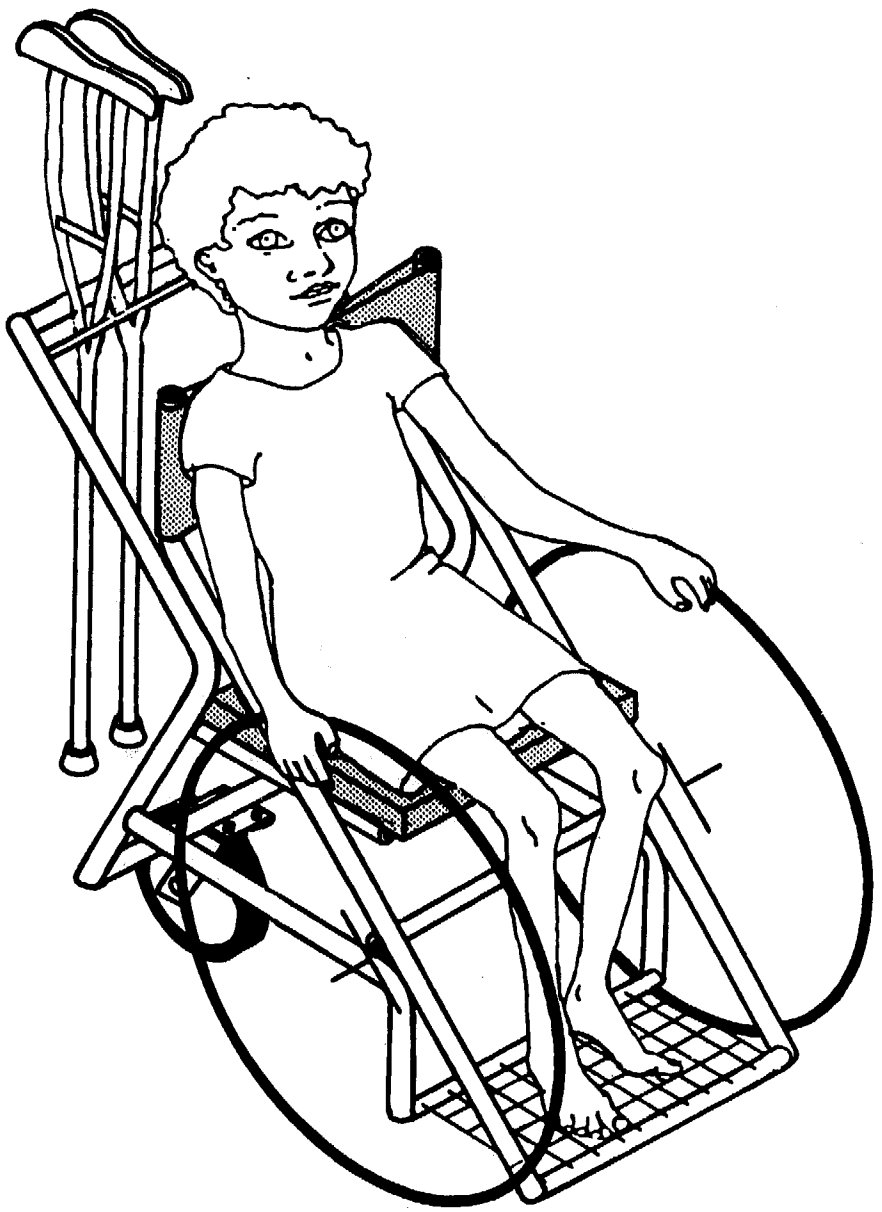
Part Nº	Material
1	Wooden frame
2	Canvas

WHEELCHAIR WITH WOODEN FRAME

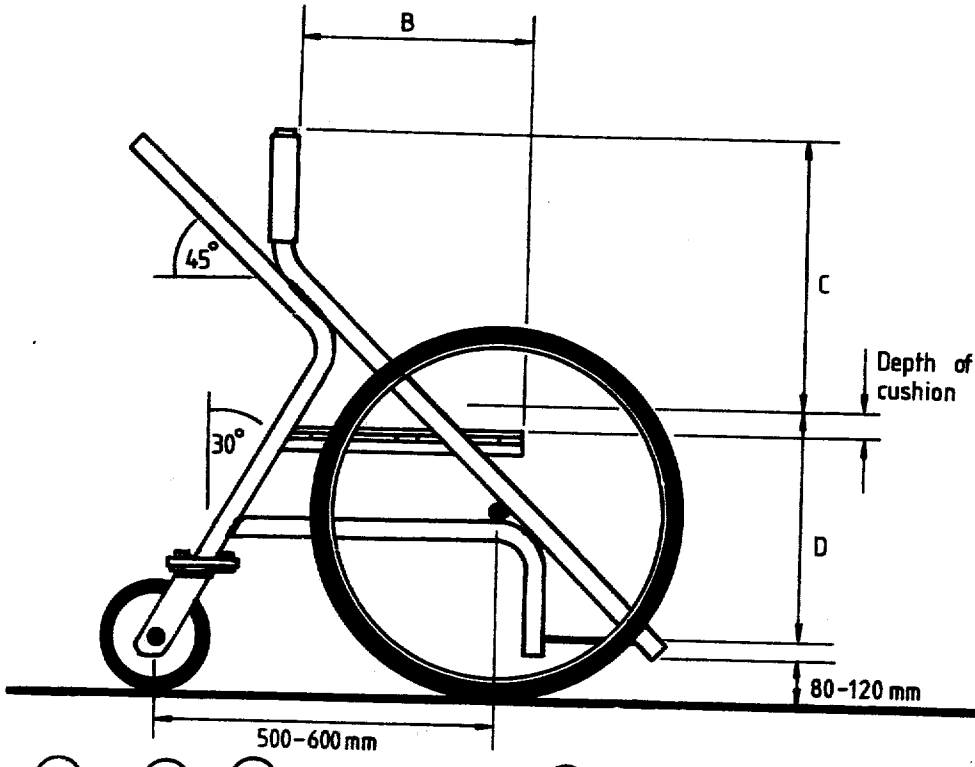
Design C: tubular steel wheelchair frame

This wheelchair frame is made from steel tube. It has two identical side-frames joined by the pushing bar, the footrest, the cross member and the castor wheel mounting. You join the different parts of the frame by welding. The wheelchair has a canvas seat-back. The user can carry a pair of crutches or a walking stick on the wheelchair.

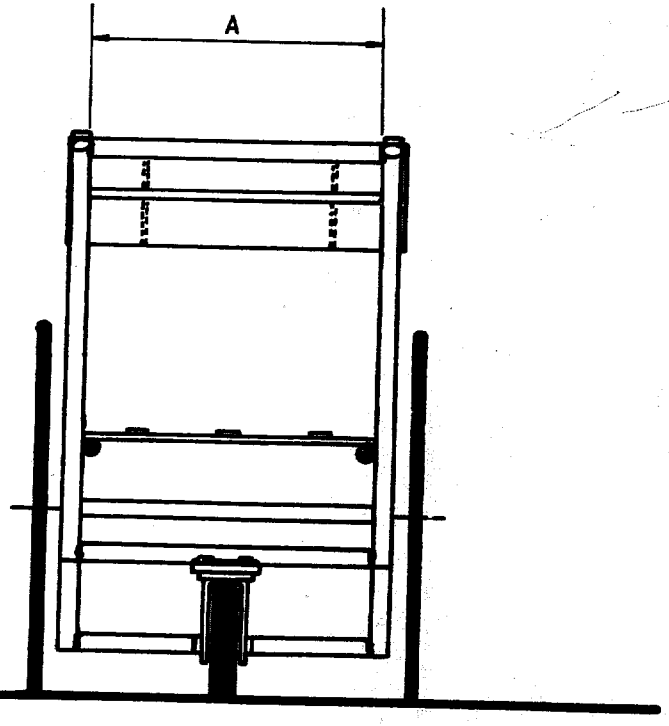
- Pages 58–61 and 63–67 show the wheels and wheel mountings that you can use with this frame.
- Use a castor wheel which you can buy easily. The wheel should be at least 150mm diameter.
- Pages 69–71 show methods of preventing punctures in the front tyres.
- You can use any of the seat bases shown on page 73.
- A seat cushion (pages 72–73, Section 5) makes the wheelchair more comfortable.
- Parking brakes are shown on pages 75–77.

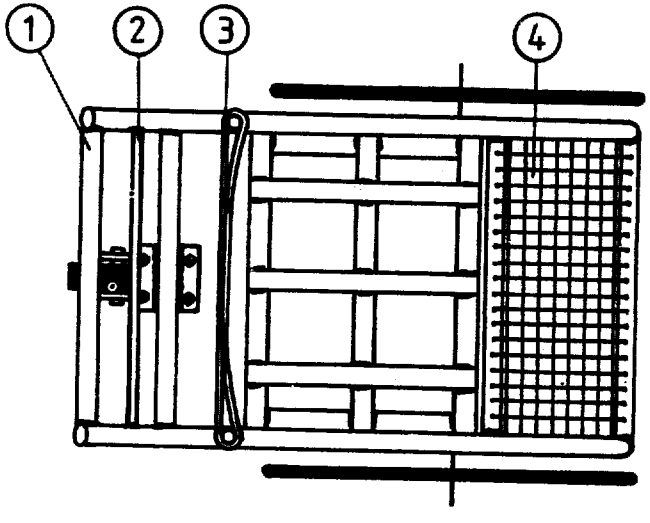


View from side



View from back





View from above

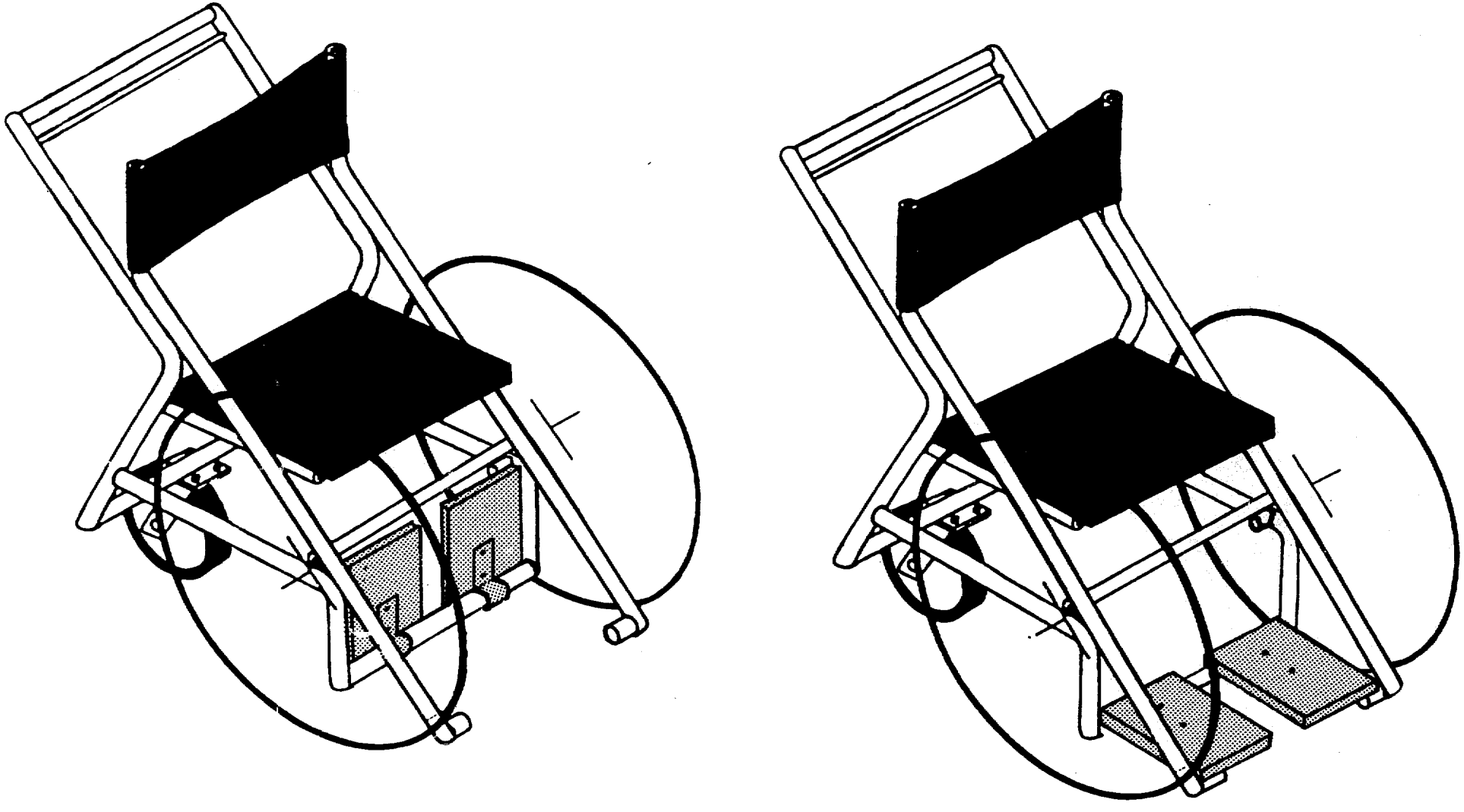
Part №	Material
1	Tubular steel
2	Steel rod
3	Canvas
4	Steel mesh (or wood)

WHEELCHAIR WITH TUBULAR STEEL FRAME

Adaptations to basic designs

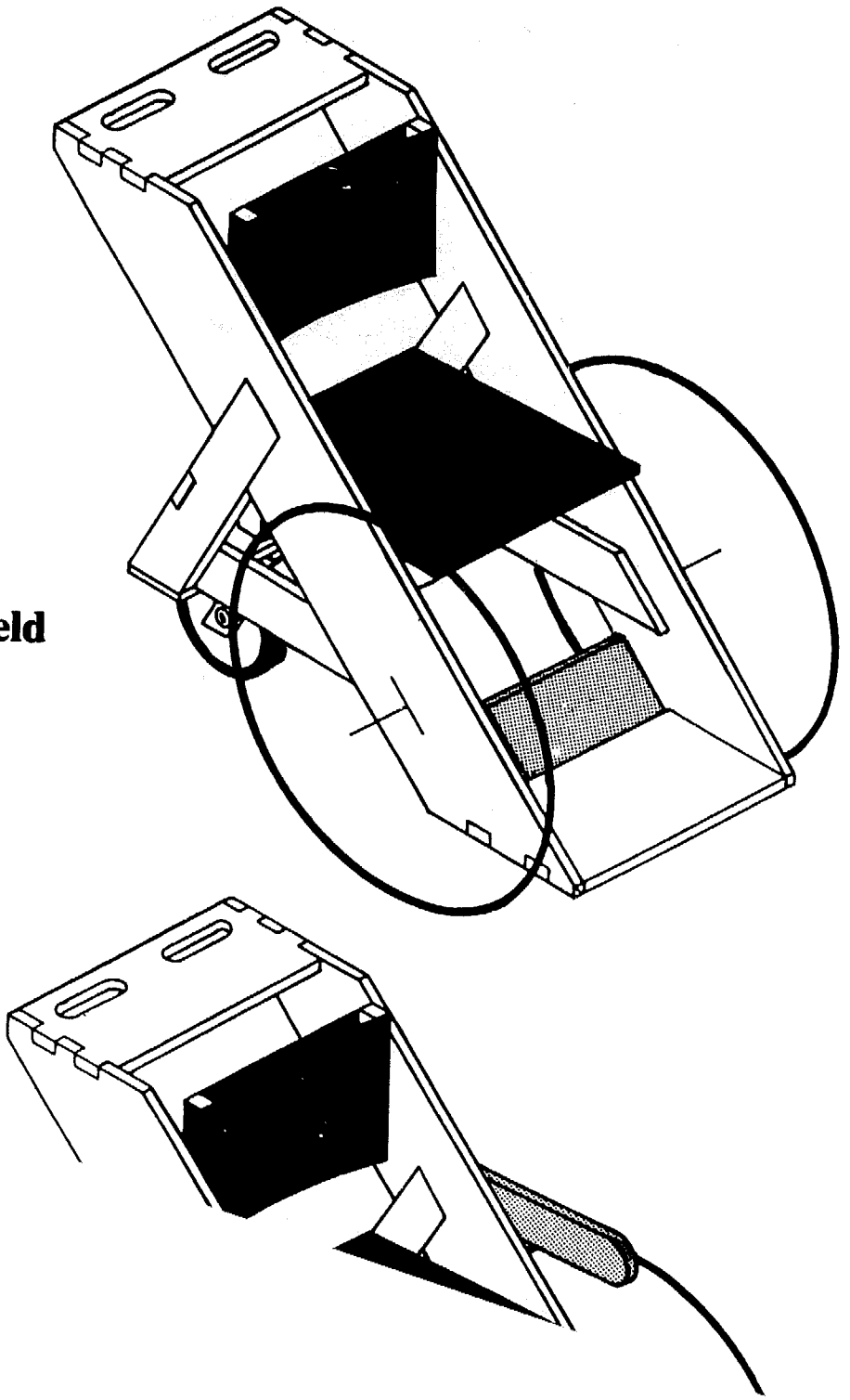
A number of adaptations to the designs shown are possible.
You can use:

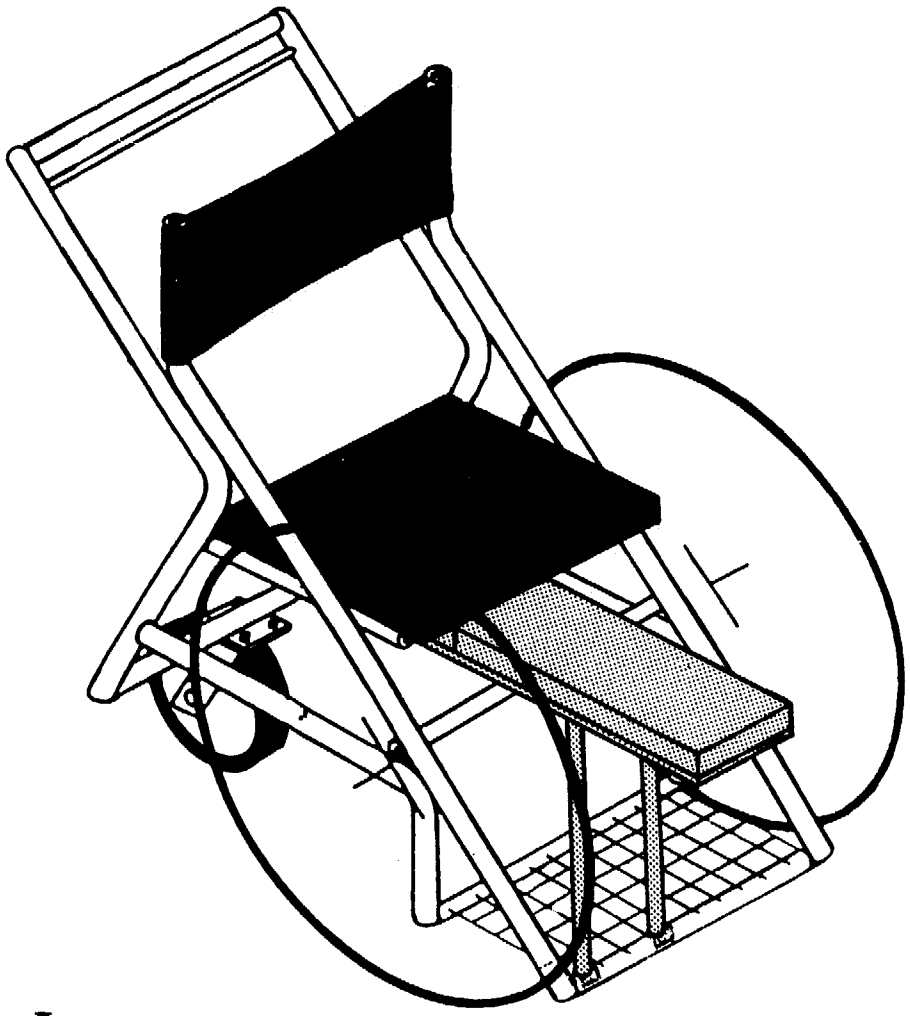
- folding footrests to allow the user to get very close to the seat before sitting down
- a shield at the back of the footrest to prevent the user's feet slipping off
- armrests
- leg supports for people who need to keep one or both legs straight



Folding footrests

Foot shield





Legrest

Section Four:

Tricycles

Introduction

Hand-propelled tricycles are the most efficient type of aid and allow the user to travel comparatively long distances. They are suitable for rural areas and urban streets. A tricycle can provide employment for the user. For example, he/she can collect and deliver, or sell goods. However, tricycles are the most expensive and complicated type of aid.

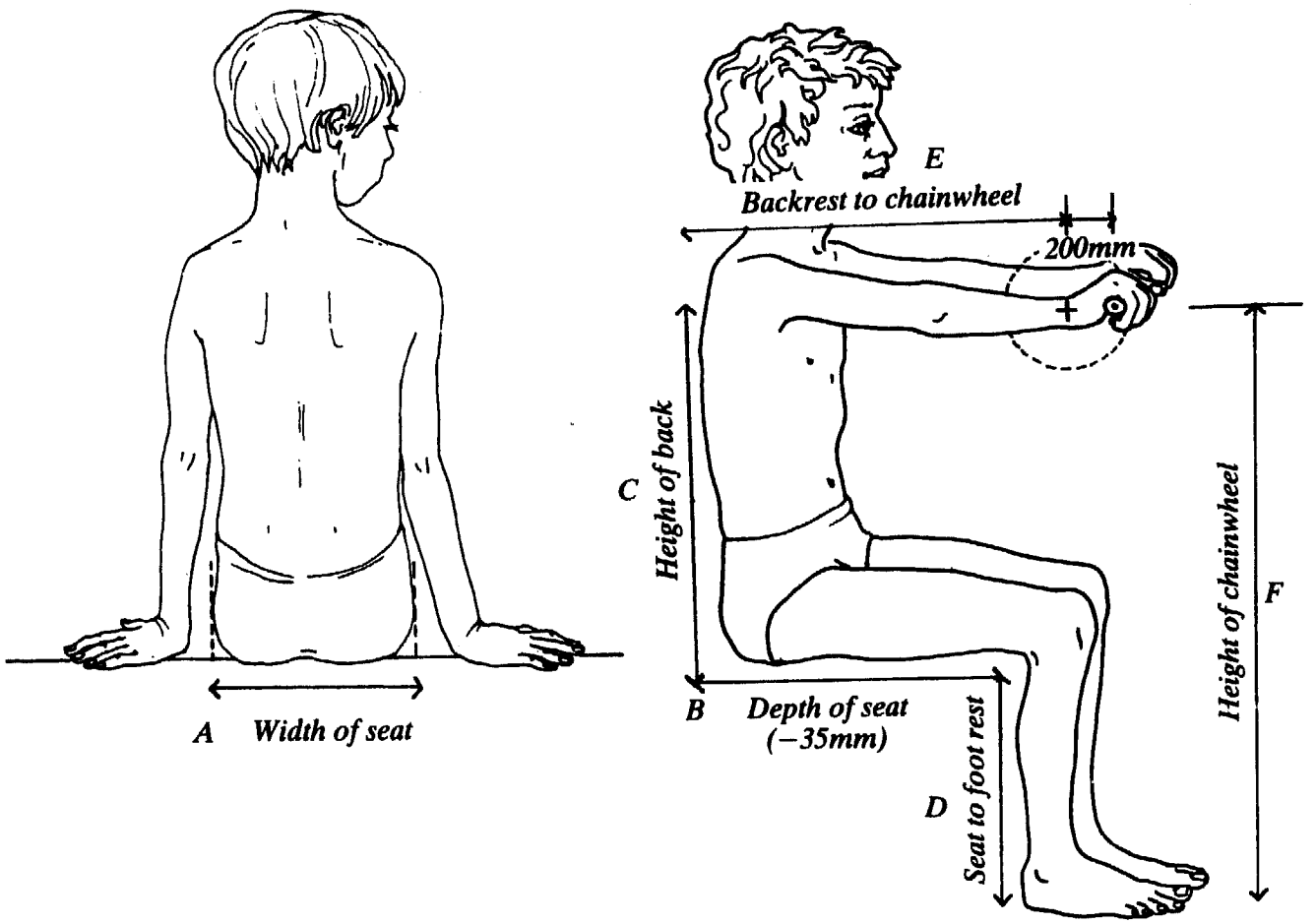
This section provides information on one tricycle design. It also describes how to achieve different gear ratios, so that you can build tricycles for different types of ground and strengths of user.

Measuring for a tricycle

Seat the person in a chair with a straight back.

1. Take exactly the same measurements as for a wheelchair (see page 29).

2. With the person's arms outstretched and level with the seat, measure from the centre of the hand to the back of the seat. Take off about 200mm from this measurement. This gives the correct distance between the backrest and the centre of the chainwheel. (Measurement E). To obtain the correct height of the chainwheel centre, measure from the ground to the centre of the person's hand. Make sure that the arm is level with the seat. (Measurement F).

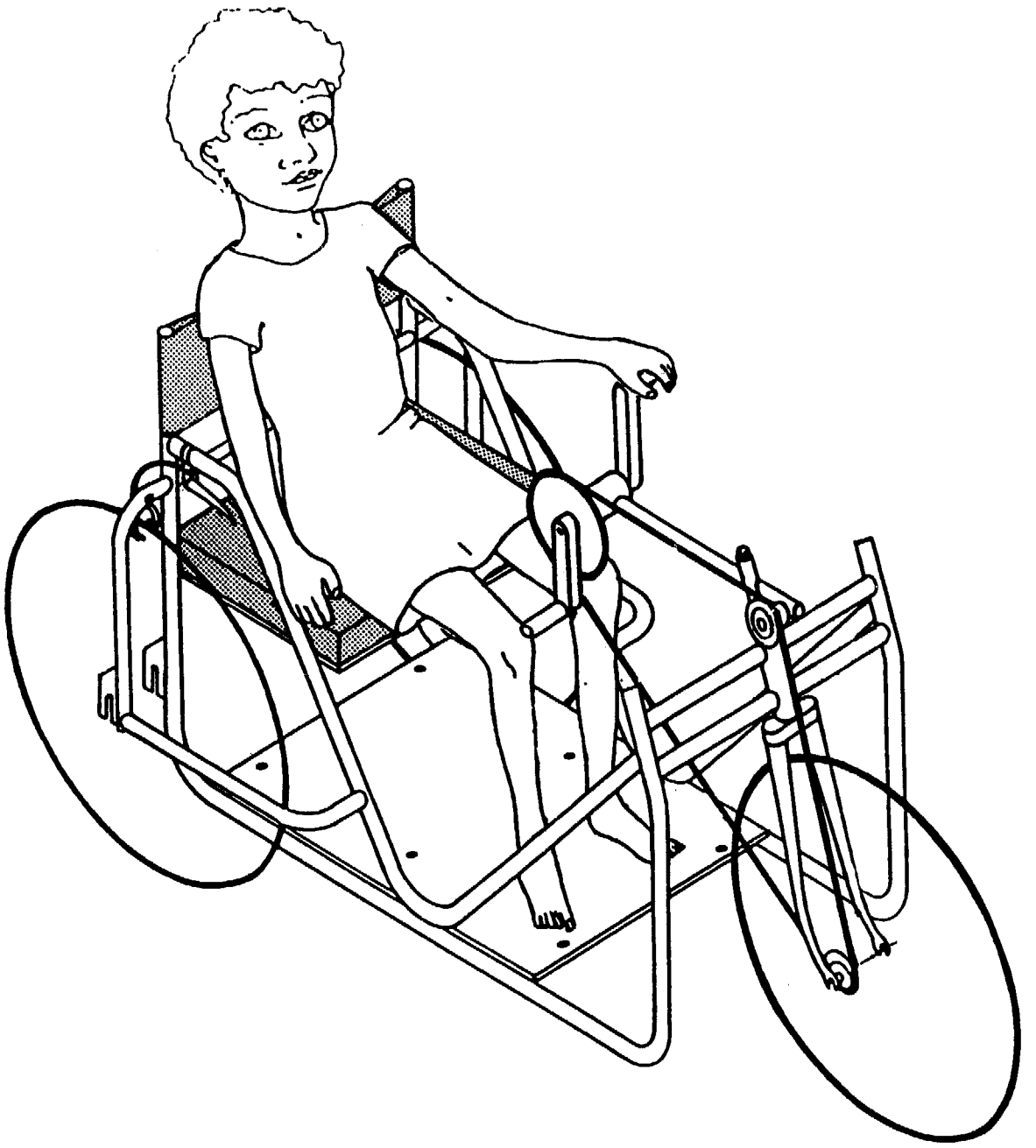


Design A: tricycle with cycle fork

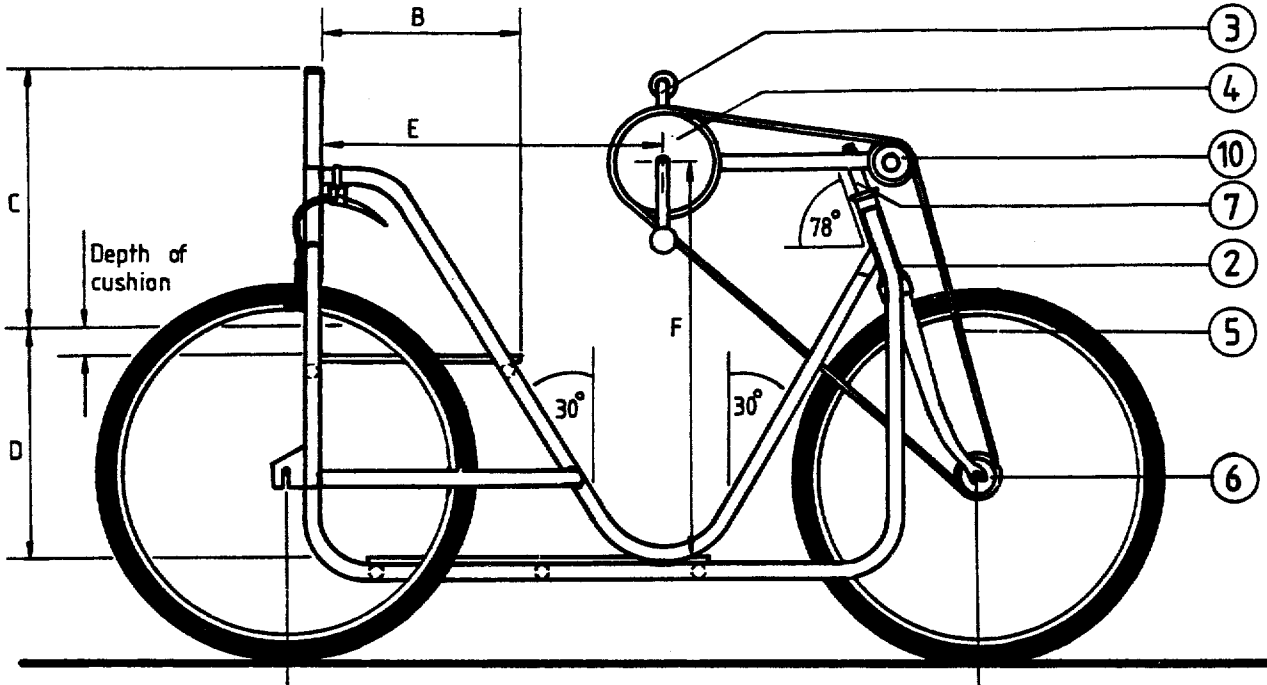
The tricycle frame is made from steel tube. You join the different parts of the frame by welding. The tricycle has a plywood or wire mesh floor. The disabled person can use this to carry a load, a pair of crutches or a walking stick.

The design uses standard bicycle wheels, fork and drive components – chain, pedals, etc. Bicycle forks get narrower towards the top. This makes it difficult to use a direct drive from the chainwheel to the sprocket. To overcome this problem, an additional freewheel is used as an 'idler wheel' to take the chain over the top of the fork.

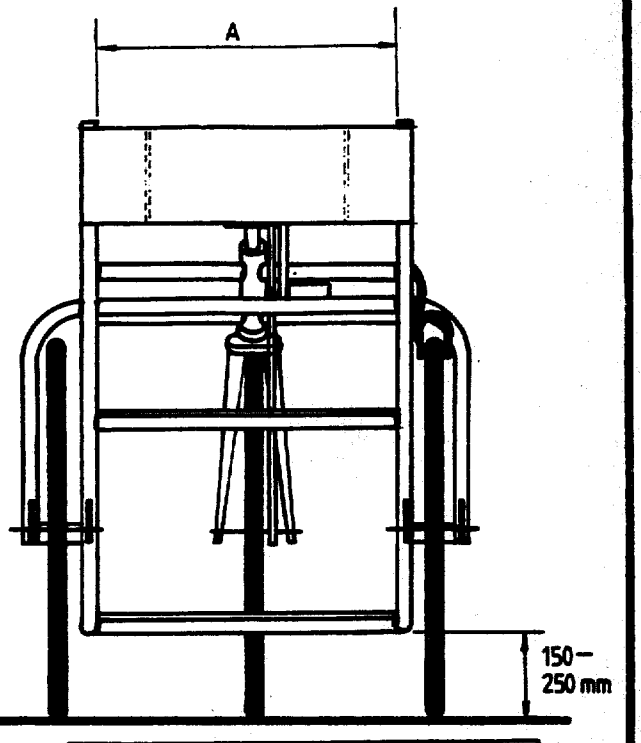
The tricycle has a canvas seat back, and seat base made from plywood or steel strips. You should position the tubes which support the seat base to suit the measurements of the user.



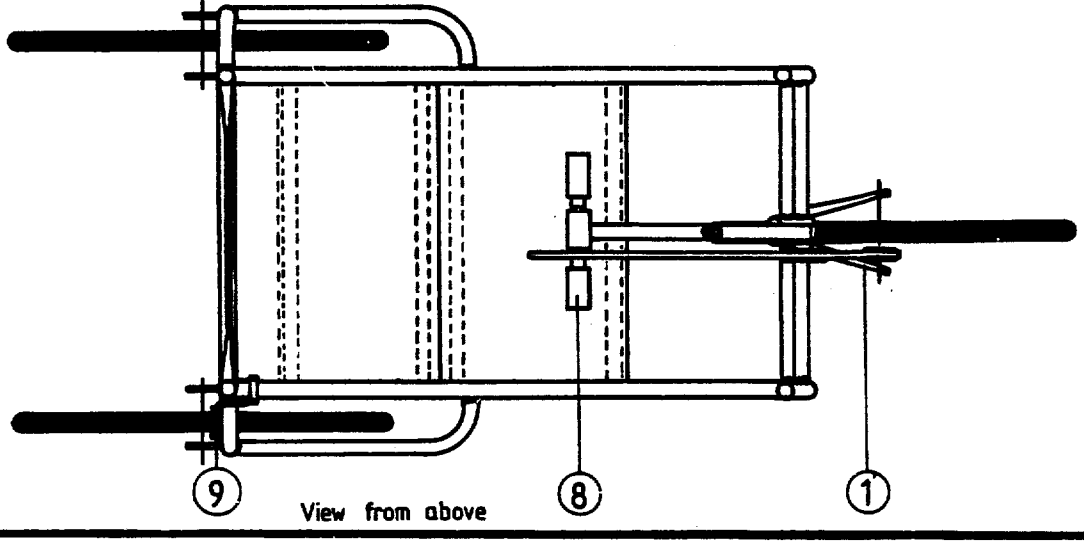
View from side



View from back



1000 – 1300 mm

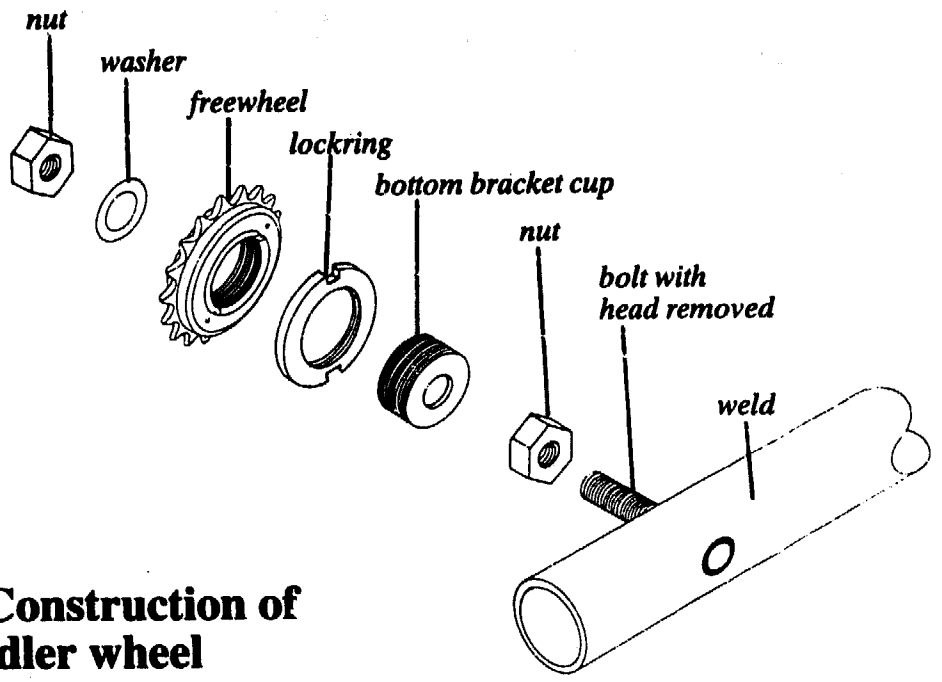


View from above

Part Nº	Description
1	Fork
2	Head tube
3	Crank
4	Chainwheel
5	Chain
6	Freewheel
7	Handlebar stem
8	Hand grip
9	Brake
10	Idler wheel

TRICYCLE

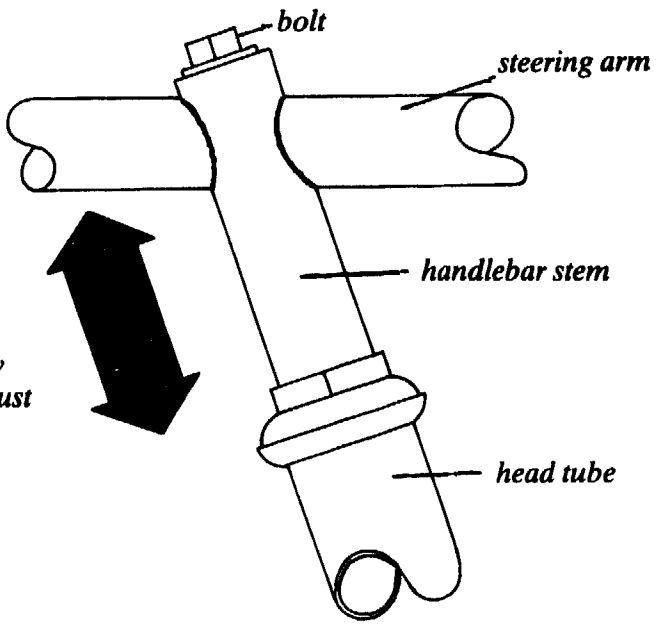
- The design uses two bicycle **front** wheels at the rear of the tricycle and a bicycle **rear** wheel at the front (see page 59).
- The idler wheel uses a freewheel with the ratchets removed (see below). You screw the freewheel onto a bottom bracket cup. The thread on the freewheel and the cup must be the same. A bottom bracket lock ring may be necessary to lock the freewheel in place. You can then bolt the cup to the steering arm as shown in the drawings.



Construction of idler wheel

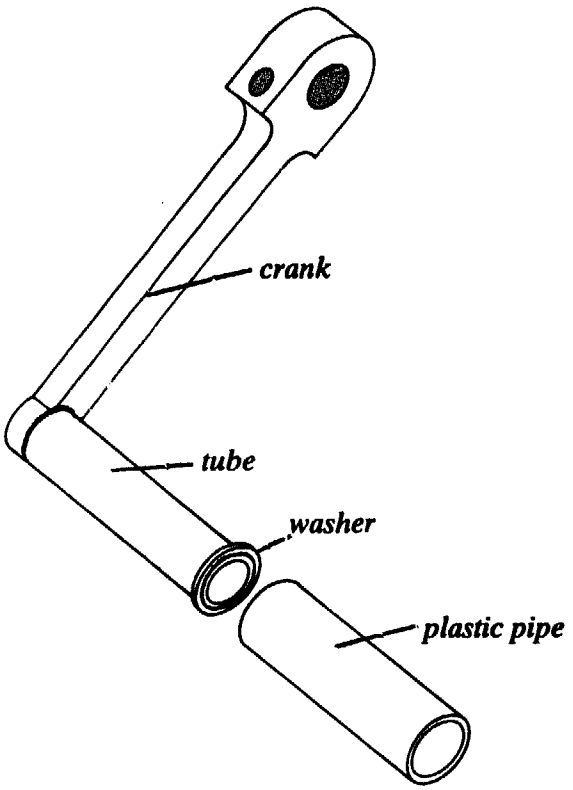
- The user can adjust the chain tension by moving the handlebar stem up or down in the normal way for adjusting the handlebar height (see below).

1. *Loosen bolt*
2. *Strike top of bolt to release expander nut at base of bolt*
3. *The handlebar stem can now be moved up or down to adjust the chain tension*
4. *Tighten bolt*



Adjustment of chain tension

- There is a bicycle brake and lever which acts on one of the rear wheels.
- Bicycle pedals are awkward to use for hand propulsion. You can make simple hand grips by welding short lengths of tube to the cranks. Then cover the tube with equal lengths of loose-fitting plastic pipe which can rotate as the cranks turn. You can weld washers to the end of the tubes before the plastic pipe is fitted. The plastic pipe will need to be forced over the washers, which will prevent it slipping off.



Hand grips

- Pages 69–71 show methods of preventing punctures in the tyres.
- A seat cushion (page 73) makes the tricycle more comfortable.

Some adaptations to the basic design are possible.

You can:

- fit a tray or box at the back for carrying loads.
- fit a fixed wheel, instead of a freewheel, on the front wheel. This allows the user to pedal the tricycle backwards as well as forwards.
- fit a wheel with a 'back-pedalling' brake hub, also known as a coaster hub, at the front. This allows the user to brake the tricycle without taking his hands off the grips.

Tricycle gearing

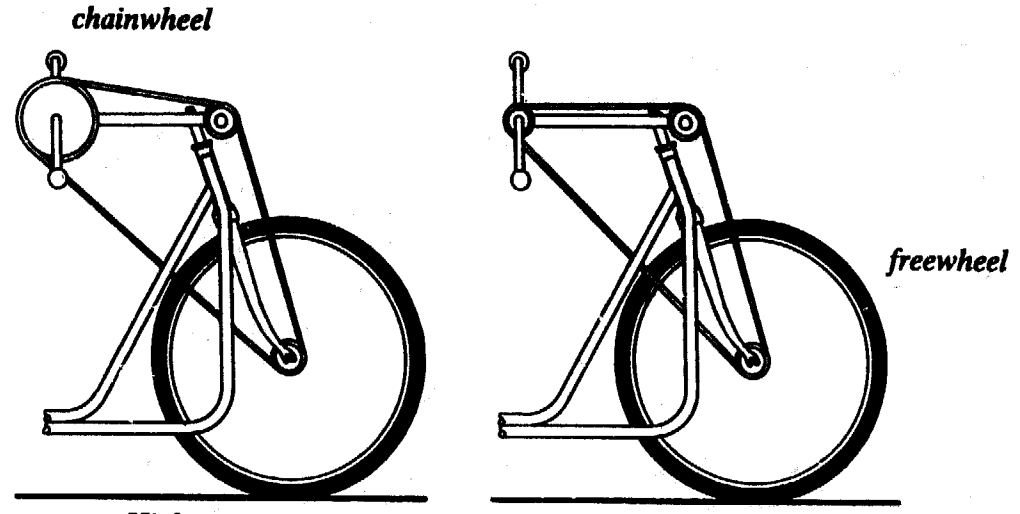
The drive system of the tricycle shown in this section uses bicycle components – chain, cranks, wheels, etc. The gear ratio of the drive system will affect how much effort is required to propel the tricycle and the speed at which it moves.

A tricycle with a high ratio will require considerable effort to start off from rest and go up hills, but will be able to travel at reasonably high speeds on level ground.

A low gear ratio will enable a tricycle to start off easily and go up inclines, but it will move more slowly.

The drive system of the tricycle shown in the drawings uses bicycle components in the conventional way and gives a high gear ratio (see below). The large chainwheel (approx 48 teeth) and the small freewheel (approx 18 teeth) give a gear ratio of about 2.5:1 (48/18:1).

You can provide a lower gear ratio by making the chainwheel and freewheel the same size (gear ratio 1:1).

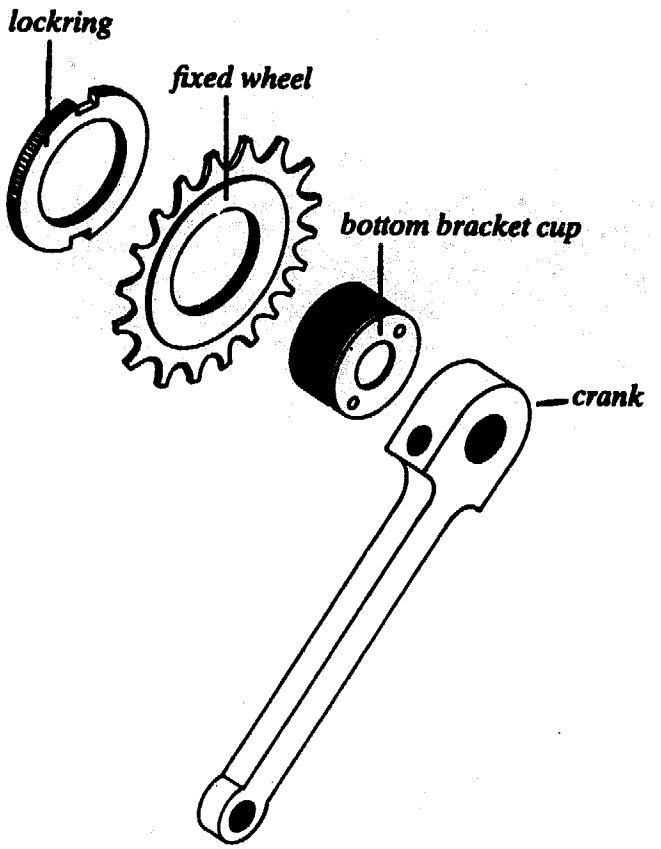


High gear ratio
(Large chainwheel/small freewheel)

Low gear ratio
(Small chainwheel/small freewheel)

To do this you must adapt standard bicycle components. It is easier to make a small chainwheel than a large freewheel. To do this

1. braze or weld a bottom bracket cup, identical to the one for the idler wheel, to a pedal crank. The cup must be exactly in the centre of the hole in the crank (see drawing)
2. then screw a fixed wheel and lockring onto the cup. If the fixed wheel on the crank and the freewheel on the drive wheel are about the same size, you will have a low gear ratio.



Construction of a small chainwheel

Another method of lowering the gear ratio is to use a smaller front wheel. However, some basic changes to the design of the tricycle will be necessary as the forks will need lowering.

An important aspect of tricycle gearing is the length of the cranks. If the cranks are short (110mm–120mm) the user will only be able to exert a small amount of leverage. If the cranks are long (170–180mm) more leverage can be applied.

If you have 3-speed gear hubs, you can build a tricycle which is suitable for hilly ground and travelling at reasonable speed on level ground. You mount the three speed hub in the front wheel of the tricycle. The user operates them by gear selector which is attached to a cable.

Information on commercial sources of 3-speed hubs is given in Annex 1.

Section Five:

Technical Information

Introduction

This section gives specific information on details of transport aid design including:

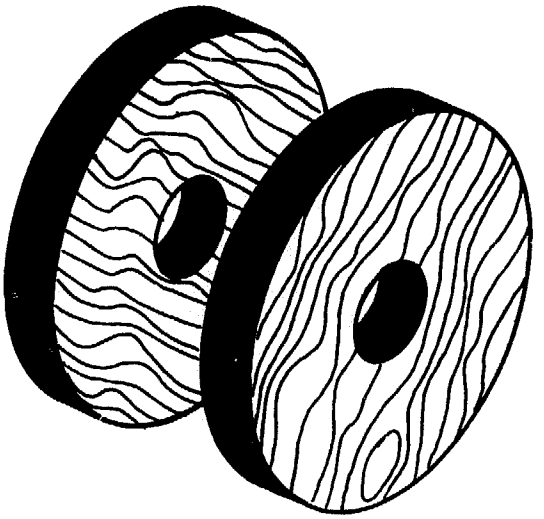
- Wheels and wheel mountings
  - trolley wheels
  - wheelchair wheels
  - castor wheels
- Tyres
  - puncture prevention
  - semi pneumatic tyres
  - solid tyres
- Seating
- Propulsion rings
- Parking brakes

Wheels and wheel mountings

Trolley wheels

Making the wheels

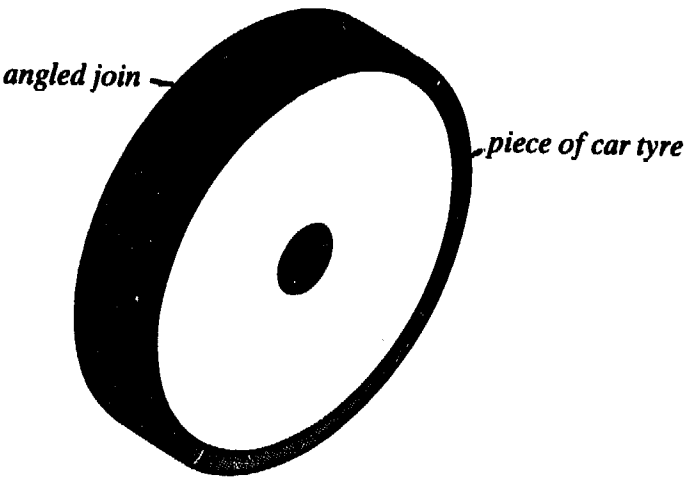
You can make a simple wheel by cutting a circular piece of wood from a length of timber. The wheel should be at least 50mm wide. If you do not have timber of the right thickness nail or glue two pieces of wood together (the 'grain' of the two pieces should be as shown below). Drill a hole through the centre of the wheel to fit onto the axle.



Making the tyre

Each wheel will need a rubber tyre and there are two ways of doing this.

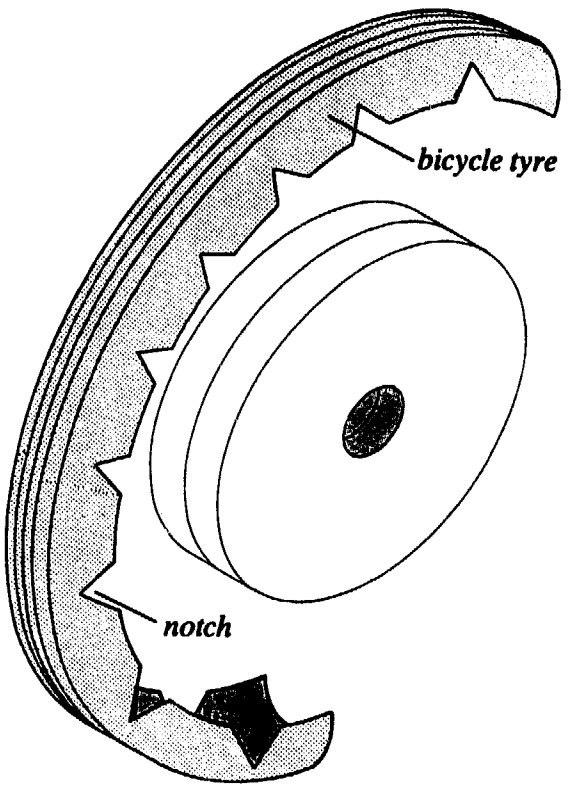
1. Using a car tyre
   Cut a strip of rubber from an old car tyre. The strip should be the same width as the wheel and long enough to wrap around the wheel. Nail the strip around the edge of the wheel. It may be necessary to repair this tyre from time to time as the heads of the nail will wear from use.

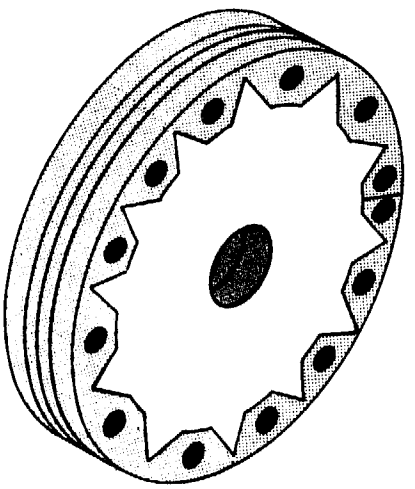


2. **Using a bicycle tyre**

   This method prevents the nails wearing away.

   Cut a length of bicycle tyre long enough to wrap around the wheel. Cut a series of notches along the sides of the tyre. Fit it around the wheel and nail the sides of the tyre to the wheel.



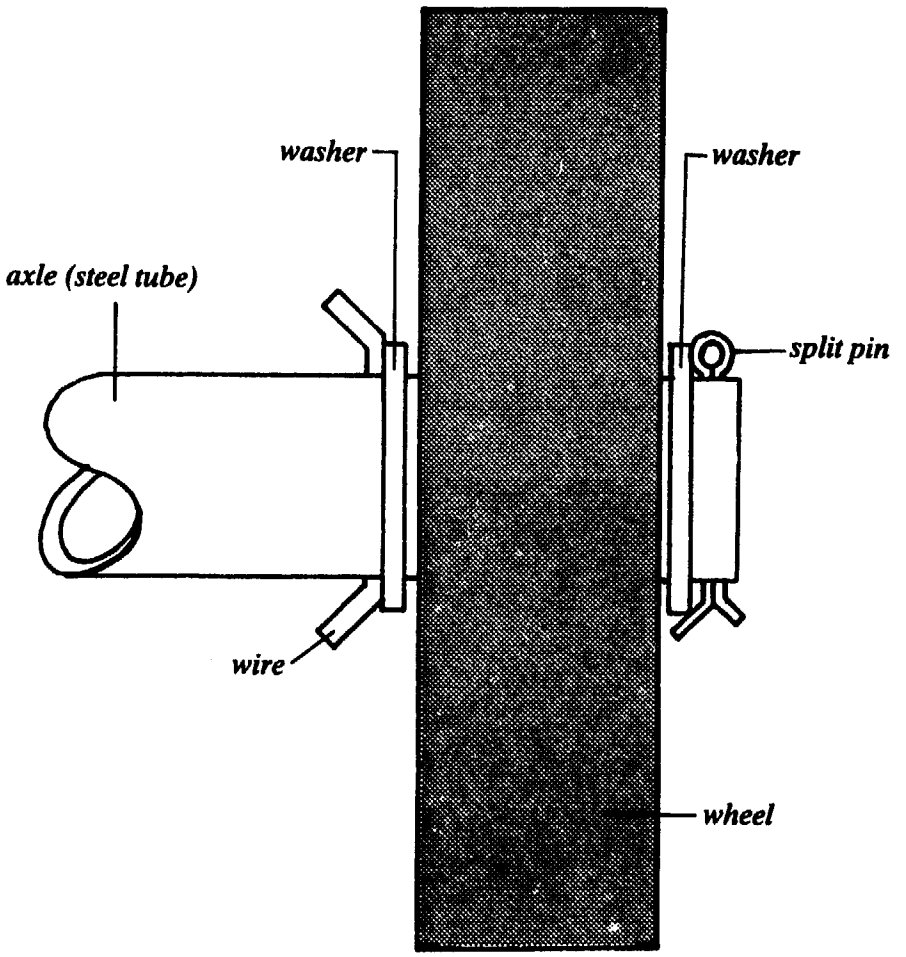


Fitting the wheels

You can fit the wheels on either wooden or steel tube axles.

To stop the wheel coming off the axle, put a washer on either side of the wheel. Hold these in place with split pins or lengths of wire.

Put grease on the axles from time to time, so that the wheels turn freely.



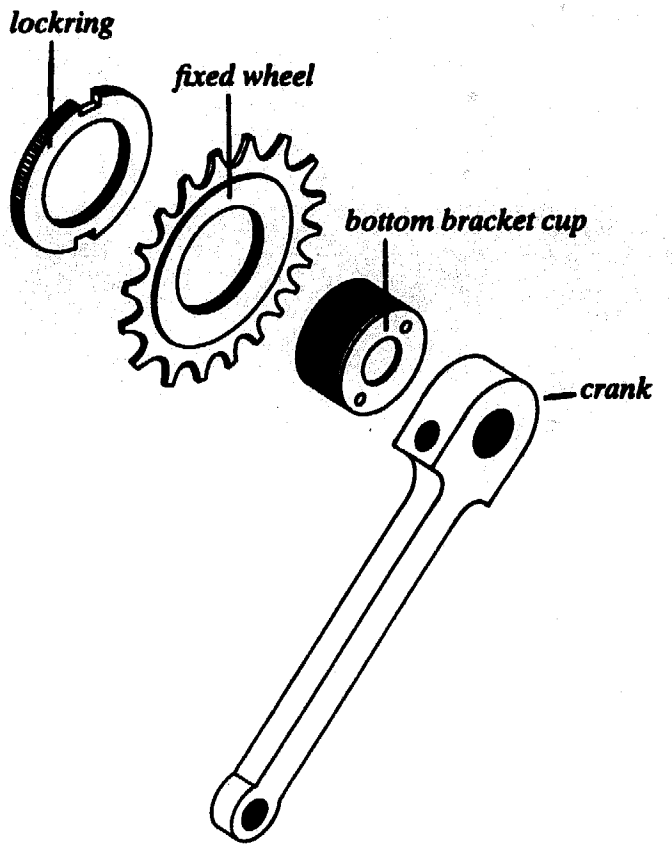
Wheelchair wheels

There are three choices for the wheels and wheel mountings on a wheelchair:

- standard bicycle wheel, double-sided mounting;
- modified bicycle wheel, single-sided mounting;
- wooden spoked wheel, single-sided mounting.

Each of these is described in the following pages.

Wheelchair designs A, B, and C can use any of these three methods. You can fit propulsion rings (see page 74) to all the wheels described here.



Construction of a small chainwheel

Another method of lowering the gear ratio is to use a smaller front wheel. However, some basic changes to the design of the tricycle will be necessary as the forks will need lowering.

An important aspect of tricycle gearing is the length of the cranks. If the cranks are short (110mm–120mm) the user will only be able to exert a small amount of leverage. If the cranks are long (170–180mm) more leverage can be applied.

If you have 3-speed gear hubs, you can build a tricycle which is suitable for hilly ground and travelling at reasonable speed on level ground. You mount the three speed hub in the front wheel of the tricycle. The user operates them by gear selector which is attached to a cable.

Information on commercial sources of 3-speed hubs is given in Annex 1.

Section Five:

Technical Information

Introduction

This section gives specific information on details of transport aid design including:

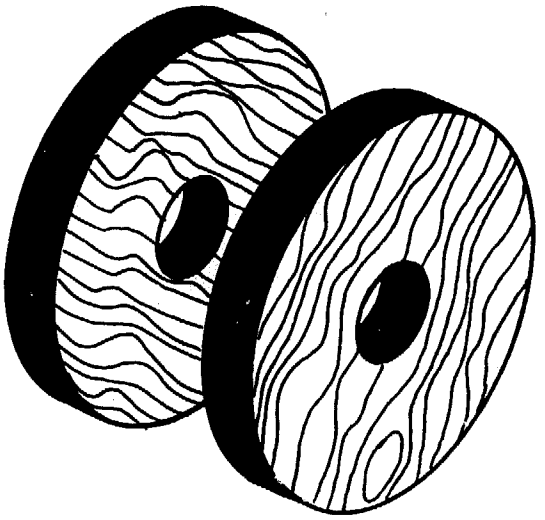
- Wheels and wheel mountings
  - trolley wheels
  - wheelchair wheels
  - castor wheels
- Tyres
  - puncture prevention
  - semi pneumatic tyres
  - solid tyres
- Seating
- Propulsion rings
- Parking brakes

Wheels and wheel mountings

Trolley wheels

Making the wheels

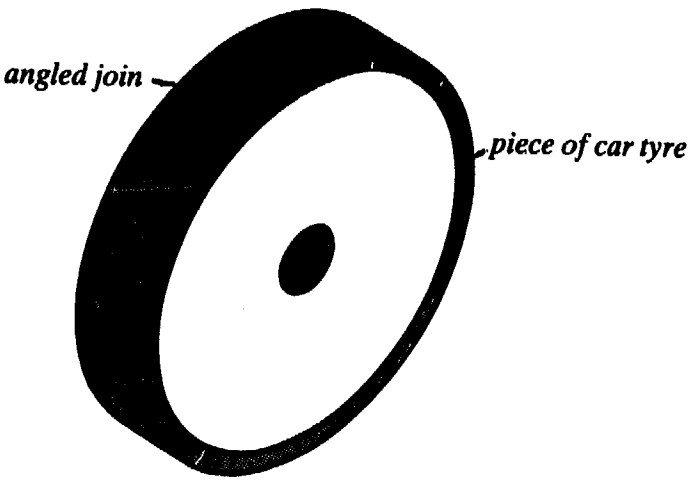
You can make a simple wheel by cutting a circular piece of wood from a length of timber. The wheel should be at least 50mm wide. If you do not have timber of the right thickness nail or glue two pieces of wood together (the 'grain' of the two pieces should be as shown below). Drill a hole through the centre of the wheel to fit onto the axle.



Making the tyre

Each wheel will need a rubber tyre and there are two ways of doing this.

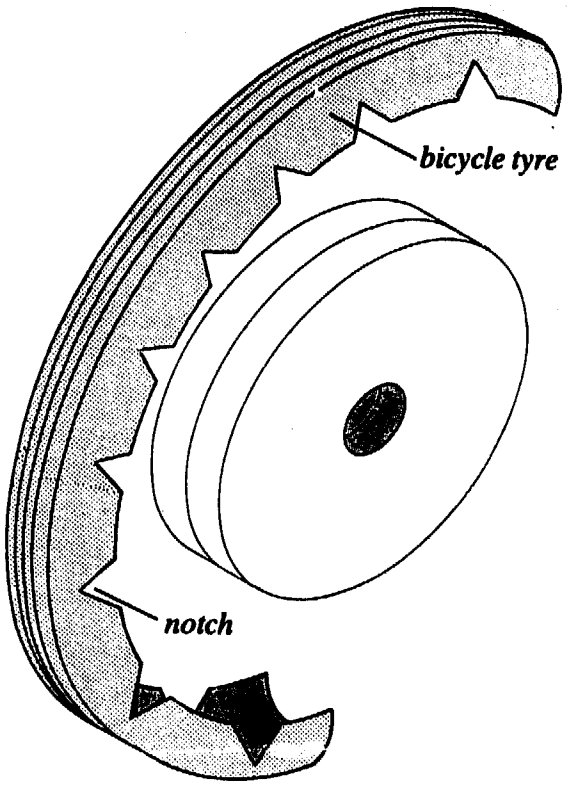
1. Using a car tyre
   Cut a strip of rubber from an old car tyre. The strip should be the same width as the wheel and long enough to wrap around the wheel. Nail the strip around the edge of the wheel. It may be necessary to repair this tyre from time to time as the heads of the nail will wear from use.

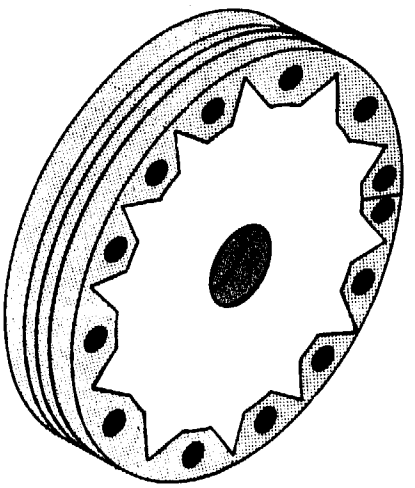


2. **Using a bicycle tyre**

This method prevents the nails wearing away.

Cut a length of bicycle tyre long enough to wrap around the wheel. Cut a series of notches along the sides of the tyre. Fit it around the wheel and nail the sides of the tyre to the wheel.



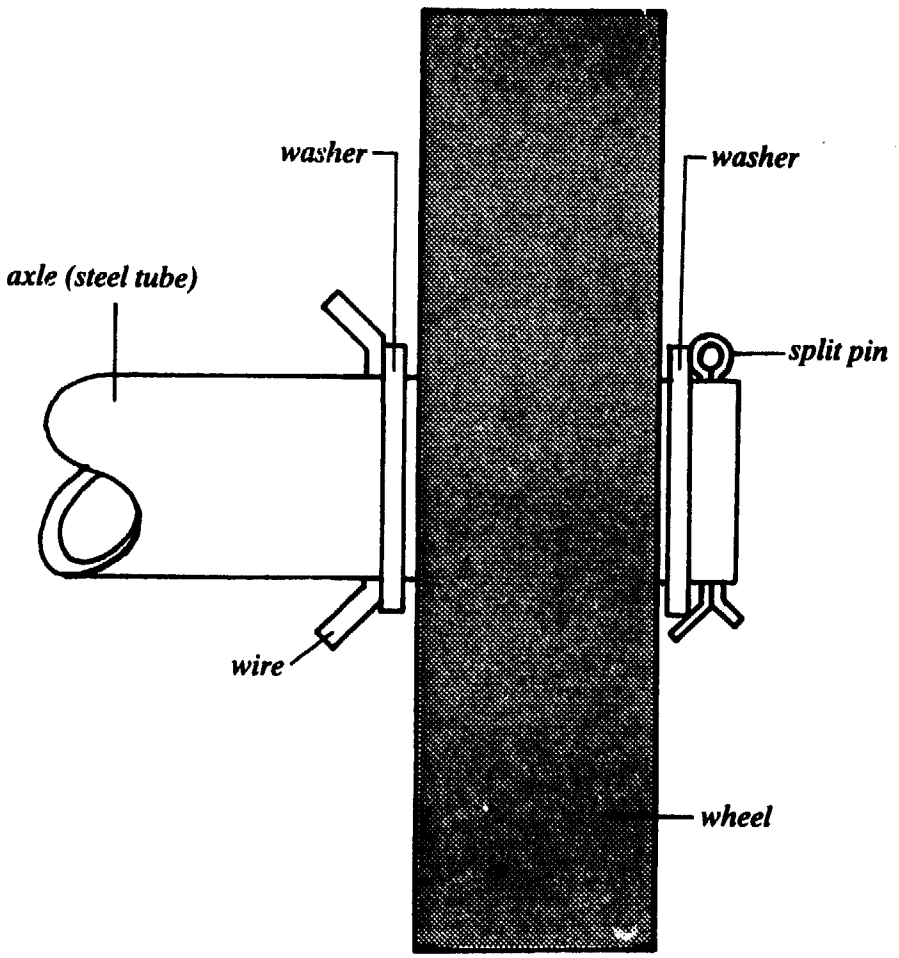


Fitting the wheels

You can fit the wheels on either wooden or steel tube axles.

To stop the wheel coming off the axle, put a washer on either side of the wheel. Hold these in place with split pins or lengths of wire.

Put grease on the axles from time to time, so that the wheels turn freely.



Wheelchair wheels

There are three choices for the wheels and wheel mountings on a wheelchair:

- standard bicycle wheel, double-sided mounting;
- modified bicycle wheel, single-sided mounting;
- wooden spoked wheel, single-sided mounting.

Each of these is described in the following pages.

Wheelchair designs A, B, and C can use any of these three methods. You can fit propulsion rings (see page 74) to all the wheels described here.

Bicycle wheels

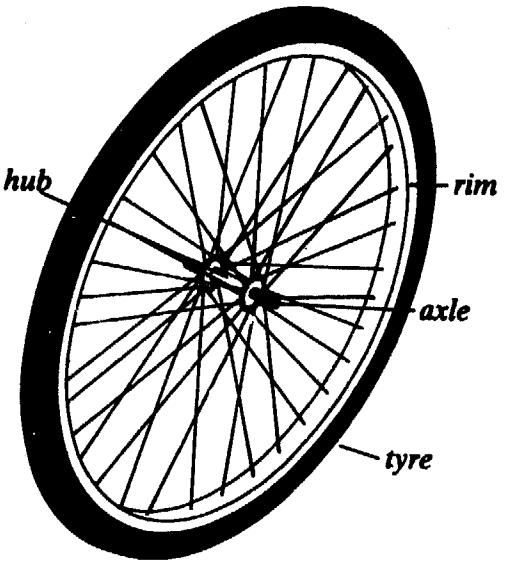
A bicycle wheel is described by:

diameter – normally 26in or 28in

width of rim – normally 1⅜in, 1½in or 1¾in

number of spokes – front wheels normally have 32 or 36 spokes, rear wheels 36 or 40 spokes

type of hub.

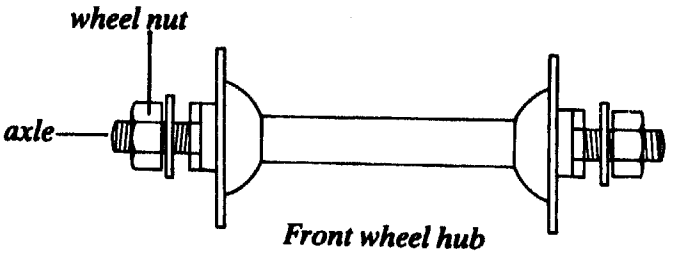


It is sensible to use the size of wheel which you have locally.

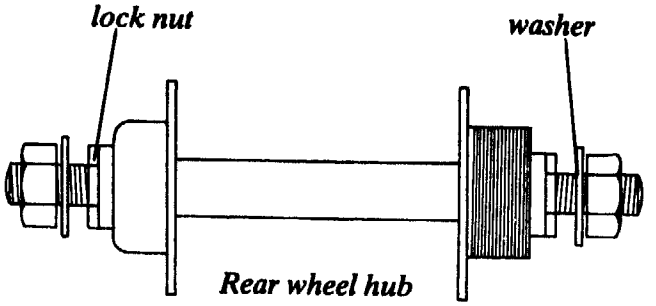
A rear wheel hub is wider across the bearings than a front wheel hub.

A rear wheel hub has a larger diameter axle than a front wheel hub.

A rear wheel hub has a threaded section on which the freewheel normally fits.



Front wheel hub



Rear wheel hub

Standard bicycle wheel, double-sided mounting

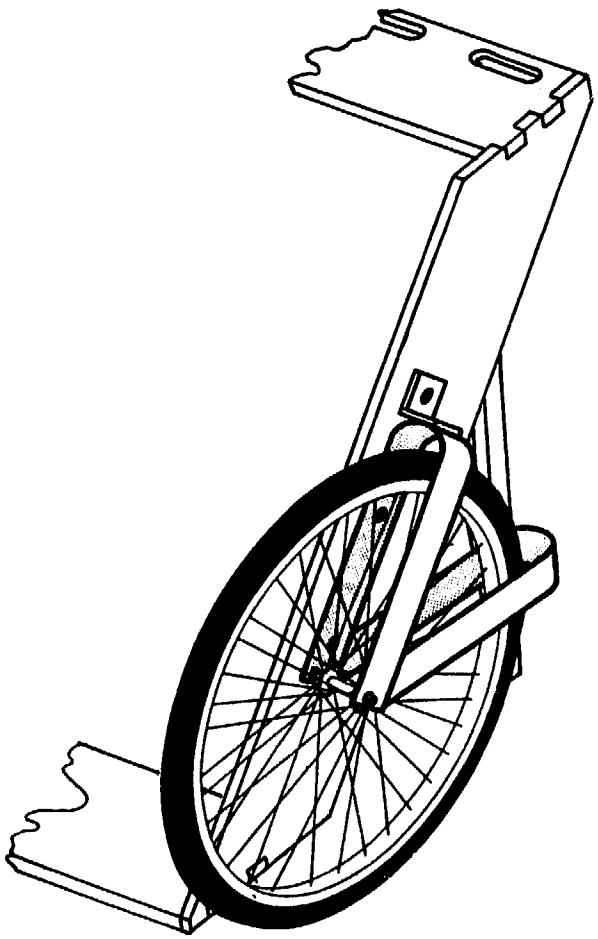
You can use standard bicycle wheels (see page 59) complete with hubs, axles and bearings. It is better to use front wheels since these have narrower hubs than rear wheels. They are also likely to be less expensive.

The diameter of a bicycle wheel axle is quite small. It must therefore have support on **both** sides when mounted on the wheelchair frame. If only one end of the axle is attached to the frame, the axle will bend and break. To support the axles on both sides you need to fit additional members to the frame which support the outer ends of the axles. These additional supports have two disadvantages:

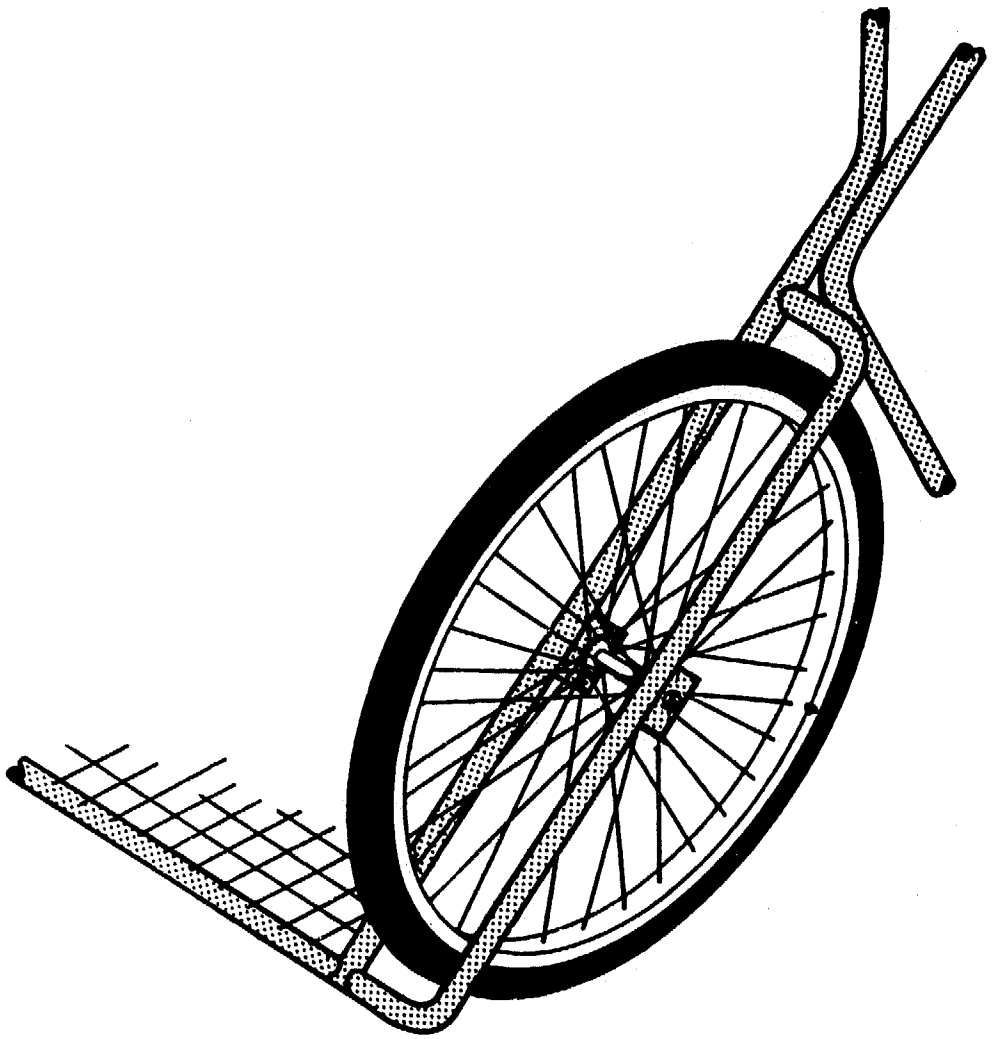
- they hinder the movement of the user's hands when propelling the wheelchair
- they can increase the overall width of the wheelchair. (Ideally a wheelchair should be able to pass through a normal doorway).

The drawing below shows a method of mounting bicycle wheels on a wooden wheelchair (design A or B).

This method uses supports made from steel strip which should be about 50mm wide by 5mm thick. You bolt the supports to the wheelchair frame. The inner ends of the axles fit into holes cut in the frame.



The drawing below shows how to mount bicycle wheels on the tubular steel wheelchair — design C.



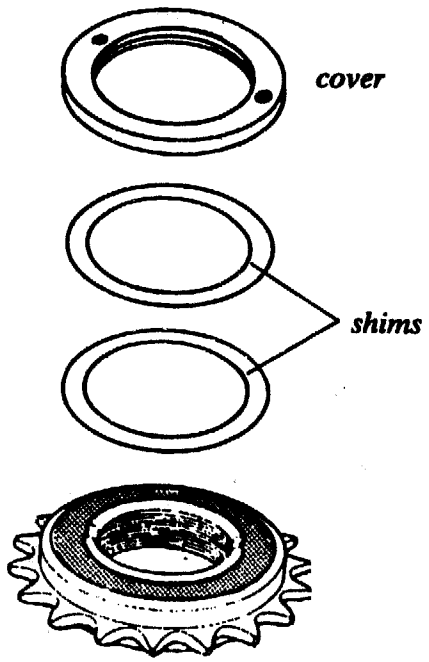
Adapted bicycle wheel, single-sided mounting

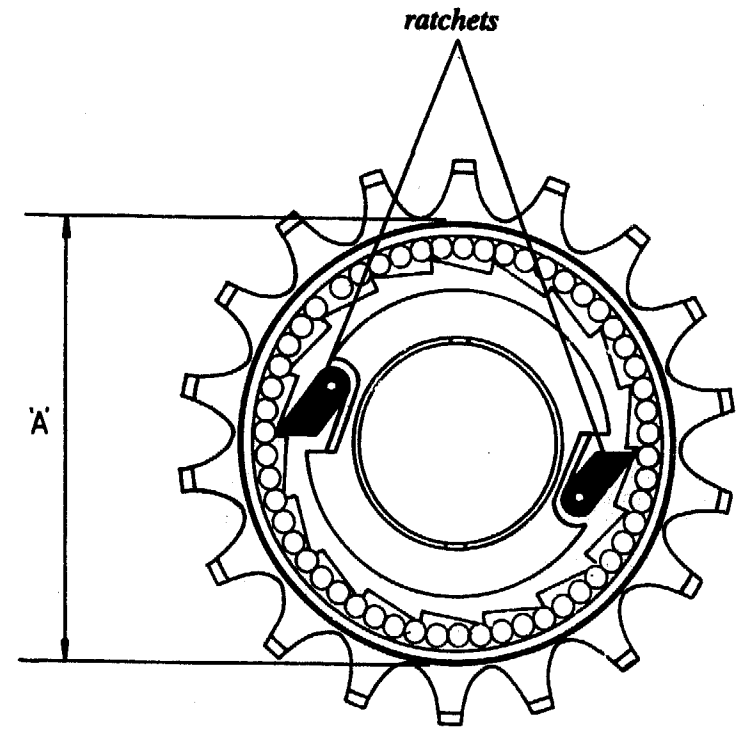
There are three ways of adapting a standard bicycle wheel so that it can be supported on one side only.

1. **Using a freewheel**

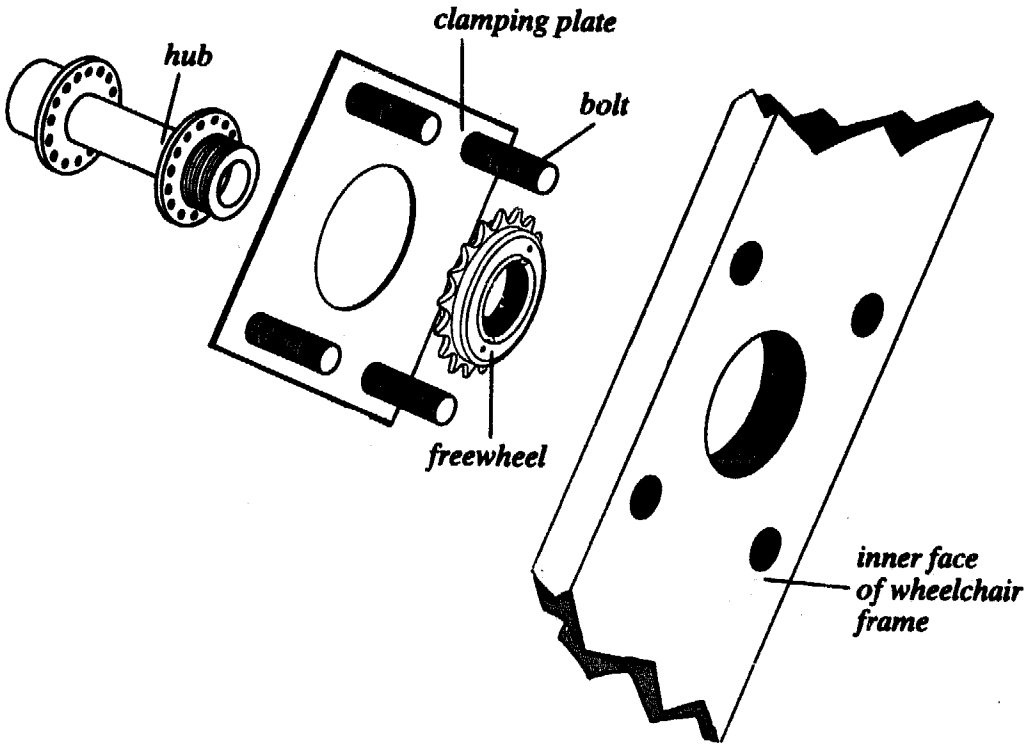
   This method uses a standard rear bicycle wheel (see page 59) and a standard bicycle freewheel. It is suitable for wooden wheelchair frames (designs A and B).

   - **Remove the axle and bearings from the hub of the bicycle wheel**
   - **Take off the cover of the freewheel**
   - **Remove the shims and the ratchets and replace the cover**





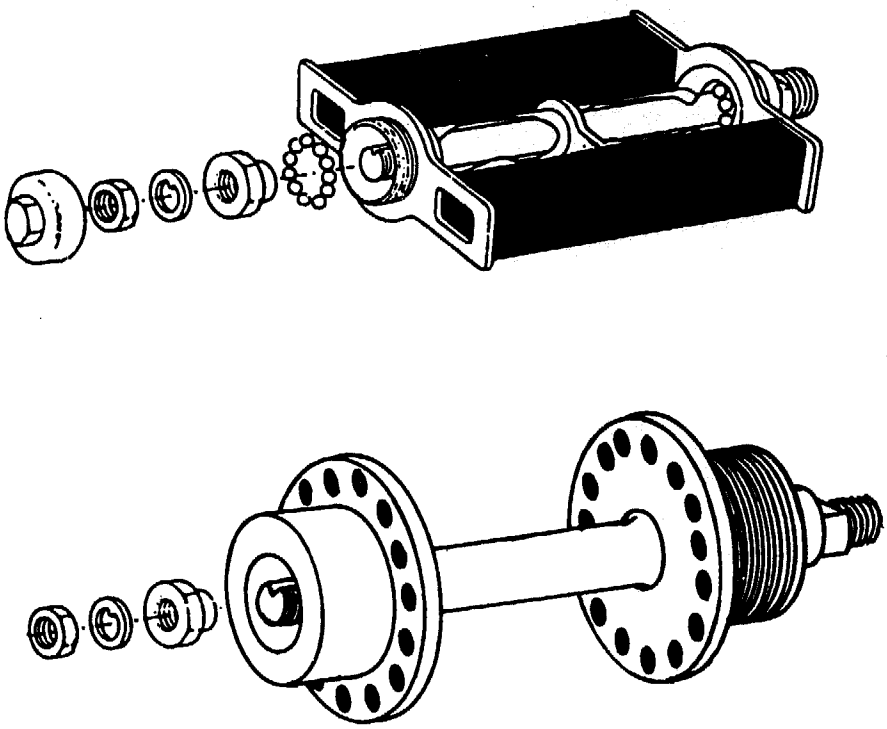
- **Make a steel clamping plate with a hole slightly larger than diameter A on the freewheel**
- **Screw the threaded section of wheel hub tight into the freewheel with the clamping plate between them. Spot-weld the end of the hub to the freewheel to stop it unscrewing. The freewheel now acts as a large diameter bearing, and the hub as an axle.**
- **Bolt this to the frame, so that the sprocket of the freewheel is fixed tightly between the clamping plate and the frame.**



2. Using a stronger axle

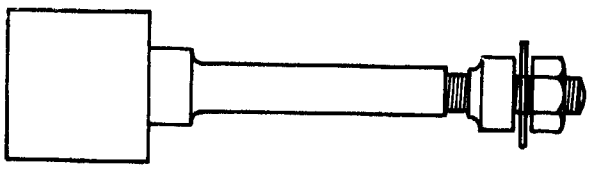
It is possible to fit a stronger axle into a standard bicycle **rear** wheel hub. The axle should have a large diameter section at one end which you attach to the wheelchair frame.

One method is to fit a standard **pedal axle** into the wheel hub. The inner end of the pedal axle has enough strength for mounting the wheel. This short axle is called a 'stub' axle.



pedal axle fitted to cycle hub

It is also possible to make an axle of this type on a lathe. Take the exact dimensions of the axle from the wheel hub you are using.



a machined stub axle

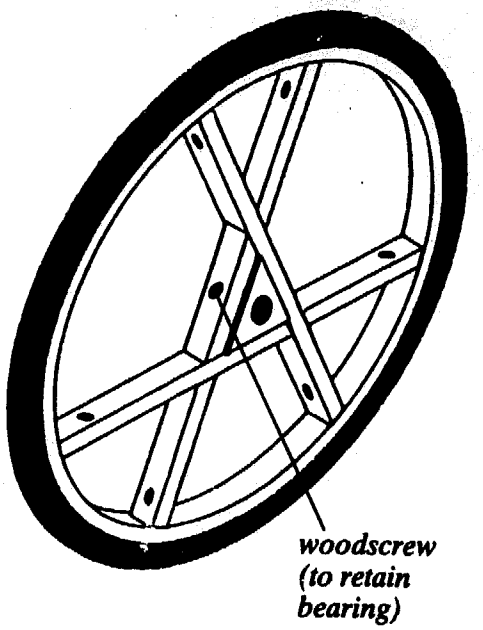
A simple way of joining either of these types of axle to the wheelchair frame is to fit a length of steel tube across the full width of the frame in the correct position for the wheels. Wheelchair design C shows the length of tube in position. You weld the larger diameter sections of the axles into the end of the tube.

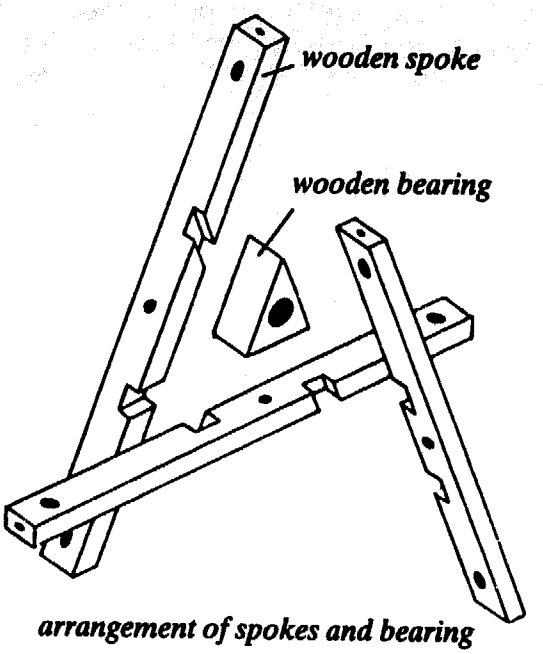
3. Using a heavy-duty hub.

   You can buy heavy-duty hubs for wheelchairs. (See Annex I for list of suppliers). These hubs are designed for single-sided mounting on a wheelchair frame. You can build wheels using these hubs together with standard bicycle spokes and rims.

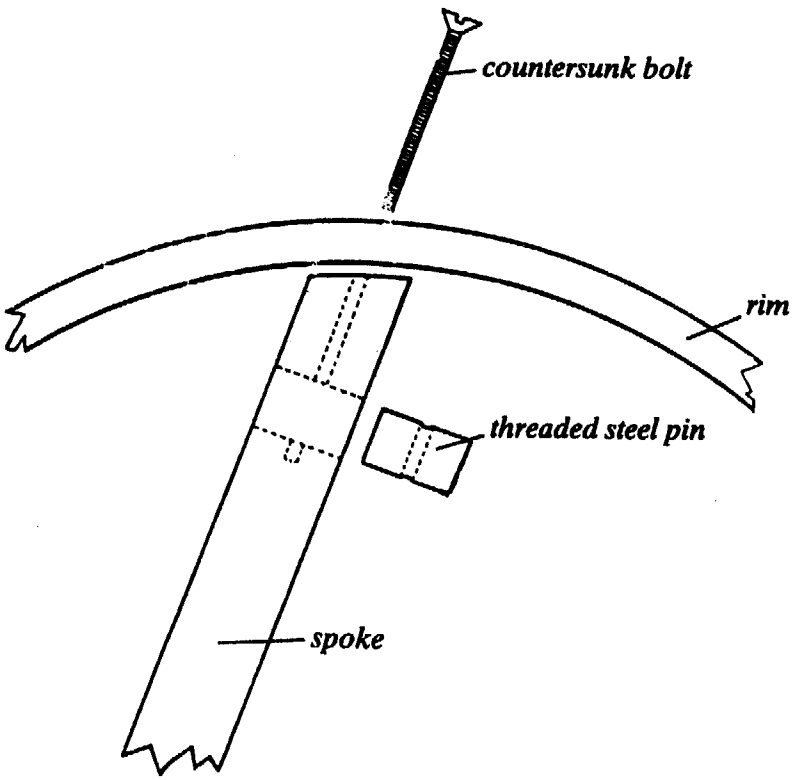
Wooden spoked wheel, single-sided mounting

You can make a simple wheel using a bicycle rim, three interlocking wooden spokes, and an oil-soaked wooden bearing.





arrangement of spokes and bearing

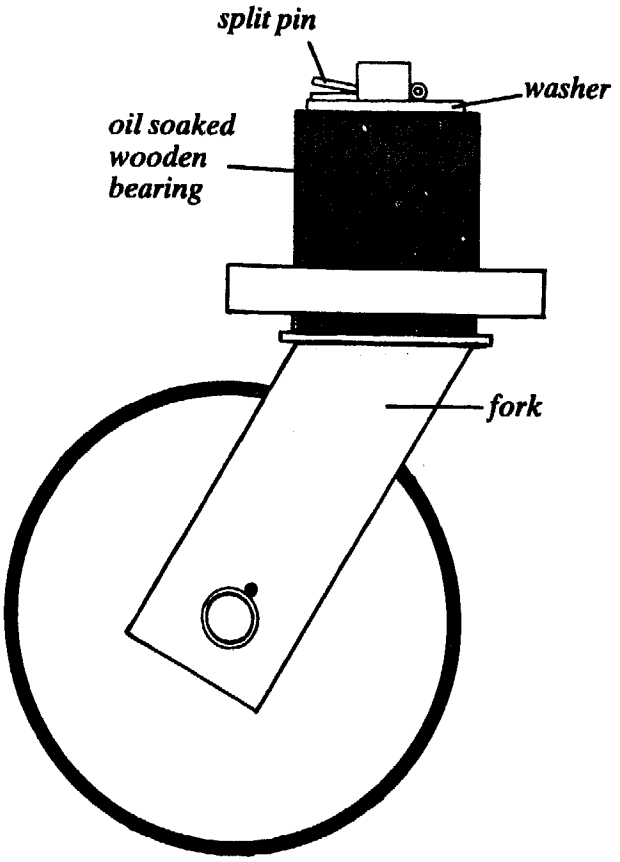


attachment of spokes to rim

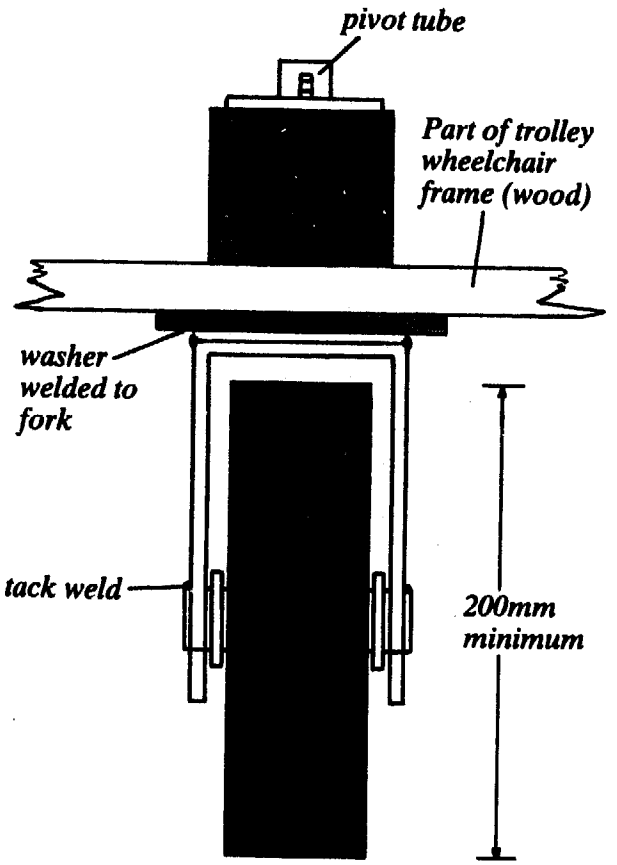
To attach these wheels to the wheelchair frame, fit a length of steel tube across the frame in the correct position for the wheels. This tube should extend beyond the width of the frame on either side to form axles for the wheels. Hold the wheels in place, using washers and split pins, as shown for the wooden trolley wheels on page 57.

Castor wheels

You can make a simple castor wheel from either of the wooden trolley wheels shown on page 55. The diameter of the wheel should be at least 200mm. The castor has a fork made from steel strip about 50mm wide by 5mm thick, and a pivot made from steel tube about 25mm diameter. The pivot turns in an oil-soaked wooden bearing block and is held in place by a washer and split pin or piece of wire. The axle is made from steel tube and you tack weld it to the fork after fitting the wheel. To remove the wheel, grind off the tack welds.

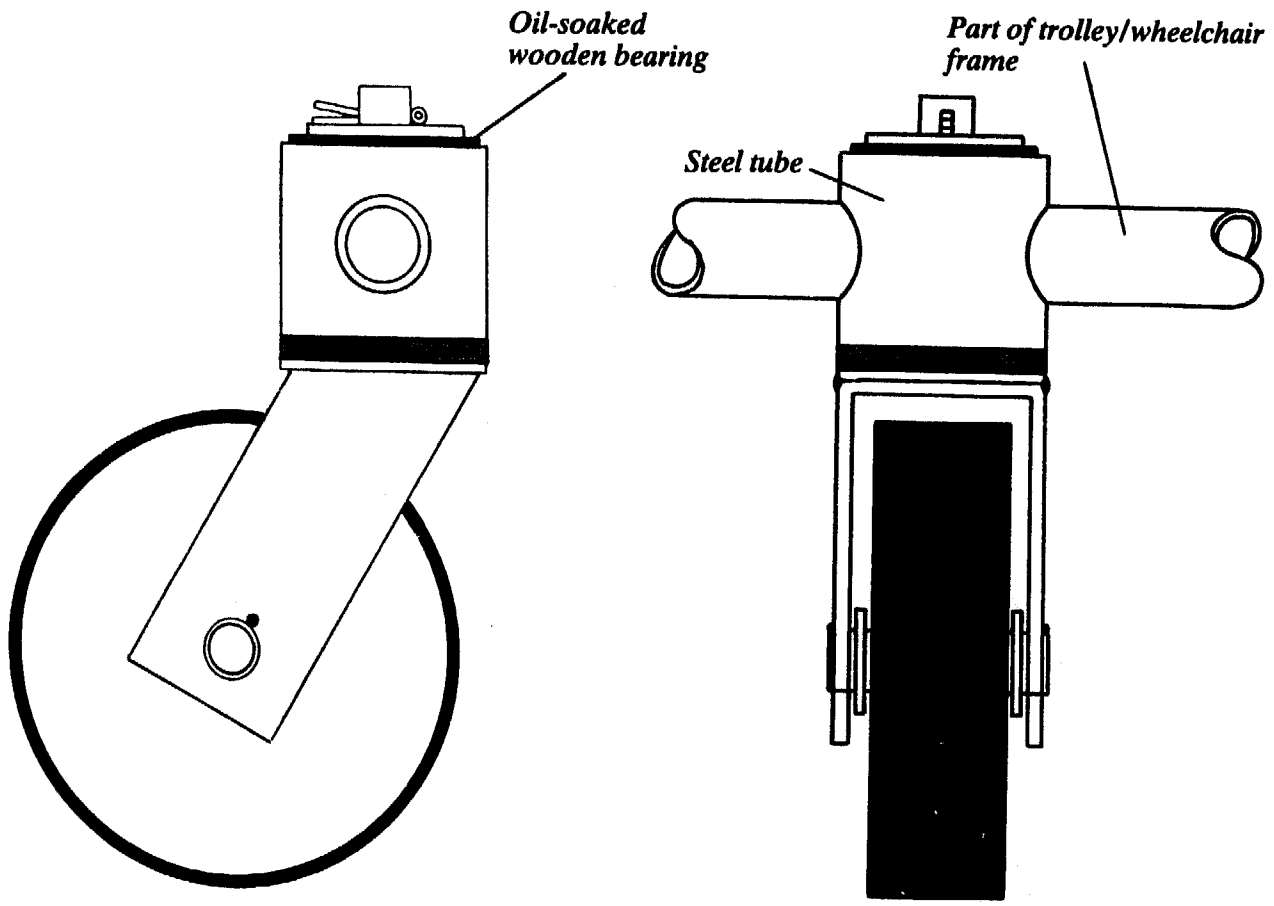


Side view



Back view

The wooden bearing can also be held inside a length of steel tube. You can then use it with aids made of steel.



Side view

Back view

Tyres

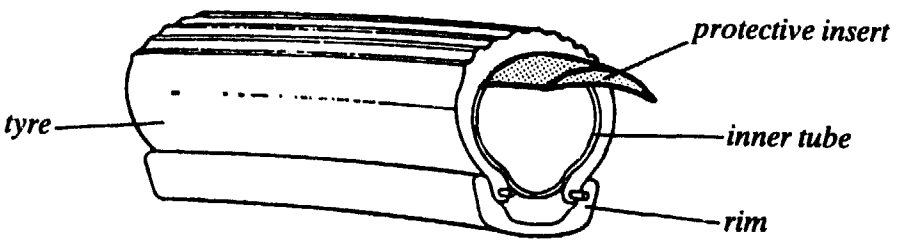
Puncture prevention

Bicycle tyres provide a comfortable ride and are efficient, but puncture quite easily. You can use the following methods to help prevent punctures or make the tyre puncture proof.

1. Puncture sealants

   There are now a number of commercially available puncture sealants which are simple to use. You inject a liquid mixed with small fibres into the inner tube through the valve stem. The liquid does not fill the tyre – only 125ml is necessary for a 26" wheel. As the tyre goes round, the liquid spreads out and covers the inside of the inner tube. When the tyre is punctured, some of the fibres in the liquid are sucked into the hole. They block the hole and seal the puncture. One injection of the liquid will seal many punctures. Puncture sealants will reduce the number of punctures, but not eliminate them. They do not protect the tyre from punctures in the side wall of the tyre and only seal punctures up to 3mm across. Information on commercial sources of puncture sealants is given in Annex 1.

2. Protective inserts
   There are also commercial protective inserts which fit between the tyre and the inner tube. They do not make the tyre puncture proof or protect the side wall, but increase the resistance of the tyre to sharp objects. They provide a protective layer which is difficult to be punctured. You place the insert between the tyre and inner tube. No special tubes are necessary, but you must position it correctly. Commercial suppliers are listed in Annex 1.



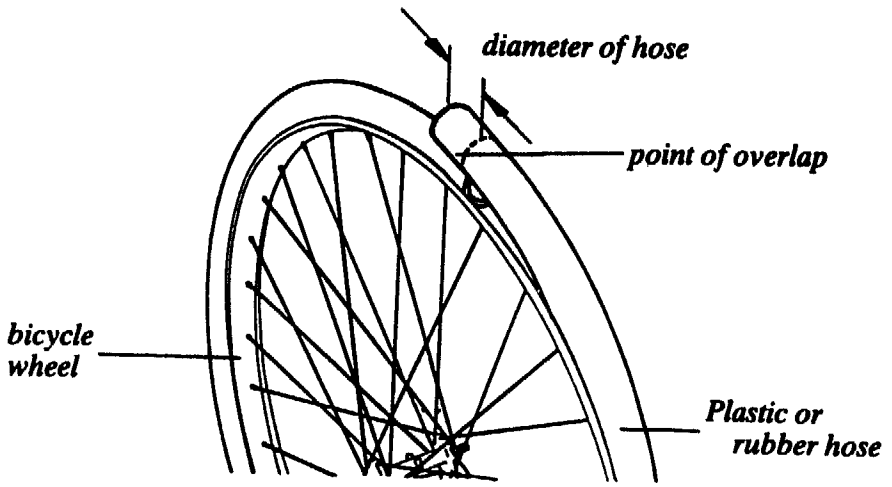
Section of wheel/tyre/tube showing protective insert

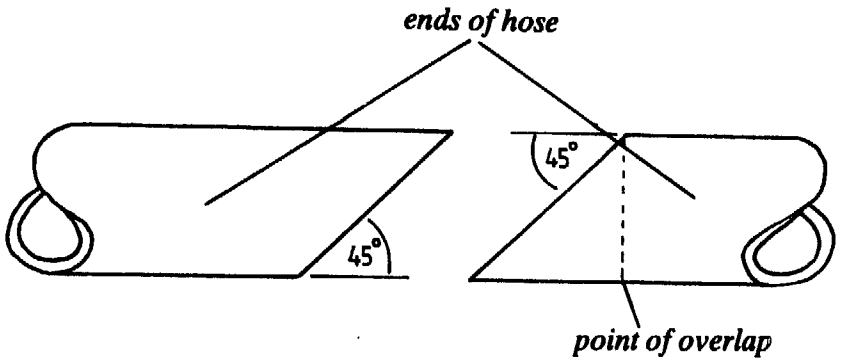
3. Inner tube replacements

   You can replace the inner tube with plastic or rubber hose pipe if you want a maintenance-free tyre. The hose pipe should have a thick wall in order to provide a firm ride. Nylon reinforced plastic hose or hydraulic/compressed air rubber hose are examples of suitable types. The outside diameter of the hose should be approximately 5mm less than the width of the tyre.

It is very important to cut the hose to the correct length as follows:

- remove the tyre and lay a length of hose around the wheel rim. Mark the point where the hose begins to overlap. Add the diameter of the hose to this length and cut the hose. Now cut the two ends at an angle of 45° so that they overlap.

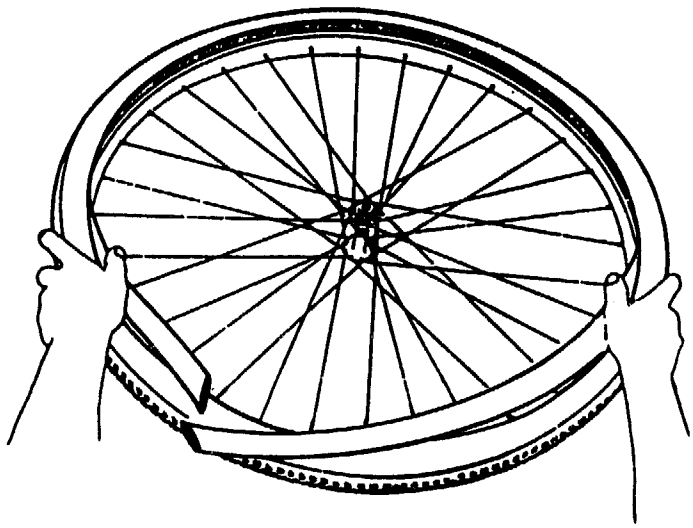




- check that the two ends meet accurately by placing the hose around the rim.

Fit the hose into the tyre as follows:

- place one side of the tyre onto the rim. Begin feeding the hose pipe between the rim and the tyre as shown below. A tyre lever may be necessary if the hose is stiff or a tight fit.
- once the hose is in place, fit the tyre on the rim in the usual way.



Fitting hosepipe into a tyre

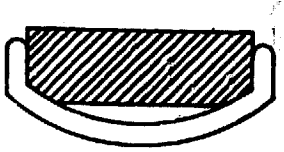
4. Semi-pneumatic tyres

A number of semi-pneumatic tyres are now commercially available. These tyres are made of plastic and replace both the tyre and the inner tube. These tyres perform like pneumatic tyres but are somewhat heavier. Semi-pneumatic tyres can be expensive, but are totally maintenance-free. There is a list of commercial suppliers in Annex 1.

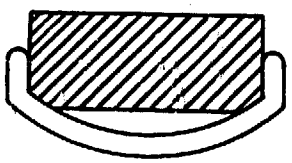
5. Solid tyres

You can fit a solid tyre on a bicycle rim instead of a bicycle tyre and inner tube. It is possible to buy lengths of rubber suitable for fitting on bicycle rims (see Annex 1 for list of suppliers).

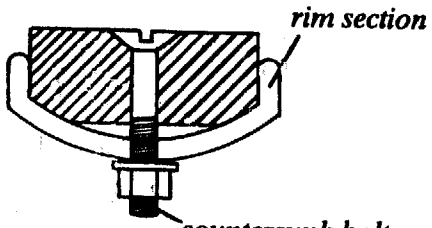
You can also cut suitable tyres from old motor vehicle tyres. Crossply tyres are easier to cut than radial tyres. Use a sharp knife to cut the tyres. Dipping the knife in water before each cutting stroke will make the work easier. Car tyres are not thick enough to provide the necessary depth of rubber. Truck tyres are more suitable.



car tyre



truck tyre



The best way to fix the tyre to the rim is to use countersunk bolts.

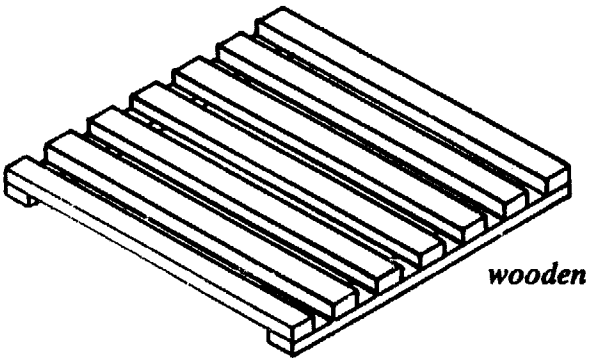
Seating

The type of seating used on an aid is important. Disabled people tend to suffer from pressure sores when they sit in one place without moving. A pressure sore can develop in a very short time – less than half an hour. These can be very difficult to cure. The seating should support the person over as wide an area as possible to help prevent sores. It is also helpful if the seating allows air to circulate. The seating normally has:

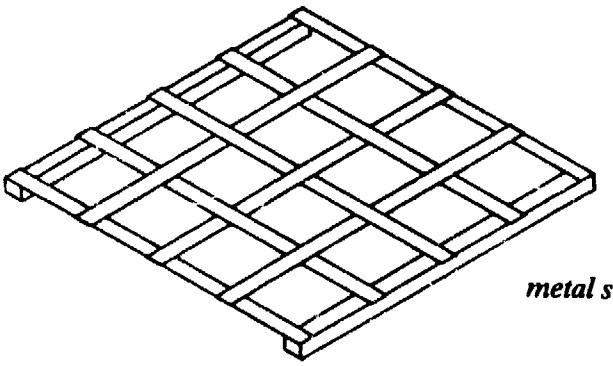
- a seat base
- a seat back
- cushions

You make the seat base in several ways:

- solid wooden base
- woven plastic strip
- wooden slats
- metal strips
- canvas or similar materials



wooden slats



metal strips

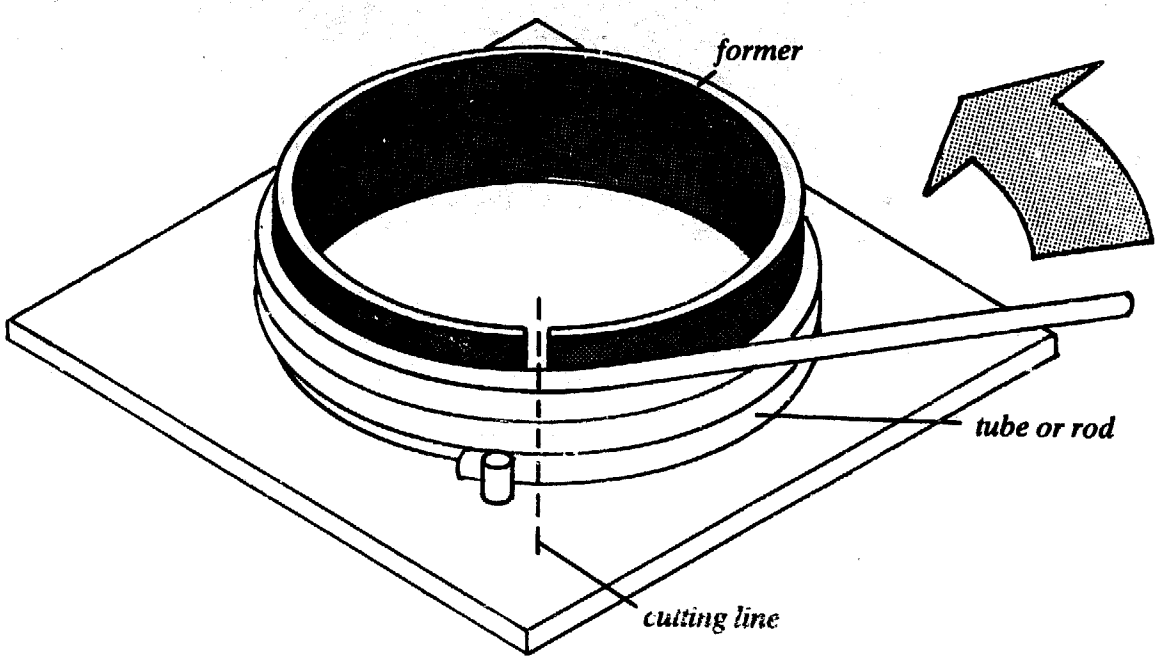
You should use a cushion on the seat. The cushion should be removable, easy to wash and covered in a material which absorbs sweat. The material should be stretched tightly across the cushion. Creases may rub the skin and cause sores. It is sensible to use traditional, local padding materials.

With a wooden slat or metal strip base, the user can take the aid under a shower, after removing the cushion.

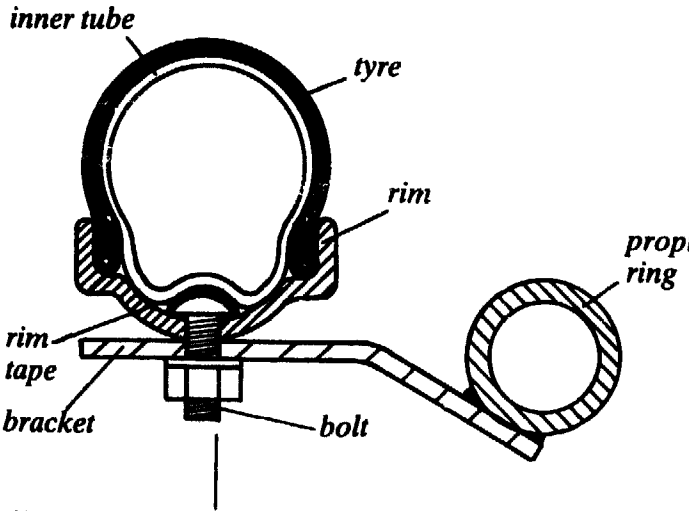
The seat-back must be firm enough to give the user something to push against. A canvas sling, as shown on some of the designs, is an efficient seat-back. You can remove it for washing. If the seat-back is hard (e.g. wooden) you should use a cushion.

Propulsion rings

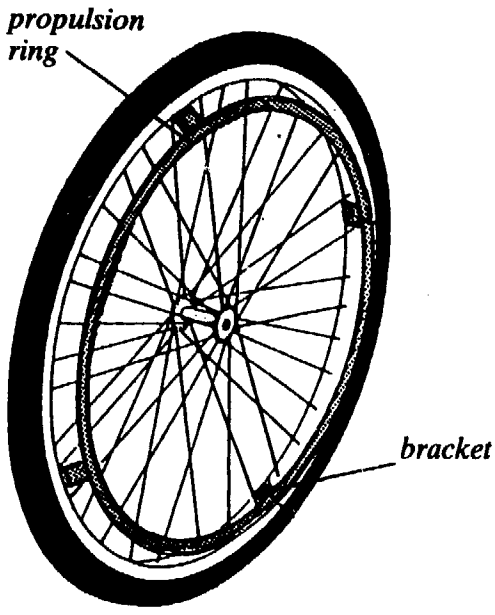
You can make propulsion rings by bending a length of steel rod or tube to a slightly smaller diameter than the wheel rim. The diameter of the rod or tube should be approximately 10mm. One method of producing a number of propulsion rings at one time is to bend a complete length of rod or tube (approximately 6m) around a former, as shown below. This produces a coil which you can then cut to produce a number of identical rings. When deciding on the dimensions of the former, make allowance for the tube or rod to 'spring back' after you bend it.



You can bolt the ring to the wheel rim. First weld four brackets to the ring at 90° intervals. Then attach these brackets to the rim by bolts. Make sure that the head of the bolt is inside the rim, is smooth and is covered by the rim tape. If it is not the tyre will puncture. The brackets should be long enough to provide clearance between the ring and tyre for the user's hands. However, propulsion rings may significantly increase the width of the wheelchair. You should consider this if the wheelchair is to go through doorways.



Section through tyre, rim and bracket showing method of attachment



Parking brakes

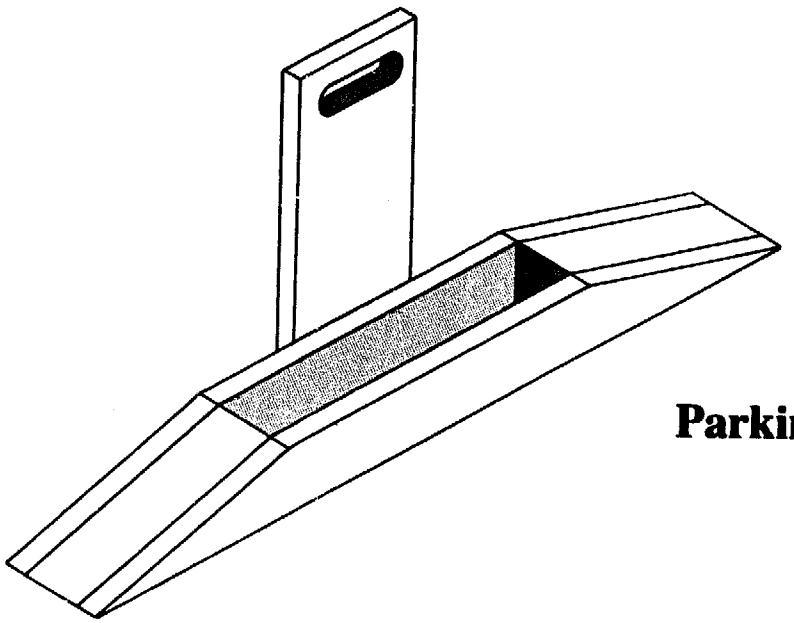
A parking brake is necessary, particularly if there is no-one to hold the aid while the user gets on or off.

Wedges

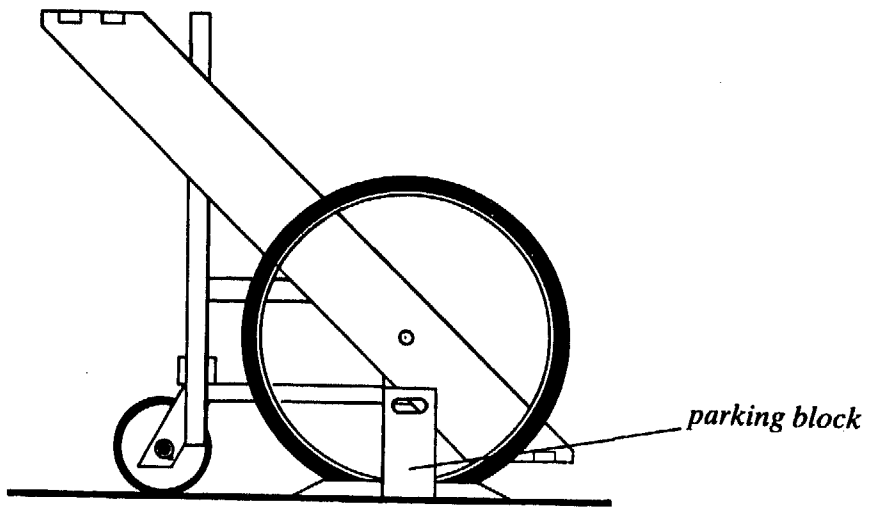
The most basic method of stopping the aid moving is to wedge the wheel(s). On a simple wooden trolley, the user can carry wooden wedges on the trolley which he can put either side of the wheels.

Parking blocks

Wedges are not suitable for a wheelchair or tricycle, as the user needs to bend down too far. The wooden 'parking block', shown below, uses the same principle as a wedge. The user, however, does not have to bend down to ground level.



Parking block



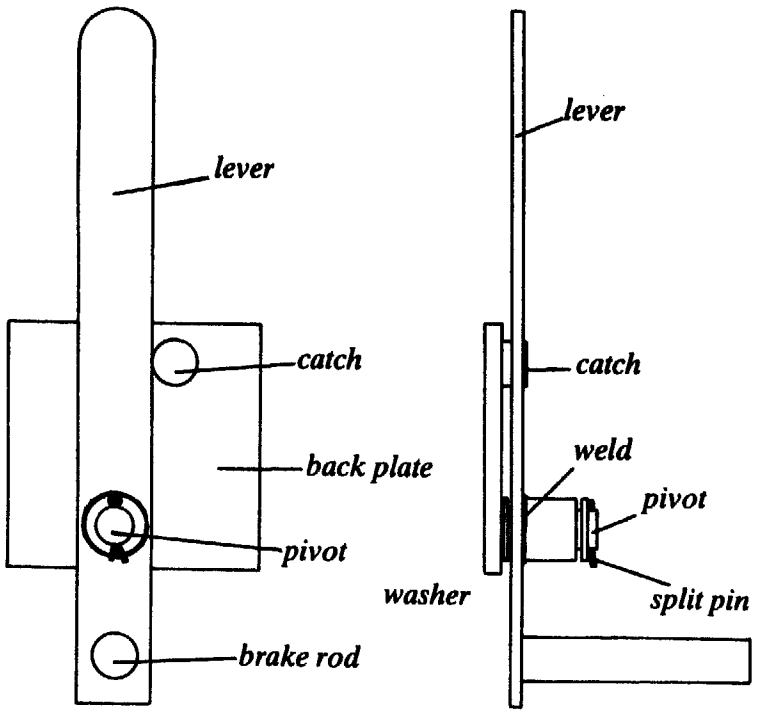
The user can carry the 'parking block' on the aid and place it on the ground when needed. Once the wheel is in the block, the user can get in or out of the wheelchair or tricycle. The aid can be removed from the block by pulling sharply on the wheel.

Lever brake

A more convenient type of parking brake uses a lever which pushes against the tyre. This type is easy to use and is always attached to the aid.

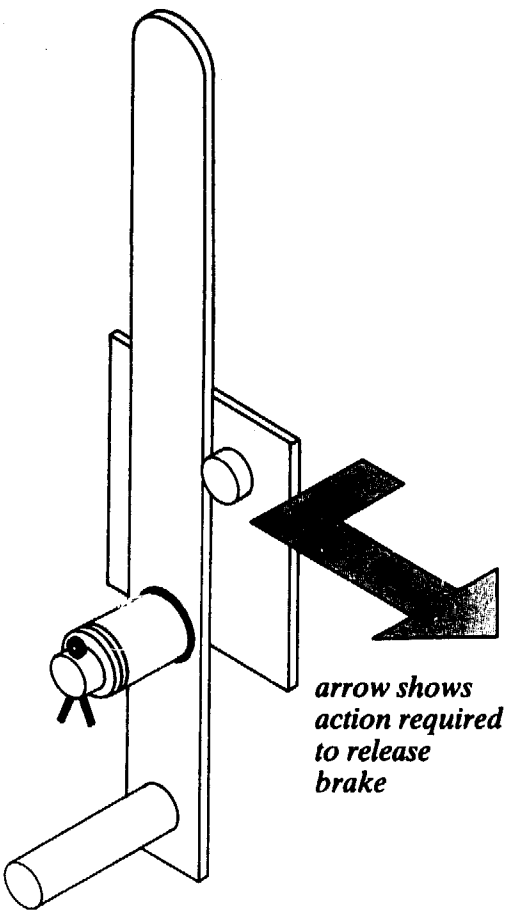
On the brake shown below, a short length of rod is used as a catch. The brake lever is made from steel strip. This steel is flexible enough to 'spring' the brake lever behind the catch and apply the brake. You must position the back plate carefully so that the brake puts sufficient pressure on the tyre. To release the brake, you spring the lever back over the catch so that it is free of the tyre.

Lever brake (shown in the 'on' position)

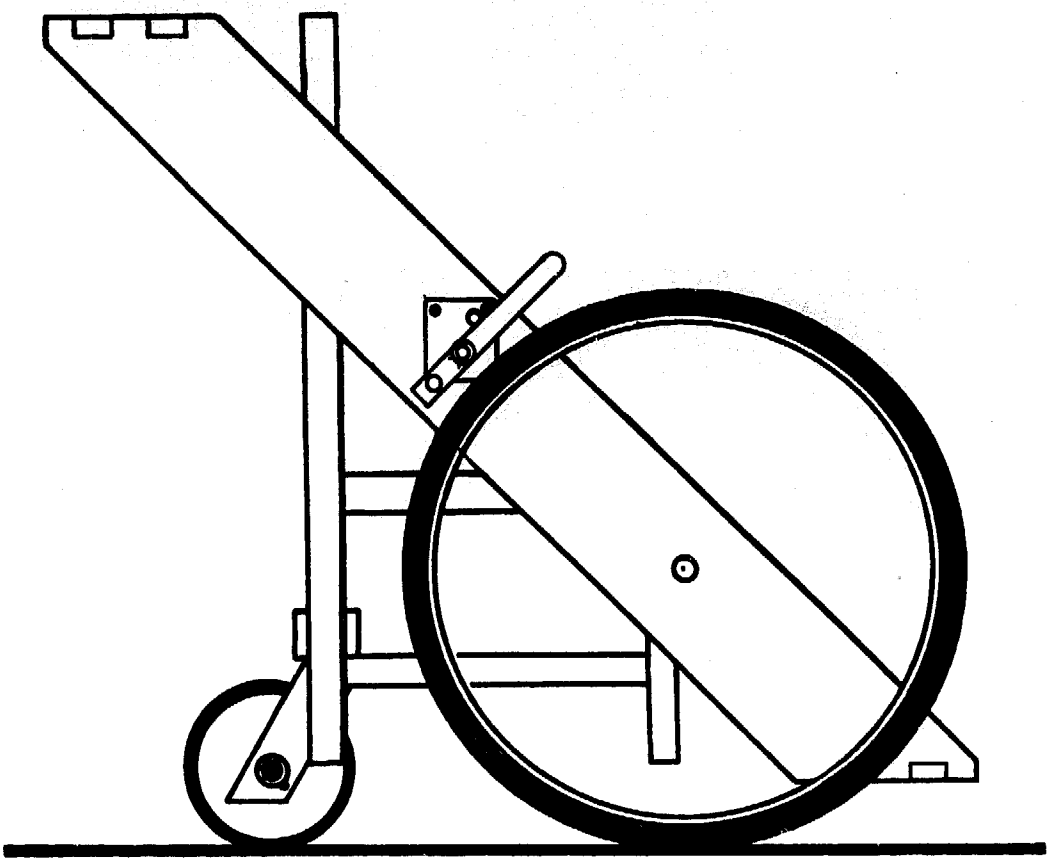


View from side

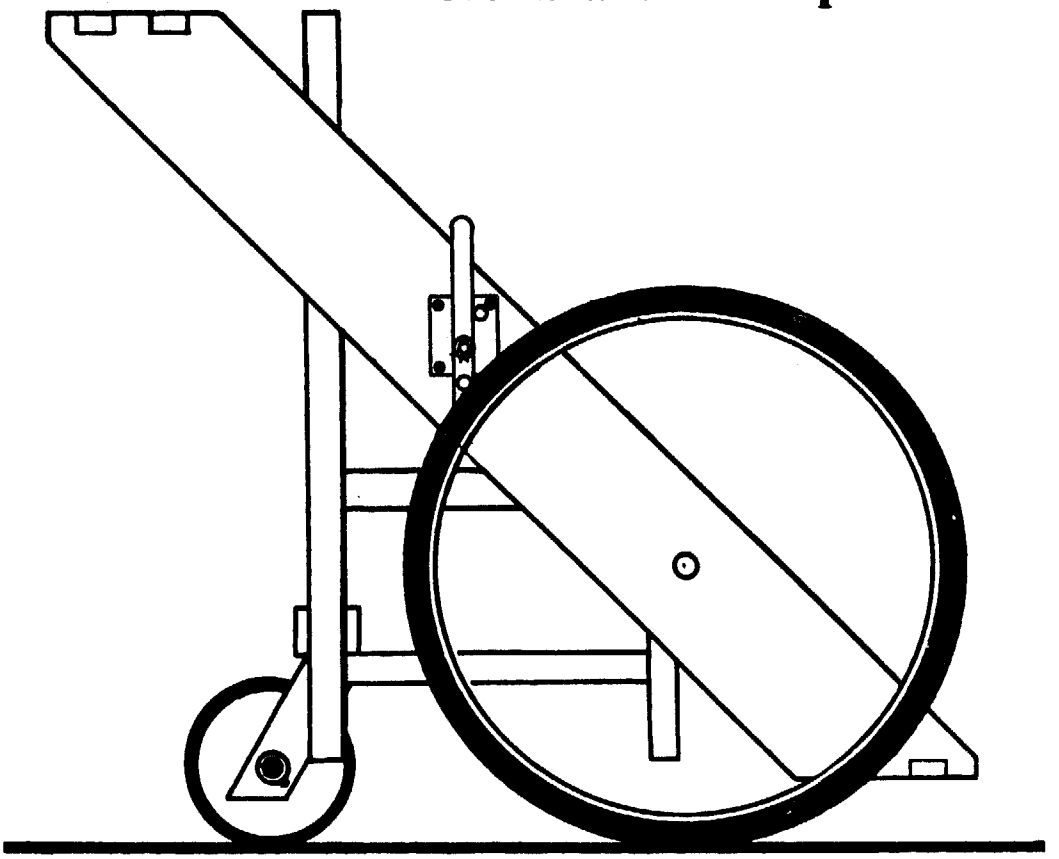
View from back



arrow shows action required to release brake



Lever brake in 'off' position



Lever brake in 'on' position

Annex 1 gives the names and addresses of commercial manufacturers of wheelchair brakes.

Annex One:

Component sources

This Annex gives details of manufacturers of standard bicycle components, and of special components that can be used on transport aids.

It is usually better to buy components from local suppliers. However if this proves difficult the sources listed here can be used.

This Annex gives information on:

- manufacturers of bicycle components – Europe
  Asia
  America
- manufacturers of special components
- addresses of manufacturers.

BICYCLE COMPONENT MANUFACTURERS

AMERICA		WHEEL RIMS	SPOKES & NIPPLES	TYRES & TUBES	CYCLE HUBS	FRONT FORK & BEARINGS	FREEWHEELS	SPROCKETS	CHAINWHEEL CRANKS & BEARINGS	CHAINS	BICYCLE MANUFACTURER
Impex	Brazil									X	
Hi-E Engineering	U.S.A.	X			X						
Schwinn	U.S.A.	X		X		X		X			
Standard	U.S.A.			X		X			X		
Swing Bike	U.S.A.					X			X		
Torrington	U.S.A		X								
Windsor	U.S.A.	X		X							

BICYCLE COMPONENT MANUFACTURES

EUROPE

		WHEEL RIMS	SPOKES & NIPPLES	TYRES & TUBES	CYCLE HUBS	FRONT FORKS & BEARINGS	FREEWHEEL	SPROCKETS	CHAINWHEELS, CRANKS & BEARINGS	CHAINS
Kohmaier	Austria								X	
Pengg-Walenta	Austria								X	
Sedis	France									
Hutchinson	France			X					X	
Souvignet	France				X					
Maillard	France			X		X				
Perrin	France			X						
Rousson Et Chamoux	France			X			X			
Dunlop	France		X							
Wolber	France		X							
AFM	France		X							
Clement-Bayard	France		X							
Cyclo	France					X	X			
Velox	France			X						
Chimiplast	France			X						
LFT	France	X								
Ledin	France					X				
Ofmega	Italy			X				X		
Garelli	Italy	X		X		X	X			
Teodoro	Italy	X			X					
Faire	Italy				X		X			
Artar	Italy			X						
Campagnolo	Italy			X		X				
Gipiemme	Italy			X						
Caimi	Italy					X	X			
Alpina	Italy		X							
Faini	Italy		X							
Pirovano	Italy				X		X			
Rizzato	Italy	X		X	X		X			

BICYCLE COMPONENT MANUFACTURERS

EUROPE continued

		WHEEL RIMS	SPOKES & NIPPLES	TYRES & TUBES	CYCLE HUBS	FRONT FORKS & BEARINGS	FREEWHEEL	SPROCKETS	CHAINWHEELS, CRANKS & BEARINGS	CHAINS
Artexim	Spain	X	X			X				
Beistegui	Spain	X				X				
Camaneiro	Spain	X				X				
Akrent	Spain	X								
Zeus	Spain	X	X			X				
Pirelli	Spain			X						
Monark Crescent AB	Sweden	X	X		X	X		X		
Samuelsson & Co AB	Sweden	X			X	X				
T.I. Raleigh	U.K.		X		X	X	X	X	X	
T.I. Tube Products	U.K.					X				
Lemet Metal Works	U.K.		X							
Hipkiss Wire Products	U.K.		X							
Michelin	U.K.			X						
Renold	U.K.								X	
Weco	W. Germany				X					
Schurmann	W. Germany	X								
Union	W. Germany		X		X					
Wipperman	W. Germany								X	
Esjot-Werk	W. Germany								X	
Fichtel & Sachs	W. Germany					X	X	X		
William Prym-Werke	W. Germany		X		X					

BICYCLE COMPONENT MANUFACTURERS

ASIA

		WHEEL RIMS	SPOKES & NIPPLES	TYRES, TUBES	CYCLE HUBS	FRONT FORKS AND BEARINGS	FREEWHEELS	SPROCKETS	CHAINWHEELS, CRANKS & BEARINGS	CHAINS	BICYCLE MANUFACTURER *
National Light	China									X	
H.K. Bicycles	Hong Kong										
Hero	Hong Kong									X	
										X	
Dwaraka	India										
Federal Sports	India		X						X		
Freewheels (India)	India								X		
Hero	India					X					
TI Cycles	India				X	X		X			
Atlas	India									X	
										X	
Nippon Kinzoku	Japan	X									
Tano	Japan								X		
Izumi	Japan								X		
Hung-a	Korea			X							
Dae Yung	Korea			X							
Rightway	Singapore									X	

SPECIAL COMPONENT MANUFACTURERS

		HEAVY DUTY HUBS	CASTOR WHEELS	PROTECTIVE INSERTS	PUNCTURE SEALANTS	SEMI-PNEUMATIC TYRES	PARKING BRAKES	SOLID TYRES
Dunlop Wheel Div	U.K.		X					
Flexello Castors	U.K.		X					
H+M	U.K.			X				
OKO	U.K.			X				
Revvo Castors	U.K.		X					
Remploy	U.K.	X						
Suretrak	U.K.				X			
Lee Healey	U.K.						X	
Everest + Jennings	U.K.					X		
Union	W. Germany	X						
Weco	W. Germany	X						
Samsong	Korea		X					
Blue Sky	U.S.A.	X						
Mr. Tuffy	U.S.A.			X				
Wilson Wheel + Tire	U.S.A.				X			

Manufacturers' addresses – America

1. BRAZIL

Impex Com Internacional Ltda
Assessoria Comercial
Av. N. Sra Copacabana 749 Gr. 502
22050 Rio De Janeiro RJ

2. U.S.A.

Blue Sky Cycle Carts
29976 Enid Road East
Eugene
Oregon 97402

Hi-E. Engineering Inc.
1247 School Lane
Nashville
Tennessee 37217

Mr. Tuffy Co.
20 Old Squan Plaza
Manasquan
N.J. 08736

Schwinn Bicycle Co.
1856 N. Kostner Ave
Chicago
Illinois 60639

Standard Cycle Co.
Div. of Bicycles Inc.
1632 South Indiana Ave.
Illinois 60616

Swing Bike
412 W. 10th N.
Logan
Utah 84321

The Torrington Company
Cycle Parts Div.
Torrington
Conn. 06790

U.S.A. *continued*

Wilson Wheel & Tyre Co.
20969 Ventura Boulevard
Suite 9
Woodland Hills
California 91364

Windsor Enterprises Inc.
2702 S. Port Way
Unit A & B
Corner of 28 West St.
National City
California 92050

Manufacturers' addresses – Europe

1. AUSTRIA

Kohmaier Franz Gesmbh
Ketten, Hebezeuge
Antriebstechnik
Lemboeckgasse 49
A 1234 Wien 23

Pengg-Walenta KG
Steirische Kettenfabriken
Theodor-Koerner-Strasse 59
A 8010 Graz Stmk

2. FRANCE

Applications Du Fil Metallique
24 rue Jean-Désorges, 03300 Cusset

Chimiplast,
60 rue Saint-Denis
93300 Aubervilliers

Clement-Bayard
27 rue d'Orleans
92200 Neuilly-Sur-Seine

Cyclo,
77 av. A.-Raimond
B.P. 3 – 42270 St.-Priest-En-Jarez

Dunlop
Tour Atlantique
92800 Puteaux

Hutchinson–MAPA Cycles
124 av. des Champs-Elysees
2, rue Balzac
75008 Paris
B.P. 762.08 – 75360

Laminiors A Froid De Thionville
Route de Manom
B.P. 50, 57101 Thionville

FRANCE *continued*

Ledin,
rue Louis-Joseph-Gras
Z.1 La Chauvetière – B.P. 153
42012 Saint-Etienne Cédex

Maillard
76117 Incheville
B.P. 1 – 75117 Incheville

Perrin – Usine de Lardy
B.P. 29,
42130 Leigneux par Boen-Sur-Lignon

Rousson & Chamoux
rue Parmentier –
B.P. 4 – 42110 FEURS

Sedis,
102 rue Danton – B.P. 200
92306 Levallois-Perret
Cédex

Souvignet
42380 Saint-Bonnet-Le Chateau

Velox,
29 bis,
rue Jean-Moulin
95100 Argenteuil

Wolber,
17 rue de Villeneuve
B.P. 6 – 02201 Soissons

3. ITALY

Agrati Garelli SPA
Via Immacolata, 35
Monticello Brianza

Alpina Raggi Spa
Via S. Francesco d'Assisi 11
Arcore

ITALY *continued*

Artar Spa
Via Marzalesco
Cureggio

Caimi Guglielmo Di A. Caimi
Via Boccaccio, 15/a
Milano

Campagnolo Brevetti Internaz Spa
C.so Padova 168
Vicenza

Carnielli Teodoro E.C. SPA
Via Dante, 61
Vittoria Veneto

Faini Federico Srl
Maggianico Sco E. Filiberto 74
Lecco

Faire Srl
Via Meda, 55
Monza

Gipiemme Srl
Via Vicenza
Camisano Vicentino

OF.ME.GA Component Speciali
Via G. Gozzano
Sarezzo

Pirovano Fratelli Spa
Via Sirtori, 14
Casatenovo

Rizzato Cesare E.C. Spa
Via Venezia, 29
Padova

4. SPAIN

Artexim S.A.
Rambia Cataluna
115 bis
11.° A. Edificio Catalonia
Barcelona-8

SPAIN *continued*

Beistegui Hermanos, S.A.
Arcacha, s/n
Vitoria

Camaneiro S.A.
Francisco Marti Mora, 1
Edificio (Bldg.)
Torre, Palma De Mallorca

Manufacturas Akrent, S.A.
Riera dels Frares
3-5-7 Hospitalet de Llobregat
Barcelona

Pirelli Productos, S.A.
Avda. Jose Antonio, 612
Barcelona-7

Zeus Industrial S.A.
Barrio Matiena, s/n
Abadiano (Vizcaya)

5. SWEDEN

Monark-Crescent AB
Berger Svenssons V28
Box 503
S-432 01 Varberg

Samuelsson & Co. AB
Albert
S-333 03 Skeppshult

6. UNITED KINGDOM

Dunlop Wheel Division
Foleshill
Coventry
W. Midlands

Everest & Jennings Ltd
Princewood Road
Corby
Northants NN17 2DX

Flexello Castors & Wheels Ltd
Slough
Berks
SL1 4ED

UNITED KINGDOM
continued

H & M Products Ltd
P.O. Box 101
London
SE9 6TQ

Hipkiss Wire Products
Goodman Street Works
Birmingham
B1 2SU

Lee Healey Co. Ltd.
Marlow Road Mills
Leicester LE3 2BR

Lemet Metal Works
Delta Way
Watling Street
Bridgtown
Cannock SW11 3BE

Michelin Tyre Co. Ltd.
81 Fulham Road
London
SW3 6RD

OKO International
Tongstyle Ltd.
Brookside
Sandalheath Ind. Estate
Fordingbridge
Hants

Remploy Ltd.
Sheffield Road
Whittington Moor
Chesterfield S41 8NJ

Renold Power Transmission Ltd.
Renold Works
Burnage Lane
Manchester M20 0ER

Revvo Castors Co. Ltd.
Christchurch
BH23 3PZ

UNITED KINGDOM
continued

Sure-trak Ltd.
19 Greenhey Place
East Gillibrands
Skelmersdale
Lancs
WN8 9SA

T.I. Raleigh Ltd.
177 Lenton Boulevard
Nottingham
NG7 2DD

T.I. Products Ltd.
P.O. Box 13, Popes Lane
Oldbury
Warley
W. Midlands

7. WEST GERMANY

Esjot-Werk
Schiermeister & Junker
Poststr. 9-15
Postf. 209
D-4763 Ense 2

Fichtel & Sachs
AG, Ernst-Sachs-Straße 62
D-8720 Schweinfurt

Schurmann-Werk
Fritz Schurmann GmbH & Co. KG
Postfach 1209
D-4811 Leopoldshone 1

Union Sils
Van de Loo & Co.
Wilhelm-Feuerhake-Str. 7
D-5758 Frondenberg/Ruhr

Weco-Werke
Postf. 1170
4806 Werther b. Bielefeld

William Prym-Werke
KG, D-5190 Stolberg

Wipperhamann Jr. GmbH
Delsterner Strasse 133
D-5800 Hagen

Manufacturers' addresses – Asia

1. CHINA (People's Republic)

Light Industrial Imp. & Exp. Corp.
172 Waoning Road
Tianjin
China

2. HONG KONG

Hero Bicycle Corporation
Mai Wah Industrial Bldg.
Flat C, B & D, 13th Floor
Kwai Chung
New Territories
Kowloon

Hong Kong Bicycles Ltd.
Kingsford Industrial Bldg
Phase 11, 4th Floor
28 Kwai Hei St.
Kwai Chung
New Territories
Kowloon

3. INDIA

Atlas Cycle Industries Ltd.
Sonepat
Punjab
India

Dwaraka Industrial Development
Pvt. Ltd
14 Canal Street
Calcutta-14
India

Federal Sports
20/1 Asaf Ali Road
New Delhi
India

Freewheels (India) Ltd.
57 Industrial Area
Faridabab
India

INDIA *continued*

Hero Cycles Pvt. Ltd.
G.T. Road
Ludhiana
India

T.I. Cycles of India Ltd.
11–12 North Beach Road
Madras-1
India

4. JAPAN

Izumi Chain Co. Ltd.
100-1 Hakozukuri Hannan-Cho
Sennan-gun
Osaka

Nippon Kinzoku
2-2-3 Uchisaiwai-Cho Chiyoda-Ku
Tokyo

Tano H. & Co. Ltd.
No. 1–15 Isogamidori 6-Chrome
Fukiaiku
Kobe – 651

5. KOREA

Dae Yung Commercial Co. Ltd.
CPO Box 2082
Seoul
Korea

Hung-A Ind. Co. Ltd.
P.O. Box Bukpusan 53
Korea.

Samsong Ind. Co. Ltd.
CPO Box 2383 Seoul
Korea

6. SINGAPORE

Rightway Industries Pte. Ltd.
Suite 11-03, 11th Floor
U.I.C. Building
5 Shenton Way
Singapore 0106