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(54) FOLDING BICYCLE

(71) I, REINDER VAN TIJEN, a citizen of The Netherlands, of 59 Fazantlaan, Dieren (Gld.) The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a folding bicycle. In general, known bicycles are assembled from parts that are manufactured in dissimilar ways, such as pipes, lugs, axles, wheels and tyres and many others, which are manufactured with the aid of many and complicated machines and tools and are assembled into a complete bicycle. In the case of folding bicycles, an additional requirement is that of being able to fold it, which is mostly realised in known bicycles by the rear wheel and the pedal mechanism forming a part that is attached hingeably to another part comprising the handlebars and the front wheel, the division being provided in a framebeam. Moreover, it is observed that a known folding bicycle in the folded state occupies less space than in the unfolded state, but is not to be used in the folded state.

It is the object of the invention to provide a bicycle that is composed of elements that can be manufactured in a simple way, substantially according to similar methods and which can be manufactured with simple tools and in particular out of light elements, but without impairing the solidity and the stability of the bicycle.

According to the invention there is provided a folding bicycle having a main frame beam comprising three parts, a centre part of which has a saddle supporting beam mounted therethrough so as to be slidable upwardly and downwardly, and front and rear parts of which are connected to wheel supports on which are supported wheels, which front and rear parts are hingeable with respect to the centre part, so that in the folded position

the wheels lie either side of the centre part and parallel to each other, the parts of the main frame beam being made out of rectangular strips of sheet which are folded and bent and have adjacent edges secured together by interlocking portions thereof to form hollow members, wherein when the bicycle is in the folded position, with the saddle supporting beam in its lowest position, the lower end of the saddle supporting beam and the wheels form a stable, ground-engageable three-point support for the saddle, a pedal drive mechanism being mounted on the centre part and a drive from the mechanism to the rear wheel comprising a driving cable which is mounted at the same side of centre part as the hinge between the centre part and the rear part.

The invention is further described below with reference to the accompanying drawings of an embodiment of a folding bicycle according to the invention. In the drawings

Figure 1 shows the bicycle in the folded state in perspective.

Figure 2 shows the bicycle in a partially unfolded state in perspective.

Figure 3 shows a side view of the bicycle in the state ready for use.

Figure 4 shows a plan view of the bicycle.

Figure 5 shows a front view of the bicycle.

Figure 6 shows a view, partially in section, of a wheel support and a wheel of the bicycle.

Figure 7 shows a section of a wheel support and a wheel of the bicycle.

Figure 8 shows a section of the pedal mechanism of the bicycle.

Figure 9 shows a section of a wheel support at the location of a short beam and the lower parts of the bicycle handlebars.

As shown in the drawings, a folding bicycle is composed of three main sections, which by means of hinges are permanently connected to each other. For that purpose a main frame beam has been provided with

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 5 a centre part 1 hinged to a swingable rear part 2 that can fold forwards and a swingable front part 3 which can fold backwards. These three parts are each manufactured from straight strips of thin sheet, which have been folded into box-shaped sections. Adjacent edges of the strips forming the sections are secured together by interlocking portions thereof, referred to below in the description as "interlocks". A wheel support 5 is attached fixedly to rear part 2 and in it a rear wheel 6 is mounted in a sprung manner. A beam 7 is fitted hingeably to front part 3 and is fixedly attached to a front wheel support 8, in which a front wheel 9 is mounted in a sprung manner. Front wheel support 8 has the same design as rear wheel support 5, while also the attachment to the beam 7 corresponds with the attachment of rear wheel support 5 to rear part 2. Wheels 6 and 9 are constructed in the same way and are of the same size.

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 15 In centre part 1 of the frame beam an opening has been provided in which a saddle supporting beam 10 is mounted so as to be movable up and down, but fixable in position. Saddle supporting beam 10 has also been folded from straight strips of thin sheet, which are connected by means of interlocks 4.

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 25 Below centre part 1, forward of saddle supporting beam 10 a pedal drive mechanism 11 is suspended, which in the folded state of the bicycle locates between wheels 6 and 9. In that folded position saddle supporting beam 10 is lowered to the lowest position with respect to centre part 1 and the lower part of beam 10 with the bases of wheels 6 and 9, which in the folded state lie side-by-side, forms a three-point set-up on the ground, which is stable to an extent that a saddle 12 on saddle supporting beam 10 can serve as a seat. In order that front wheel 9 can be folded beside rear wheel 6 it is necessary that a handlebar system 13 of the bicycle can also be folded and for that purpose this handlebar system 13 is composed of a number of parts that to the left and to the right of beam 7 and wheel support 8 are folded downward to below the level of saddle 12. In the folded position, the bicycle thus offers a comfortable seat.

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 55 The frame beam composed of parts 1, 2 and 3 runs from rear wheel support 5 slantingly upwards to above front wheel support 8, and so that wheels 6 and 9 in the folded state lie side-by-side, pivot axes 14 and 15 of the hinged joints between rear part 2 and centre part 1 and between centre part 1 and front part 3 run at different sides of centre part 1 and at acute angles to the longitudinal direction of the frame beam. In the embodiment drawn, axes 14 and 15 are

vertical and the distance between these lines is equal to the sum of the distance from axis 14 to the axle of rear wheel 6 and from axis 15 to the axle of front wheel 9. In this way, in the folded state of the bicycle, the axles of the wheels are co-axial. The distance between axis 14 and the axle of treadle drive mechanism 11 is smaller than the distance from axis 14 to the axle of rear wheel 6, so as to avoid that the axle of pedal drive mechanism 11 also locates between the axles of wheels 6 and 9 in the folded state, so that the width of the folded bicycle would become very large.

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 65 The hinge joints of axes 14 and 15 have been provided in straps 16, which have been passed around the ends of frame beam parts 1, 2 and 3 that are directed towards each other. Each of these straps 16 consists of two substantially U-shaped folded strips between which the box-shaped section of the end of a part 1, 2 or 3 is clamped and attached, while the legs of each strip protrude at the sides of the parts and are connected to the legs of the other strip. Between rear part 2 and centre part 1 protruding straps 16 at the upper side are connected to form a hinge joint 17, which lies at the side of centre part 1 and are connected at the lower side of part 1 to form a hinge joint 18, which lies at the side of rear part 2. Then the axis 14 through hinge joints 17 and 18 is spaced laterally from frame beam parts 1 and 2 and intersects the projection of the dividing plane between those parts at an acute angle at the height of interlocks 4. In the same way, but at the other side of centre part 1 by the connection of straps 16 at upper hinge joint 19 is formed at the side of front part 3 and a lower hinge joint 20 at the side of centre part 1, which hinge points lie on axis 15.

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 100 For reinforcement of the ends of frame beam parts 1, 2 and 3 directed towards each other, in the interior of the box-shaped sections at the location of straps 16 fillings provided with central openings have been placed.

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 130 Because of the position of hinge joints 17, 18, 19 and 20 in straps 16 next to frame beam parts 1, 2 and 3, i.e. hinge joints 17 and 18 with axis 14 at the right-hand side of the frame beam and hinge joints 19 and 20 with central axis 15 at the left-hand side of the frame beam, rear and front parts 2 and 3 can be swung such that they come to lie in substantially parallel vertical planes with centre part 1 in the middle. Because of the equal angles which the axes 14 and 15 make with the longitudinal direction of the frame beam it is possible that upon swinging the wheels remain at the same level. The angles which the axes 14 and 15 make with the longitudinal direction of the centre part 1 of

the frame beam, need not be equal but then the distances from the wheel axles of wheels 6 and 9 to the intersections of axes 14 and 15 with the longitudinal direction must be chosen such that upon folding the axles of the wheels become coaxial.

The construction with equal angles and parallel vertical axes 14 and 15, and with distances between the axes and the adjacent wheel axles whose sum is equal to the mutual spacing of axes 14 and 15, can however be realized in the most simple way.

Locking parts 1, 2 and 3 in the non-folded or in-use position of the bicycle is carried out by a clamping construction. A substantially U-shaped clamp lever 21 embraces centre part 1, the ends of which lever are inserted through openings in part 1 and are provided with square or rectangular tips that are inserted in links 22, which support rollers 23. Over rollers 23 a tensioning wire 24 is passed, one end of which is attached at the strongest place at the front of front part 3 with the aid of an adjusting screw 25, and the wire to the rear of links 22 is divided into two separate wires that within centre part 1 pass either side of saddle supporting beam 10 and are fixed in rear wheel support 5 by means of an anchor 26. In the folded position of the bicycle, lever 21 is swung towards saddle supporting beam 10 and tensioning wire 24 is of sufficient length to enable free swinging of the front and rear parts around axes 15 and 14. When frame beam parts 2 and 3 with the components connected to them are swung as far as the in-use position relative to the centre part 1, lever 21 is turned and tensioning wire 24 with great force draws towards each other the extremities of parts 1, 2 and 3 that are directed towards each other owing to the arrangement of the links 22 shown in Figure 3. Moreover, the adjusting screw 25 in front part 3 is provided to adjust the length of tensioning wire 24 to achieve the desired tensile force.

With clamp lever 21 is, however, connected a wire 27, which passes across centre part 1 and is connected to the base of saddle supporting beam 10. So, when clamp lever 21 is turned anticlockwise from the position illustrated in Figure 3, the saddle supporting beam 10 can be moved upward or downward. So as to secure saddle supporting beam 10 in the highest position, a clamping means 28 is provided, which on tensioning of the wire 24 locks saddle supporting beam 10. In order to be able to secure clamp lever 21 in the forward position it is bent so that one leg can be hooked behind the lugs of straps 16, which form hinge joint 19 as shown in Figure 4.

Because it must be possible to adjust saddle 12 at different heights, in saddle supporting beam 10 a slidable extension 30

has been provided, which is also constructed out of folded strips of sheet connected together by interlocks. This extension can be locked at different heights because at the upper end of saddle supporting beam 10 a locking member 31 is provided with a bent-over rectangular end 32 which extends into saddle supporting beam 10 and upon turning presses a pressure plate 33 against extension 30. Extension 30 at its upper end is provided with a flattened end 34, which forms a centre of rotation for a saddle pin 35, which is slidably coupled with saddle 12. Saddle 12 can swivel to a limited extent around the saddle pin so as to facilitate the lateral movement of the body of the rider.

Front part 3 of the frame beam has been flattened out into a hinge part 37 which is connected by means of a pin 38 to the beam 7 of handlebar system 13, which pin 38 bears in a cup 39 of front wheel support 8. The lower side of hinge part 37 also bears on cup 39. At the upper end, pin 38 is locked by an eye 36 of a pin 40 which has been attached in upper end 41 of beam 7 which is also constructed out of folded strips of sheet which are interlocked. The lower ends of beam 7 are attached to front wheel support 8 with bushes 42. On these bushes 42 straps 43 are mounted around which side plates 44 are hingeable. Side plates 44 are constructed out of folded strips of sheet which are interlocked and through which rods 45 extend, which protrude forward and backward and form part of frames 46 which constitute a parcel carrier and which can be fastened around upper end 41 of the beam 7 by a clip 47. Frames 46 are formed out of wire and are each supported, moreover, by supporting arms 48 and 49, which run upwards from the ends of the associated rod 45 and are suspended from a respective axle 51 at upper edges 50 of the associated side plate 44. Besides supporting arms 48 and 49, around this axle 51 an upper steering linkage 52 and a reinforcing rod 53 are attached hingeably. The front end of axle 51 is bent somewhat so that in folding upper steering linkage 52 can carry out a slight turn around its axis, in order that handlebars 57 in the folded position of handlebar system 13 are situated parallel to each other. Moreover, in upper steering linkages 52 connecting members 54 are attached, which are connected permanently, but hingeably with each other at 55 while in the unfolded position of the handlebar system 13 these members 54 are fixed with respect to each other by a lock 56.

When handlebar system 13 is to be folded, the supporting frames 46 are loosened from the upper end 41 of the

beam 7 and turned towards their respective side plates 44. Upper steering linkages 52 are then pivoted about the axles 51 and moved towards the positions shown in phantom in Figure 5. This causes the connecting members 54 to be folded together and forward around coupling point 55 and the side plates 44 to drop by pivoting about hinges 43. To unfold the handlebar system, the reverse process is carried out.

If then supporting frames 46 are turned up and have been attached on upper end 41 of beam 7 with clip 47, the lower part of the handlebar system 13 has been fixed. By closing lock 56 around connecting members 54, the upper part of the handlebar system 13 is also fixed.

At the upper end of the upper steering linkages handlegrips 57 have been attached. In one of the handlegrips a set of batteries can be provided for a spotlight 58, which can be manipulated by hand and on to the other handlegrip 57, a reflector 59 can be mounted, the cup of which can also be used as a bell. In the unfolded position of handlebar system 13 handlegrips 57 are directed outward, but by applying appropriate angles in the bends of axles 51 and between axles 51 and hinges 43 and an adequate dimensioning of the length of side plates 44 and upper steering linkages 52 it is arranged that in the folded position of the handlebar system handlegrips 57 come to lie parallel to each other with upper end 41 of beam 7 between them.

With handlebar system 13 constructed in this way, between side plates 44 and upper steering linkages 52 a protected space for luggage is obtained, which, if necessary, can serve as a children's seat, because in the unfolded position of the bicycle supporting frames 46 bear on beam 7 and have been locked with it.

On to rear part 2 and rear wheel support 5 a foldable parcel carrier has been provided. It is mounted on two frames 60, which are placed vertically, and are coupled with each other by means of three connecting plates 61, while the ends of frames 60 bent downward have been attached to rear part 2 and rear wheel support 5. Centre connecting plate 61 has been attached to rear wheel support 5 with a rivet 62 and hindmost connecting plate 61 bears a rear light or reflector 63. At the bends in the frames 60 bent rods 64 are hinged, which in the folded position are suspended downwardly past frames 60. Supporting rods 65 are mounted, however, which are rotatable at connecting points 66 on frames 60 and can slide along rods 64 by means of eyes 67. In these rods 64 a bend 68 has been provided and in the unfolded position eyes 67 engage with bends 68 and

in so doing fix rods 64 in the horizontal plane. As a result of the bent shape of rods 64, in this plane a saddle-shaped platform is produced. When eyes 67 are lifted out of bends 68 they slide to the centre of rods 64, which then drop downwards of themselves.

Like all parts of the frame folded out of substantially rectangular strips of sheet metal, the rear wheel support (Figures 6 and 7) is also formed out of folded strips of sheet, a strip 71, which forms the radially outer side and a strip 72, which forms the inner side. The folded strips are connected with each other in the correct shape by means of an interlock 73. At one end the strips are flattened and bent into a hook 74 with a cylindrical cavity. In this hook a bifurcated support member 75 has been inserted for the wheel. Ends 76 of the legs of member 75 are flattened, provided with bores and also bent through a right angle. In the bores legs 77 having a double bend as shown in Figure 6 are inserted of a second bifurcated support member 78, which takes vertical load and makes an approximately right angle with support member 75. The upper end of support member 78 is connected with a curved plate spring 79, which is attached to bent strips 71 and 72 with rivets 80 and 81. The plate spring flattens and bears itself against the strips under changing load and in this way a suitable spring characteristic can be obtained without local high stresses.

Near hook 74 a brake shoe 82 is provided, which is suspended from a plate spring 83, which is attached to strip 72 with a rivet 84. In brake shoe 82 also a lever 85 is inserted which can turn about hook 74 and when a brake wire 86 is pulled brake shoe 82 is pressed against the sides of the rear tyre. In a way known in the art brake wire 86 is guided with a Bowden cable to a brake lever 87 on handlebar system 13. Because brake shoe 82 has been provided at the location of guiding frame 75, effectively braking is effected independent of the spring movement of the wheel in the wheel support.

Pedal drive mechanism 11, which is shown in Figure 8 has been suspended from centre part 1 of the frame beam and in front of saddle supporting beam 10. So as to obtain a correct positioning of the pedal drive mechanism 11, centre part 1 has been indented at the lower side into a bearing surface for an annular housing of the pedal mechanism 11, which is suspended from centre part 1 by means of straps 90. The housing is formed by two substantially identical housing parts 91 and 92, which preferably have been deep drawn from thin sheet. At the inner periphery each housing part is provided with a ball bearing race 93

for balls 94 and at the outer periphery with a corrugated screw thread 95. Housing part 91 at the side has openings for the passage of a drive cable of the wheel drive and for that reason must be attached fixedly with respect to centre part 1. Housing part 92 is adjusted rotatably with the aid of screw threads 95 until the correct clearance of ball-bearing races 93 has been obtained and then fixed. By disconnecting the fixation at straps 90, housing part 92 can be rotated and after the adjustment again be fixed in a desired position.

On balls 94 in bearing races 93 runs a pedal axle. The latter is formed by two identical deep drawn cups 96, which are supported on balls 94 with ball bearing races 97. Cups 96 are interconnected by pins 98 while a centre plate 99 is interposed between the cups 96. Pins 98 transmit the pedal drive couple from cups 96 to centre plate 99. The outer sides of bearing races 97 form cups 100 for inner plates 101 of the pedal cranks. Like substantially all parts of the bicycle, the cranks are also formed out of strips of sheet that have been flanged and drawn in the correct shape and connected with each other by means of interlocks.

Within cups 100 inner plates 101 have been forced out into cones 102 with another cone 103 in the opposite direction in the centre. Outer plates 104 of the cranks in the centre are provided with a cone 105, whose edges 106 are interlocked around cones 103. Now both cranks are combined with cups 96 and centre plate 99 into one unit with the aid of a bolt 107, with a head 108 and a nut 109, which fits in cones 105.

Centre plate 99 is star-shaped and bears straps 110 at its points, which hold fast links 111. The links 111 are coupled with bearing pins 112. An odd number of bearing pins 112 is provided, preferably five. Bearing pins 112 form the axles of planet gear wheel sets in each of which a small cog wheel 113 cooperates with a common toothed ring 114, which is fixed into a sleeve-shaped holder 115. The holder 115 is enveloped by a helicoidal spring 116, while a larger cog wheel 117, rotatable with the wheel 113 cooperates with a toothed ring 118, which is fixed in a sleeve-shaped holder 119, which is enveloped by a helicoidal spring 120. Cog wheels 113 and 117 may be made out of solid material, but may also consist of a plurality of sheets, the peripheries of which have been stamped into the shape of toothed wheels, which plates are connected robustly with each other. Toothed rings 114 and 118 are preferably made out of strips bent to form teeth.

The larger cog wheels 117 also cooperate with a central toothed ring 121, which runs on needles 122 running on the cup 96. Central toothed ring 121 is connected with

a V-section disc 123 in which runs endless driving cable 124, which goes to rear wheel 6 and lies at the same side of the centre part 1 of the main frame beam as the hinge 17—18 between the centre part 1 and rear part 2. Preferably, central toothed ring 121 consists of two parts of sheet, one part, which is corrugated to form teeth and furthermore extends conically outward to form one arm of the V-section disc 123 and another part which is cylindrical and forms the outer bearing ring for needles 122 and furthermore also extends conically outward and forms the other arm of V-section disc 123.

The connections between the toothed rings 114 and 118 and sleeve-shaped holders 115 and 119 and between the parts of central toothed ring 121 can be effected by soldering, but it is advisable that the cavities within the teeth are filled with non-compressible material, in order to prevent deformation. Helicoidal springs 116 and 120 are coiled around sleeve-shaped holders 115 and 119 to provide spring bias in one direction, one end of the springs being anchored in housing parts 92 and 91. Each helicoidal spring 116 and 120 can be replaced by two adjacent springs for the centering of a sleeve-shaped holder. The end of helicoidal coupling spring 116 belonging to toothed ring 114 with the smallest diameter with the last winding lies slightly clamping around holder 115. The other end of helicoidal coupling spring 120 is connected by a Bowden cable (not shown) to a handle 88 on handlebar system 13. Upon tightening the end of helicoidal coupling spring 120 sleeve-shaped holder 119 is held, but because of the difference in diameter of cog wheels 113 and 117, the toothed ring 114 starts rotating in a direction in which it releases helicoidal coupling spring 116, and holder 115 becomes freely movable in the latter. With this gear mechanism two speeds can be selected according to choice.

The cranks, which as has been described before, are composed of strips of sheet, an inner plate 101 being drawn into cones 102 and 103 at the pedal axle and an outer sheet 104 at that location only being equipped with a cone 105, at the pedal side have been provided with foldable pedals. On that side outer plate 104 has been deformed more and interlock 125, which connects both plates, consequently runs diagonally over the length of the crank from cups 100 as far as a bearing ring 126, which has been formed in outer plate 104. In this way interlock 125 having a triple material thickness contributes to the solidity and stability of the cranks in the places that are most heavily loaded.

In bearing ring 126 balls 127 run, which

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are held by a two-part inner bearing ring, consisting of a cup 128 and a washer 129, which are attached to each other by means of bolts 130. The outer side of cup 128 is square and to one side a plate spring 131 is attached, which ends in a hook 132. The opposite side of cup 128 is bent-over locally and provided with a slot-shaped eye 133. Through this eye a bent lug 134 of a pedal plate 135 passes. By punching out lug 134 and bending it a rim 136 is produced behind which hook 132 of plate spring 131 can engage and pedal plate 135 can be fixed in an unfolded position.

In the folded position of pedal plate 135, hook 132 engages behind eye 133 and a projection 137 of plate spring 131 presses treadle plate 135 right against cup 128, the sides of the pedal plate being enabled to fall on either side alongside interlock 125 and as a result being enabled to secure the pedal against rotation.

In wheel supports 5 and 8 respective wheels 6 and 9 have been provided. In the same way as the other parts, these wheels have been composed of rectangular strips of sheet secured together by interlocks. Each wheel rim is hollow and consists of a bent rim part 140 in which a rim part 141, also bent, has been provided. At the outer periphery both rim parts are interconnected with interlocks 142. In the rim part 141 a circumferential groove 143 is provided in which the attachment of the rim by spoke wires 144 to the hub plates is effected. In rim parts 140 and 141 corresponding openings 145 have been provided distributed over the circumference, through which loops of spoke wire 144 pass, which are held in cavity 143 by pins 146.

On a wheel axle 147, which can be fastened with nuts 148 in bores of the flat ends 76 of support member 75 cones 149 are situated on which balls 150 run, which have been enclosed in cups 151. Cups 151 are spaced from one another by a hub sleeve 152, which preferably has been made out of a coiled strip of sheet. Between cups 151 and hub sleeve 152 hub plates 154 are situated. Hub plates 154 are provided with bearing edges 155 in which openings 156 have been provided for loops of spoke wire 144. The hub plates are provided with a flanged edge 157 at the outer periphery. An additional hub ring 158 with lugs 159 is mounted on the rear wheel 6 and this hub ring, together with a hub plate 154 forms a V-notch pulley for driving cable 124, which comes from drive mechanism 11.

Before the wheel is manufactured, spoke wire 144 is coiled on an auxiliary device such as a flat rectangular plate, so that it is bent into loops in the right places. The loops are then alternately passed through

openings 145 of the rim and through openings 156 of hub plates 154, which latter lie right next to each other and have not yet been separated by hub sleeve 152. A loop in the rim is locked with a pin 146, a next loop is inserted into a hub plate 154 and locked with a pin 160, the next loop in turn is locked in the rim and the next loop in the other hub plate. When the wheel is completed, the ends of spoke wire 144 are locked in place. Because the loops have been bent previously, the spoke lengths are equal to each other and because each loop per se has been locked with a pin, spoke wire 144 cannot be pulled out. In case of a fracture in one of the spokes, the rest of the spokes do not become loose but remain under tension. The tension is only obtained, however, when in case of the completed wheel the hub plates are pulled from each other and separated by the introduction of hub sleeve 152. The latter, preferably, has been split or formed out of a coiled strip and is inserted through a central opening of a hub plate. When cups 151 are pressed into the hub sleeve, it is expanded and fixes hub plates 154 at the right mutual distance. Because the wheels have a rather small diameter, forcing hub plates 154 from each other produces sufficient tension in spoke wire 144.

The connection between pedal drive mechanism 11 and rear wheel 6 is formed by the driving cable 124. This cable 124 preferably, is of circular cross-section and preferably is manufactured of rubber or a plastic-coated steel core. On the one hand the cable 124 has been laid around disc 123 in the pedal drive mechanism 11 and through a slit 161 in housing part 91 emerges to the outside and on the other hand has been laid around the pulley formed by flanged edge 157 of hub plate 154 and hub ring 158.

The drive cable between pedal drive mechanism 11 and rear wheel 6 lies to one side of central axis 14 of the frame beam below hinge joints 17 and 18. A driving cable of circular cross-section 124 is used because it can bend in all directions. When rear part 2 is swung the driving cable is doubled up. So as to support cable 124 in so doing, below hinge joint 18 at centre part 1 of the frame beam a hooked guide pin 162 is provided. As a result, the bent loops of driving cable 124 are caught and the possibility that the cable falls out of the pulleys becomes very slight. In the in-use position of the frame beam it is of importance that driving cable 124 is also under the correct tension and therefore, at pedal drive mechanism 11 a tensioning roller 163 on a lever 164 has been provided, which roller has been springingly attached in housing part 91.

Under pedal drive mechanism 11 an additional stand has been provided whose legs 166 in the folded position are parallel to the frame beam but in the unfolded position are spread. They have been mounted in projections 167 of housing parts 91 and 92 and provided with a stop 168, which in the unfolded position rests against housing parts 91 and 92. The stand is made of spring steel wire, which is sufficiently stiff to keep the bicycle upright but bends away under greater load so that the pedal drive mechanism 11 is not overloaded or deformed.

On the rim of each wheel lies a tyre 170 of rubber or plastics which is normally flat, but is bent when compressed between interlocks 142 of rim parts 140 and 141. The tyre 170 has a tread comprising four circumferential ribs 171 with grooves 172 between them. When the tyre is in unloaded condition, grooves 172 are open but when the tyre is loaded and bears on the ground, the tread is depressed. This means that grooves 172 become narrower and the tyre 170 is pressed flatter into rim cavity 143. The tyre can be endless but also have been manufactured as an extruded strip, the ends of which are joined together by a butt weld.

If the application of a butt weld is difficult, the strip coiled around the rim can be secured by means of circumferential wires arranged in slits 172. Slits 172 have the drawback that they can get filled with dirt so that the flexibility of the tyre can be lost or strongly reduced. A solution for this is to provide, instead of slits 172, in the inner part of the strip cavities that are closed under load.

Finally in Figure 9 an additional detail is given of the attachment of wheel support 8 to beam 7 at the location of handlebar system 13. Side plates 69 and 70 of beam 7 at the lower ends thereof run together with interlocks 73 of wheel support 8 to form bushes 42 formed in strips 71, 72, which are hollow and bent according to the curvature of the interlock. In each bush 42, a leg of a strap 43 has been inserted whose other leg is straight and forms the hinge for side plate 44 because this latter leg is inserted in a bush 89, which has been mounted at the lower end of side plate 44.

At the upper end of beam 7, side plates 69 and 70 join each other and form a bush 41, which forms the upper end of beam 7. The side plates are held in bush 41 because in the cavity of the bush a pin 40 has been driven. A protruding part of the latter forms eye 36, which holds the upper part of pin 38. Then hinge part 37 is enclosed between eye 36 and cup 39.

The attachment of rear wheel support 5 is effected in a similar way, the side plates of

part 2 together with interlocking 73 inserted in bent bushes 29 and fixed with a pin.

Extension 30, too, which at the upper end has been provided with a flattened end 34, can be provided with a bush in which saddle pin 35 is rotatable. Hinge part 37 of front part 3 of the frame beam can also be provided with a bush which supports pin 38.

It may be advisable to fill all hollow parts of the bicycle with a rigid plastics foam so that very thin sheet can be used, while formation of rust in the interior is avoided and also any resonating of the sheet material is prevented.

WHAT I CLAIM IS:—

1. A folding bicycle having a main frame beam comprising three parts, a centre part of which has a saddle supporting beam mounted therethrough so as to be slidable upwardly and downwardly, and front and rear parts of which are connected to wheel supports on which are supported wheels, which front and rear parts are hingeable with respect to the centre part, so that in the folded position the wheels lie either side of the centre part and parallel to each other, the parts of the main frame beam being made out of rectangular strips of sheet which are folded and bent and have adjacent edges secured together by interlocking portions thereof to form hollow members, wherein when the bicycle is in the folded position, with the saddle supporting beam in its lowest position, the lower end of the saddle supporting beam and the wheels form a stable, ground-engageable three-point support for the saddle, a pedal drive mechanism being mounted on the centre part and a drive from the mechanism to the rear wheel comprising a driving cable which is mounted at the same side of centre part as the hinge between the centre part and the rear part.

2. A folding bicycle according to claim 1, wherein the distance between the hinges between the centre part and the front and rear parts is equal to the sum of the distances from respective hinges to the axles of the adjacent wheels so that in the folded position the axles of the wheels are co-axial.

3. A folding bicycle according to claim 1 or 2, further comprising a tensioning device which can be locked in the non-folded position so as to tension the frame parts and fix the saddle supporting beam.

4. A folding bicycle according to any preceding claim, having a handlebar system comprising four parts, two lower parts of the handlebar system being connected hingeably with an upwardly extending beam which at a rear side is attached hingeably to the front frame beam part for



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Under pedal drive mechanism 11 an additional stand has been provided whose legs 166 in the folded position are parallel to the frame beam but in the unfolded position are spread. They have been mounted in projections 167 of housing parts 91 and 92 and provided with a stop 168, which in the unfolded position rests against housing parts 91 and 92. The stand is made of spring steel wire, which is sufficiently stiff to keep the bicycle upright but bends away under greater load so that the pedal drive mechanism 11 is not overloaded or deformed.

On the rim of each wheel lies a tyre 170 of rubber or plastics which is normally flat, but is bent when compressed between interlocks 142 of rim parts 140 and 141. The tyre 170 has a tread comprising four circumferential ribs 171 with grooves 172 between them. When the tyre is in unloaded condition, grooves 172 are open but when the tyre is loaded and bears on the ground, the tread is depressed. This means that grooves 172 become narrower and the tyre 170 is pressed flatter into rim cavity 143. The tyre can be endless but also have been manufactured as an extruded strip, the ends of which are joined together by a butt weld.

If the application of a butt weld is difficult, the strip coiled around the rim can be secured by means of circumferential wires arranged in slits 172. Slits 172 have the drawback that they can get filled with dirt so that the flexibility of the tyre can be lost or strongly reduced. A solution for this is to provide, instead of slits 172, in the inner part of the strip cavities that are closed under load.

Finally in Figure 9 an additional detail is given of the attachment of wheel support 8 to beam 7 at the location of handlebar system 13. Side plates 69 and 70 of beam 7 at the lower ends thereof run together with interlocks 73 of wheel support 8 to form bushes 42 formed in strips 71, 72, which are hollow and bent according to the curvature of the interlock. In each bush 42, a leg of a strap 43 has been inserted whose other leg is straight and forms the hinge for side plate 44 because this latter leg is inserted in a bush 89, which has been mounted at the lower end of side plate 44.

At the upper end of beam 7, side plates 69 and 70 join each other and form a bush 41, which forms the upper end of beam 7. The side plates are held in bush 41 because in the cavity of the bush a pin 40 has been driven. A protruding part of the latter forms eye 36, which holds the upper part of pin 38. Then hinge part 37 is enclosed between eye 36 and cup 39.

The attachment of rear wheel support 5 is effected in a similar way, the side plates of

part 2 together with interlocking 73 inserted in bent bushes 29 and fixed with a pin.

Extension 30, too, which at the upper end has been provided with a flattened end 34, can be provided with a bush in which saddle pin 35 is rotatable. Hinge part 37 of front part 3 of the frame beam can also be provided with a bush which supports pin 38.

It may be advisable to fill all hollow parts of the bicycle with a rigid plastics foam so that very thin sheet can be used, while formation of rust in the interior is avoided and also any resonating of the sheet material is prevented.

WHAT I CLAIM IS:—

1. A folding bicycle having a main frame beam comprising three parts, a centre part of which has a saddle supporting beam mounted therethrough so as to be slidable upwardly and downwardly, and front and rear parts of which are connected to wheel supports on which are supported wheels, which front and rear parts are hingeable with respect to the centre part, so that in the folded position the wheels lie either side of the centre part and parallel to each other, the parts of the main frame beam being made out of rectangular strips of sheet which are folded and bent and have adjacent edges secured together by interlocking portions thereof to form hollow members, wherein when the bicycle is in the folded position, with the saddle supporting beam in its lowest position, the lower end of the saddle supporting beam and the wheels form a stable, ground-engageable three-point support for the saddle, a pedal drive mechanism being mounted on the centre part and a drive from the mechanism to the rear wheel comprising a driving cable which is mounted at the same side of centre part as the hinge between the centre part and the rear part.

2. A folding bicycle according to claim 1, wherein the distance between the hinges between the centre part and the front and rear parts is equal to the sum of the distances from respective hinges to the axles of the adjacent wheels so that in the folded position the axles of the wheels are co-axial.

3. A folding bicycle according to claim 1 or 2, further comprising a tensioning device which can be locked in the non-folded position so as to tension the frame parts and fix the saddle supporting beam.

4. A folding bicycle according to any preceding claim, having a handlebar system comprising four parts, two lower parts of the handlebar system being connected hingeably with an upwardly extending beam which at a rear side is attached hingeably to the front frame beam part for

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steering purposes and at its lower end is
connected with the front wheel support,
said lower parts of the handlebar system
being foldable downwardly on either side of
5 the front wheel support, two upper parts of
the handlebar system being permanently
intercoupled by hingeably interconnected
coupling straps which in the unfolded
10 position are lockable so as to fix the parts of
the handlebar system, while the handlebar
system is such that in the folded position
handle grips of the handlebar system lie
parallel to each other and by the sides of
15 the upper end of said upwardly extending
beam.

5. A folding bicycle according to claim 4,
wherein two bearing frames are connected
hingeably to respective lower parts of said
handlebar system and can be locked with
20 the upper end of the said upwardly
extending beam so as to form a parcel
carrier.

6. A folding bicycle according to claim 1,
wherein the pedal drive mechanism is
25 mounted in a housing comprising two
annular housing parts each of which is
provided at the inner periphery thereof
with a ball bearing race and at the outer
periphery with a screwthread, and the pedal
30 axle is formed of two cups provided with
respective ball bearing races, which cups
are connected to each other and lie to
either side of a centre plate and, together
with pedal crank arms are connected into a
35 single unit by a bolt and nut, the crank arms
being formed out of two flanged strips
interconnected along line at an angle to the
length of the arms.

7. A folding bicycle according to claim 6,
40 wherein at least one planet gear wheel is
coupled to the centre plate, which wheel

runs around a toothed ring bearing on one
of the cups and connected with a pulley and
also runs within a toothed ring mounted in a
sleeve-shaped holder that can be held
45 against rotation with respect to one of the
housing parts by a helicoidal spring coiled
around the holder and connected to the
said one of the housing parts.

8. A folding bicycle according to claim 7,
50 wherein a second planet gear wheel having
a smaller diameter than the first planet gear
wheel is rotatable with the first planet gear
wheel, the second planet gear wheel
running in a second toothed ring and having
55 a smaller diameter than the first toothed
ring which second toothed ring is mounted
in a second sleeve-shaped holder which is
held against rotation with respect to the
housing by a helicoidal coupling spring
60 coiled around the holder and connected to
the housing, the first helicoidal coupling
spring being operated from outside of the
housing.

9. A folding bicycle according to any
65 preceding claim, wherein the wheels are
produced by winding a spoke wire around a
rectangular plate to form loops in the wire,
which loops are then inserted into openings
70 in the wheel rim and into openings in hub
plates, and held in place by means of pins.

10. A folding bicycle substantially as
herein described with reference to the
accompanying drawings.

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