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(54) **Title**: IMPROVED ALL-TERRAIN BOARD OR MOUNTAINBOARD

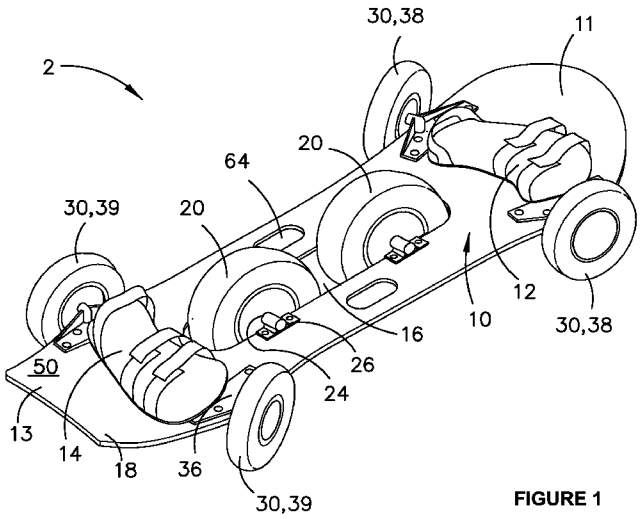


FIGURE 1

(57) **Abstract**: A vehicle (2) for travelling across ground (4). The vehicle (2) includes two or more inline wheels (20), other wheels (30) and structure (10). The inline wheels are spaced in a direction of travel. The other wheels include two forward wheels (38), spaced laterally from and forward of the inline wheels, and two rearward wheels (39), spaced laterally from and rearward of the in-line wheels (20). The structure carries the wheels (20,30) and defines respective forward and rearward foot supporting portions (12,14) forward and rearward of the inline wheels (20). The wheels (20,30) are arranged such that when the vehicle (2) is in a neutral orientation, the inline wheels (20) bear on the ground (4) and the other wheels (30) clear the ground (4), and the vehicle (2) is manipulable by a user standing on the foot supporting portions (12,14) to bring one or more of the other wheels (30) into contact with the ground (4) to steer the vehicle (2). The structure (10) is shaped to receive the inline wheels (20) whereby when the vehicle (2) is in a neutral orientation the foot supporting portions (12,14) are below an upper extent of the inline wheels (20).

IMPROVED ALL-TERRAIN BOARD OR MOUNTAINBOARD

FIELD OF THE INVENTION

This invention relates to vehicles for travelling across ground such as personal sports vehicles in the form of all-terrain boards, also known as mountainboards, used for recreational purposes on a variety of ground surfaces, including natural surfaces such as sand, grass and dirt, and man-made surfaces such as streets, concrete ramps, half pipes and the like. Preferred variants of such vehicles may be used on flat or level ground and are also capable of traversing sloped ground surfaces, and rough and irregular terrain, as may be encountered on a natural field or hill. The invention also relates to decks for such vehicles.

BACKGROUND

All-terrain, or mountain, boarding surfaces include border cross tracks, slope style parks, grass hills, fields, woodlands, gravel tracks, streets, skate parks, ski resorts, BMX courses and mountain bike trails.

Mountain boarding is a sport developed as a summer alternative to snowboarding. The sport can be carried out on sloped terrain, or on substantially level terrain such as fields and streets. Thus reference herein to mountainboards or mountain boarding is a reference also to all-terrain boards or all-terrain boarding. Users may participate in a variety of sport styles, including free-style and performing tricks.

Commercially available prior art mountainboards have many similarities to a skateboard. They consist of a deck structure to which is attached forward and rearward wheel mounting structures known as “trucks”. Each truck supports a pair of wheels. On a traditional skateboard, the wheels are relatively small, and positioned below the deck such that they do not protrude beyond each side of the deck. On the

prior art mountainboard however, the wheels are mounted on wider axles such that each pair of wheels is laterally spaced wider than the width of the deck. This enables larger wheels to be used, improving the ability of a mountainboard to cope with rough terrain, holes, ruts and the like when compared to a traditional skateboard. Optionally, a braking arrangement is provided.

As with a skateboard, the mountainboard trucks are rotatable enabling the axle supporting each pair of wheels to be steered or turned relative to the longitudinal axis of the mountainboard, the user steering the mountainboard by adjusting his/her weight distribution.

Users of a snowboard stand with their feet approximately transverse to the longitudinal axis of the board which corresponds to the forward or rearward direction of travel. The bottom surface of the board glides across a snow surface. Basic forward or backward movement is also called gliding, and is achieved on a slope by leaning body weight forward. Both the front and rear ends of a snowboard are upturned, enabling the board to more easily slide over uneven snow, whether forward or rearward. Lateral sliding is also possible. A rider can adjust his/her weight such that the board can slide forward, backward, sideways or some amount in each direction as is side slipping using a longitudinal edge of the board approximately perpendicular to the fall line of a slope, such that the direction of travel is perpendicular the longitudinal axes of the snowboard.

The longitudinally extending side edges of the board have a thin steel edge strip, which enables the board to engage, grab or dig in to hard snow and ice in a manner similar to the blades of an ice skate, known as carving. In this carving mode of travel a turn is made around an arc. It is one of the most enjoyable aspects of snowboarding.

To perform a carving turn, the user places his/her weight over the carving edge of the board, laterally tilting the snowboard. As the snowboard leans onto its side edge, it turns in an arc equivalent to the radius of the board's edge or side cut.

Where the turn is “clean”, it is referred to as carving involving little or no lateral slippage or skidding. Where the turn is not “clean”, the forward and rearward ends of the board may make turns of different radius and result in slipping or skid turning. In a skidded turn the rear of the snowboard follows a different path than the front of the snowboard causing the skid action.

In a skid turn, the board is longitudinally tilted, that is one end of the board is raised at a higher angle than the other which in conjunction with lateral tilting causes it to bite into snow a little more than the other end, causing the higher end to slow down and forcing a rotation of the board.

A much higher speed is achieved in a carved turn than for a skid turn. A carved turn is made using the edge of a snowboard rather than “twisting” the board with lateral and longitudinal tilt as done for a skidded turn. The sound and feel of a carved turn is very different from a skid turn and is more enjoyable.

A pivot turn is where a board is turned around a pivot point on the snowboard, typically at the front foot supporting portion. By longitudinally tilting the board to raise one end, it becomes easier for a user to rotate the board relative to the ground. Thus, modes of travel on a snowboard include longitudinal and lateral sliding, skidding, carving and pivot turns.

The present inventor has recognised deficiencies in existing vehicles.

On a mountainboard, the wheels are intended to emulate the carving edge of a snowboard. A user can adjust distribution of his/her weight to steer the wheel trucks and/or try to laterally tilt the board or deck. However, prior art mountainboards and skateboards do not allow tilting of the board deck in the longitudinal direction. At high speed the mountainboard becomes unstable, known as “speed wobble” due to the rotatable trucks and a general lack of stability. Turning can be difficult with the wide lateral spacing between the left side wheels and right side wheels. Thus travel is primarily longitudinal, with turning enabled by rotatable trucks.

To achieve a quick or tight turn, a user may need to lift the wheels on the left or right side of a board off the ground by lateral tilting.

Once wheels on one side of the board have been raised off the ground, stability is adversely affected as the wheels are mounted on rotatable trucks, and the board is supported by one track (left or right side) of wheels rather than two tracks. As this shift can be very sudden, minor movement can rotate the trucks and affect stability in a manner that would not have affected the board when riding on two tracks. The board becomes far more volatile to handle and the transition to the volatile state is sudden.

Such mountainboards are very reactive or jerky, as they can initially remain stable in lateral tilting or a turn, but then become suddenly uncontrollable and unstable within very little additional tilt. Many manoeuvres performed on a snowboard cannot be achieved on such a mountainboard, because it is very difficult to obtain longitudinal tilting of the deck.

It is desirable to provide an improved mountainboard, which more closely resembles the characteristics of a snowboard or at least to provide an alternative.

Any reference to prior art in this specification is not, and should not be taken as, an acknowledgement or admission that the prior art forms part of the common general knowledge of a person skilled in the relevant art or could reasonably be expected to be ascertained, understood or regarded as relevant by a person skilled in the relevant art.

SUMMARY

In a first aspect of the invention, there is provided a vehicle for travelling across ground, the vehicle including:

- two or more inline wheels spaced in a direction of travel;
- other wheels including:

- two forward wheels spaced laterally from and forward of the inline wheels;
- two rearward wheels spaced laterally from and rearward of the inline wheels; and
- structure carrying the wheels and defining respective forward and rearward foot supporting portions forward and rearward of the inline wheels;

the wheels being arranged such that:

- when the vehicle is in a neutral orientation the inline wheels bear on the ground and the other wheels clear the ground; and
- the vehicle is manipulable by a user standing on the foot supporting portions to bring one or more of the other wheels into contact with the ground to steer the vehicle;

the structure being shaped to receive the inline wheels whereby when the vehicle is in the neutral orientation the foot supporting portions are below an upper extent of the inline wheels.

Preferably, the inline wheels each have a respective axis of rotation and said foot supporting portions are below said inline wheels axes of rotation. Optionally, said other wheels each have a respective axis of rotation and said foot supporting portions are below said other wheels axes of rotation.

It is desirable that the structure includes one or more voids for receiving said inline wheels whereby said inline wheels extend beyond upper and lower surfaces of said structure. Optionally, one or more reinforcing portions may be attached to the structure to reinforce the structure.

Preferably, the other wheels are angled relative to said direction of travel. By way of example, the forward and/or the rearward wheels may be angled between 1 to 30 degrees relative to said direction of travel.

The vehicle may further include a respective axle for each of said inline wheels wherein said inline wheel axles are mounted above a top surface of said structure. The vehicle may further include a respective axle for each of said other wheels wherein said other wheel axles are mounted above a top surface of said structure. The other wheel axles may be stub axles.

Preferably the vehicle further includes an adjustable mounting arrangement for adjusting positioning of one or more of said wheels. The forward foot supporting portion is preferably rearward of said two forward wheels and said rearward foot supporting potion is preferably forward of said two rearward wheels.

The structure may be or include an elongate deck.

It is preferred that the inline wheels are of larger diameter than said other wheels.

Another wheel may be arranged inline with the two or more inline wheels and arranged such that when the vehicle is in a neutral orientation the two or more inline wheels bear on the ground and said another wheel clears the ground.

Preferably, bindings are respectively associated with the foot supporting portions.

A second aspect of the invention provides a mountainboard for travelling across ground, the mountainboard including:

- a deck having a forward and a rearward foot supporting portion for supporting respective feet of a user;
- a plurality of loadbearing wheels for supporting the deck, the loadbearing wheels arranged inline and spaced in a direction of travel; and
- a plurality of control wheels supported by the deck, the respective control wheels each laterally spaced from said loadbearing wheels;

wherein, when the mountainboard is in level orientation, at least one of said plurality of loadbearing wheels protrudes above the forward or the rearward foot

supporting portion, and at least one of said plurality of loadbearing wheels protrudes below at least one of said plurality of control wheels, whereby a user may control the mountainboard by adjusting his/her weight to control the force applied through each wheel to the ground.

A third aspect of the invention provides a vehicle for travelling across ground, the vehicle including:

- at least a forward and a rearward inline wheel spaced in a direction of travel;
- other wheels including:
  - two forward wheels spaced laterally from and forward of the inline wheels;
  - two rearward wheels spaced laterally from and rearward of the inline wheels; and
- structure carrying the wheels and defining respective forward and rearward foot supporting portions forward and rearward of the inline wheels;

the wheels being arranged such that:

- when the vehicle is in a neutral orientation the inline wheels bear on the ground and the other wheels clear the ground; and
- the vehicle is manipulable by a user standing on the foot supporting portions to bring one of the forward or rearward inline wheels clear of the ground whereby the user may pivot the vehicle on the other of the forward or rearward inline wheels;

the structure being shaped to receive the inline wheels whereby when the vehicle is in the neutral orientation the foot supporting portions are below an upper extent of the inline wheels.

A fourth aspect of the invention provides a deck to which wheels and wheel mounting structures are attachable to form a vehicle.

Also disclosed is a structure for assembly into a vehicle as hereinbefore described, the structure adapted to carry an arrangement of:

two or more inline wheels spaced in a direction of travel, and other wheels including two forward wheels spaced laterally from and forward of the inline wheels and two rearward wheels spaced laterally from and rearward of the inline wheels whereby when the vehicle is in a neutral orientation the inline wheels will bear on the ground and the other wheels will clear the ground such that the vehicle will be manipulable by a user standing on the foot supporting portions to bring one or more of the other wheels into contact with the ground to steer the vehicle;

the structure defining respective forward and rearward foot supporting portions and shaped to receive the inline wheels whereby when assembled as a vehicle in a neutral orientation the foot supporting portions will be below an upper extent of the inline wheels. Further preferred aspects of the invention may be as defined in the dependent claims annexed hereto, which claims are hereby made part of the disclosure of this invention by this reference thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the apparatus will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a mountainboard according to the present invention;

Figure 2 is a top plan view of the mountainboard of Figure 1;

Figure 3a to Figure 3f are, respectively, the top view, bottom view, side view, other side view, front view, and rear view of the mountainboard of Figure 1;

Figures 4a to 4f are, respectively, the top view, side view, front view, other side view, rear view and bottom view of a stub axle and mounting bracket for use with the invention of Figure 1;

Figures 5a to 5f are, respectively, the top view, side view, front view, other side view, bottom view and rear view of a mounting bracket for the central or inline wheels of the mountainboard according to Figure 1;

Figure 6a is a perspective view of an alternative embodiment of the invention and Figure 6b is a top plan view of the embodiment of Figure 6a;

Figure 7a shows a mountainboard in which the front and rear ends are curved upwards and Figure 7b shows a board in which the front end is curved upwards to a greater degree than and from a different position on the board than the mountainboard of Figure 7a;

Figure 8a shows a mountainboard having a housing or mud guard receiving the inline wheels and a rail slider attached to the bottom of the deck;

Figure 8b shows a mountainboard having differently sized inline wheels; and

Figure 9 shows a mountainboard having an alternative structure to a single piece planar deck.

DESCRIPTION OF AN EMBODIMENT

Figures 1, 2 and 3a to 3f show a personal non-motorised sports vehicle, being a mountainboard according to a preferred embodiment of the invention. The mountainboard 2 is shown in a neutral orientation with respect to the ground 4. The mountainboard 2 has a structure 10 defining forward 12 and rearward 14 foot supporting portions located respectively at the forward 11 and rearward 13 ends of an elongate deck 50. The foot supporting portions may have foot straps or bindings as shown to receive a user's foot, or could simply be surfaces upon which a user may stand. Preferably snowboard style bindings are provided (not shown).

The structure 10 is shaped with a void 16, in the form of a through hole, for receiving a pair of loadbearing or inline wheels 20 such that, when the vehicle is in a neutral orientation as shown in Figures 3a to 3f, the foot supporting portions 12,14 are

below the upper extent, or top surface, of the inline wheels 20; i.e. at least a portion of the wheels 20 is above the foot supporting portions 12,14. The wheel portion may be a very small portion of a wheel, but is preferably about half of each wheel as illustrated. Thus a user can have a relatively low centre of gravity for a given wheel diameter, enabling use of larger wheels than on a skateboard with traditional trucks.

Figure 2 shows the inline wheels 20 spaced apart along a direction of travel in a straight line or forward direction d_s which in this embodiment is coaxial with a longitudinal centreline of the mountainboard 2. The inline wheels could, however, be laterally spaced from the mountainboard centreline in other embodiments, not shown. The mountainboard 2 includes other wheels 30 spaced laterally from the inline wheels 20. These other wheels 30 include a pair of forward wheels 38 and a pair of rearward wheels 39. The forward wheels 38 are spaced forward of the inline wheels 20, that is the axes of rotation 32 or axles 34 of forward wheels 38 intersect the longitudinal centreline of the mountainboard 2 at a location further towards the forward end 11 of the mountainboard than the axes of rotation 22 or axles 24 of the inline wheels 20. Similarly, the rearward wheels 39 are spaced rearward of the inline wheels 20.

The other wheels 30 are mounted on wheel mounting structures including stub axles 34. Advantageously, use of stub axles 34 allows more room for foot supporting portions 12,14 so that a user may stand with a forward foot between the forward pair of other wheels and a rearward foot between the rearward pair of other wheels if desired. Such a stance would be much more difficult if a single axle carried a pair of the wheels.

In the embodiment shown, the stub axles 34 are fixed to the structure 10 and thus the other wheels 30 have a fixed direction of rotation. The inline wheels 30 are mounted on straight axles 34 and thus also have a fixed direction of rotation, unlike the wheels of a traditional skateboard which may be mounted on trucks that may both rotate and tilt relative to the board structure.

The structure and wheels of the mountainboard 2 are arranged such that as seen in Figures 3a to 3f, when the vehicle is in a neutral orientation the loadbearing inline wheels 20 bear on the ground 4, while the other wheels 30 are supported by the structure 10 clear of the ground 4. The vehicle is thus manipulable by a user standing on the foot supporting portions 12,14 to laterally tilt the structure 10 to bring one or more of the other wheels 30 (also referred to herein as control wheels) into contact with the ground 4 in order to control or steer the vehicle 2. This arrangement can be achieved in a variety of configurations, depending for example on: the shape of the structure 10; any differences in height of wheel mounting positions; use of wheel mounting brackets, blocks and the like to adjust axle heights; and relative differences in wheel diameters. Preferably each wheel is a pneumatic rubber tired wheel. In a preferred embodiment, the tyres are narrow, high pressure tyres that provide a small contact area as they bear on the ground, but width and pressure may be varied to suit terrain or user.

Figure 2 shows the inline wheels 20 which, when they are the only wheels bearing on the ground 4, roll the mountainboard 2 in a straight line in a forward direction of travel d_s. The right hand pair of other wheels 30 are mounted at a slip angle α to the inline wheels 20. In this embodiment both the forward and rearward right hand other wheels 30 have the same slip angle, and are mounted to match with a cut-out 52 in the deck 50, on an arc of radius r, such that the right hand other wheels 30 may turn the mountainboard 2 along the arc of radius r when they bear on the ground 4. The forward right hand other wheel 38 rotates in the tangential direction d_t.

The slip angle α mentioned above can also be referred to as the steering angle, or toe in/ toe out. The slip angle α of the outer wheels initiates turning, and will affect how tightly a turn can be made.

When the mountainboard 2 operates with only the central inline wheels 20 bearing on the ground 4 it will move in a straight line d_s. If the mountainboard 2

operated with only the right hand other wheels 30 bearing on the ground 4 it would travel along the arc of radius r. Where the mountainboard 2 operates with both inline and right hand outer wheels 20, 30 bearing on the ground, and thus on two different wheel tracks, the direction of travel will be somewhere between the vectors d_s and d_t, depending on the force acting through each of the wheels 20, 30 in contact with ground 4 and turns of large or small radius may be achieved.

A user may select from the three wheel-tracks that are available. This can be particularly advantageous when traversing a steep slope. Most usually, a user selects between travel on the central inline wheel-track and travel on both the central track and either left or right outer tracks.

The mountainboard 2 has several modes of travel, analogous to or closely mimicking the modes of travel of a snowboard. The other or outer wheels mimic a snowboard edge, while the inline centre wheels mimic a snowboard deck.

The first mode of travel is akin to gliding or sliding on a snowboard in a forward or straight ahead direction (or in a rearward straight backwards direction). The mountainboard 2 is supported solely by the load bearing or central inline wheels 20 as it rolls forward in a straight line in the direction of travel d_s. It can also roll backward in a straight line. In this case, the mountainboard 2 is in a neutral orientation when on level ground, with both inline wheels 20 in contact with the ground while the structure 10 (hereinafter also referred to as the deck 50) is not tilted in a lateral direction and the other wheels 30 thus clear the ground 4.

To achieve a second mode of travel and in order to obtain a lateral gliding or sliding component to the movement, which may include skid steering, a user may turn the mountainboard 2, by shifting his/her weight in a lateral direction to the left or right side. As the mountainboard 2 is laterally tilted, the laterally spaced or offset other wheels 30 are brought into contact with the ground 4 on either the left or right side respectively.

Skidding and skid steering or skid turning may occur where the front and rear of the mountainboard 2 are moving on a different radius turn, as occurs for snowboards.

As the mountainboard 2 is even further laterally tilted, to a user it appears to move from the second mode of travel to a third mode of travel in which substantially most or all of the user's weight acts through either the left or the right other wheels 30, such that the other wheels 30 engage with the ground to provide a smooth carving action in which the mountainboard 2 travels on an arc of constant radius r, with the forward one of the other wheels 38 rotating in a tangential direction d_t. In practice, a light contact between the ground and inline wheels 20 is maintained, and the mountainboard remains controllable as, the mountainboard 2 turns on radius r resulting in a smooth arc carving turn mimicking a carving turn on a snowboard. The "carving" turn is thus a form of skid steering in which the inline wheels provide lateral stability but little impact on the turn or feel of the motion. In some circumstances turns of even tighter radius than "r" can be achieved. Once all weight has been transferred onto the outer wheels 30, such that the inline wheels are raised above the ground 4, control can be lost and generally this state is only achievable for a moment before the inline wheels again contact ground. The third mode of travel is thus forward (or rearward) movement in the direction d_t, but due to the turning action, actually along the arc of radius r, with a user's weight acting significantly but not exclusively on a single wheel track of either the left or right other wheels.

Thus the first mode of travel is forward (or rearward) movement in the direction d_s on a single or inline wheel track in a straight line, with a sliding or gliding feel. The second mode of travel has a lateral component with wheels rolling along two tracks – the track of inline wheels 20 and either the left or right other wheels 30. It is still with a sliding or gliding feel but also may involve skidding or skid steering. The third mode of travel is a carving turn, with limited input from the inline wheels and a "feel" of being on a single wheel track being the left or right other wheels.

A major advantage of at least a preferred form of the present invention is that the transition between the first, second and third modes of travel is very stable and smooth, so that a user can readily control the required speed and sharpness of a turn by smoothly altering the degree of lateral tilt (or possibly longitudinal tilt) of the mountainboard 2. For improved turning and transition between the first, second and third modes of travel, the other wheels 30 are mounted at a slip angle α relative to the angle of the inline wheels 20. As the other wheels 30 bear on the ground 4 the inline wheels 20 have an opposing slip angle resulting in a sliding or skidding effect. This creates the smooth turning transition when a user laterally tilts the board side to side.

This ability to change modes of travel and to introduce lateral gliding or sliding movement (or slipping and skidding movement) is provided by the alignment of the inline and other wheels.

In an alternative embodiment, not shown, the stub axles of the other wheels could be mounted to the structure via a swivel connection, in conjunction with a return mechanism such as a return spring, or a latching arrangement. In normal use, the stub axle behaves as a fixed axle, giving the other wheel a fixed direction of rotation and thus a fixed slip angle between other wheel and inline wheels. However, in use beyond a predetermined force level, the stub axle is able to pivot or rotate to alter the slip angle and thus to adjust handling characteristics of the mountainboard. As the in-use force level decreases, the stub axle returns to its original slip angle and original handling characteristics. This can be useful for trick riding.

Discussions herein regarding direction and force must be considered in light of variations in terrain smoothness, the slope or gradient of terrain and the direction of travel across the ground of that terrain, as this will have impact upon forces acting on the mountainboard. For example, to achieve straight line travel transverse the slope of a hill, it may be appropriate and necessary to have four wheels in touch with the ground with some of the user's weight balanced over the left or right pair of other wheels.

Other factors affecting the forces and direction of travel will include the various positions at which each wheel can be mounted, for example mounting the outer other wheels with closer spacing will provide a shorter radius and the ability to make a tighter carving turn.

While the above configuration provides significant advantages enabling modes of travel very similar to a snowboard, there is yet a further advantage resulting from the configuration.

Provision of two or more inline wheels enables pivot turns to be made on either the front or the rear inline wheel. That is, a pivot turn around the point contact of one wheel 20 with the ground 4 may be made. This can be achieved by a user adjusting weight to obtain a longitudinal tilt of the board between front 11 or rear 13 ends. Tilting longitudinally raises one of the inline wheels 20 clear of the ground 4 and with appropriate lateral application of force a user rotates the off ground end of the mountainboard 2 in the desired direction, the mountainboard 2 turning about the ground engaging inline wheel 20 as the pivot point. This is thus a fourth mode of travel or at least a mode of turning.

This ability to make a pivot turn on the mountainboard 2 closely mimics the similar ability of a snowboard. Thus the provision of two inline wheels 20 gives two advantages – the ability to make pivot turns around a forward or rearward end of the mountainboard 2, as well as the increased stability provided by multiple wheels mounted inline, when travelling at high speed in a straight line.

It is speculated, but the invention is not thereby bound by this theory, that the two or more inline wheels act as points of contact with similarity to the cambered shape of many snowboards which provides a “rocker” between front and rear ends. The lower surface of a snowboard in a common form has an overall convex shape, with raised front and rear ends, and a concave area in the central zone of the board, creating two contact points with the ground when the board is in a neutral orientation. The level of curvature, whether convex or concave, is varied according to the

intended purpose of use (for example free ride, racing, carving etc,) but the important aspect noted is that the contact points with ground provided by the two inline wheels 20 tend to mimic the contact points provided on such snowboards. The ability to make pivot turns as discussed above provides a highly manoeuvrable mountain boarding experience of great similarity to snowboards.

Pivot turns, end stands and end spins can also be achieved using the front or rear tip end of the mountainboard, as with trick riding of skateboards and the like.

Also of interest in the embodiment of the present invention is that provision of large wheels (compared to skateboard wheels) for the inline or central wheels 20 enables transit of extremely rough ground, and that it is the provision of these wheels protruding through a void or voids 16,17 in the deck 50 that enables the mountainboard 2 and user to have a useful, low centre of gravity. Were the user to place his/her feet at a height above the full diameter of the large inline wheels the vehicle would be unstable. The shape of the structure 10 or deck 50 is thus important. Lowering the centre of gravity by providing the voids ensures a more stable ride in each of the modes of travel, again mimicking a snowboard where the deck of the board has its lower surface actually in contact with the ground. Of course for a mountainboard this is not practicable due to the rough terrain and the ground surface not having the slipping quality of snow, but the board may be lowered as far as practical to suit given terrain.

Importantly, the inline wheels 20 are mounted on fixed straight axles 24 and have a fixed direction of rotation or travel, rather than on skateboard trucks. Provision of two large inline wheels 20 on fixed axles reduces or avoids “speed wobble”. Used in conjunction with fixed axles 34 for the other wheels 30, the mountainboard has improved turning and turn transition stability, unlike skateboards using a “steerable” skateboard truck, as the inline wheel rotates always in the direction d_t and is thus a known factor. Stub axles also reduce overall rigidity of the mountainboard 2, as each

stub axle provides flexing or independent suspension to its wheel, as the wheels are not mounted in pairs to a rigid axle.

Yet a further advantage in providing two inline and centrally located wheels is that while the mountainboard operates on four wheels, that is, on two wheel-tracks, one in the direction d_s and the other along arc of radius r, the lateral spacing of the two wheel-tracks is narrower than for a prior art mountainboard of similar deck width operating on all four outer wheels. The ability to obtain lateral leverage across the board is improved by the closer spacing of available wheel tracks and improves the ability to make tight turns, yet retains stability of four wheels in a tight turn.

The mountainboard user can ride the board on a variety of surfaces and can even ride the board while being towed e.g. on a rope to gain higher speed and different turning leverage.

The embodiment shown in Figures 1, 2, and 3 is suited to the “free ride” style of mountain boarding. The configuration of the mountainboard 2 can be adjusted to suit particular terrain, the gradient or steepness of a hill or the weight and height and preferences of a particular user, for example by raising or lowering the outer wheel stub axles 34, or by adjusting the toe in / toe out (slip angle) of the other wheels 30.

In a preferred embodiment of a mountainboard for free ride mountain boarding, the board is 1020 millimetres long, and 320 millimetres wide. The two inline wheels are of 9 inch diameter and are spaced 260 millimetres apart (axle to axle). The two wheels are positioned in a void 495 millimetres long and 80 millimetres wide. The axle of the front inline wheel is located 440mm from the front of the deck.

The other wheels are of 8 inch diameter at 10 degrees toe in / toe out (slip angle) and clear the ground by 45 millimetres when the mountainboard 2 is in a neutral orientation. The forward outer wheels are mounted 215 millimetres in front of the forward inline wheel axle to axle, measured along the longitudinal centreline to intersection with a perpendicular line (not shown) that would be the shortest distance

between the wheel and longitudinal centreline. Similarly, the rear outer other wheels are located with the axle 160 millimetres behind rearward of the rear inline wheel.

A spacing of 260mm between the axles of the centre inline wheels 30 is good for many board shapes and many users. For a beginner or intermediate user, the other wheels 20 are desirably around 35mm clear of the ground when the mountainboard is in a neutral orientation. However when the board is ridden on a steep slope, a greater clearance is required.

Preferably the forward foot supporting portion 12 is immediately forward the forward inline wheel, with a foot binding mounted from 15mm forward the inline wheel, while the rear foot supporting portion 14 is rearward the rear inline wheel with a footbinding mounted 50mm rear of the rearward inline wheel. Thus the user's weight (when equally distributed) is slightly to the rear of the inline wheel pivot points, a position found to be more generally stable on rough terrain. The width of the mountainboard also allows the bindings to be moved laterally to suit a user's preference for balance and feel. Figures provided above for a preferred embodiment are approximately +/- 5 mm.

Preferably the distance between the forward end tip 11 of the mountainboard 2 to the forward inline wheel 20 axle 24 is greater than the distance between the rearward inline wheel axle 24 and the rearward tip 13 of the mountainboard 2. This makes it easier for a user to do a pivot turn on the rear inline wheel 20 than on the forward wheel, and also highly importantly enables a user to engage the skid plate 66 as a brake at the rear end 13 of the mountainboard. It is of course possible to provide alternative breaking systems known in the art.

In another preferred embodiment (not shown) the deck is 990 millimetres long, and 360 millimetres wide. The two inline wheels are of 8, 9 or 10 inch (or metric 200mm, 230mm or 260mm) and are spaced 250 millimetres apart (axle to axle). The two wheels are positioned in a void 500 millimetres long and 80 millimetres wide. The axle of the front inline wheel is located 400 millimetres from the front of the deck.

The other wheels are of 8, 9 or 10 inch diameter adjustable between 1 and 10 degrees toe in/toe out (slip angle) and clear the ground by 50 millimetres when the board is in neutral orientation. The forward outer wheels are mounted 315mm in front of the forward inline wheel axle to axle.

Similarly, the rear outer other wheels are located with the axle 160 millimetres rearward of the rear inline wheel axle to axle.

Flat plates on an underside of the deck are bolted through the deck to match the underside of front and rear outer wheel mounts – for extra strength and deck flex control.

Outer wheel mounts have a 6 millimetre bolt protruding through underdeck flat plates, through the deck and engaging a threaded bore passing vertically through an axle of the outer wheel.

Inner and outer wheel mounts may be integral with deck or attached with bolts.

The base of a rider's shoe may be above, equal or below axle height but below the upper extent of the inline wheels (the upper extent of wheel is the top of the wheel).

Inline wheel axle mounts are welded or attached to external or integral strengthening bars (as bars 62 of figure 3b) and protrude through the void of deck.

Cut-outs in the deck provide room for nuts on the axles and allow the axles to be moved up and down.

All measurements +/- 50 millimetres for this embodiment.

This embodiment allows for direct change of wheel sizes between 8 and 9 inch without any adjustments.

Compared to the embodiment of figure 7b:

1. the front of the deck has a sharper radius which turns up directly adjacent the front wheels in front of the outer wheel mount and follows a similar radius to hub diameter of the front wheels so as to maintain clearance under the front of the deck if the back of the deck is raised; and
2. There is a longer distance (about 100mm longer) from the front inline wheel to front outer wheel, axle to axle

In general, adjustments may be made as follows – for high speed straight line travel, the outer or other wheels have a low slip angle of approximately one to five degrees with the inline wheels and the other wheels are also lowered to have less ground clearance.

For use on steep terrain, the other wheels are raised and toed out at a higher slip angle, preferably from 10 to 20 degrees, optionally up to 30 degrees depending on skill of a rider but the invention is not limited thereby. The height of the other wheel axles (in combination with wheel diameter) affects the ability to laterally tilt the mountainboard and is also highly relevant to the steepness of terrain. Preferably the other wheels are arranged with front and rear wheels all the same height from the ground. Depending on deck shape, they may be mounted on brackets of different sizes. The size of the central inline wheels should also be matched to the terrain type and steepness.

Using smaller (for example 8 inch) inline wheels can enable tighter and more precise turning, as can positioning the inline wheels closer together. In this case, the other wheels could also be lowered to re-adjust available lateral tilt or leverage. Longitudinal tilt and pivot turns can be adjusted by spacing the forward and rearward inline wheels closer together.

Moving the forward other wheels further forward of the inline wheels provides a more stable ride in high speed turns or where the user leans too far forward.

However it can result in sluggish turns at lower speeds, all due to the resulting changes in slip angle and carving turn radius r.

Moving the rear other wheels forward or backward affects skid plate braking control abilities, as well as the ease of pivoting about the rear inline wheel. When pivoting, the rear other wheels may or not bear on the ground.

Moving the other rear wheels backwards can make it easier to “switch”, that is to roll backwards rather than in a forwards direction. Stability is improved if the user leans towards the front of the board while travelling backwards.

The degree of toe in / toe out (slip angle) of the wheels affects the sharpness or turn radius of the mountainboard, as does the longitudinal space in between the other wheels on the left or right hand side.

Preferred embodiments of the mountainboard have inline wheels of between 8 to 10 inch diameter.

In alternative embodiments of the invention, the mountainboard may have more than six wheels. Shown in Figures 6a and 6b is a mountainboard 102 having another wheel 180, mounted at the forward end 111, inline with the two inline wheels 120. Said another wheel 180 is smaller (for example 2 to 3 inch diameter) than the inline wheels 120, and when the mountainboard is in neutral orientation, is clear of the ground. However, where a user longitudinally tilts up the rear end 113 of the mountainboard 102 to pivot around the forward inline wheel 120, the another wheel 180 may be brought into contact with ground 180 whereby the user may ride in a more stable manner than on a single inline wheel 120, with a longitudinally tilted deck, the two rearward other wheels 130 raised clear of the ground and one or both of the two forward other wheels 130 in contact with the ground. The another wheel 180 can also reduce crashes, when a user who chances to fall forward, as the mountainboard may continue to move rather than halt abruptly. More than two inline wheels (not shown) could be provided, with all the inline wheels bearing on the ground when the

mountainboard is in a neutral orientation. This can further improve stability at speed in a straight line. The another wheel 180 could also be a roller-style wheel (for example of around 1 to 2 inches diameter and 3 inches wide). The another wheel or wheel-roller 180 is especially useful where the mountainboard has two closely spaced inline wheels 20 as in this instance longitudinal tilting of the board is more easily achieved than where two inline wheels 20 are spaced further apart. In the alternative, moving the two forward other wheels 30 further forward can also help avoid crashes.

The foot supporting portions 112,114 may be provided with bindings, or not (whether one or both).

In further alternatives, the inline wheels are not positioned on the mountainboard 2 longitudinal centreline but rather laterally spaced from the mountainboard 2 centreline on a different longitudinal axis. This provides different characteristics for right or left turns and may be useful for doing tricks.

Figures 6a and 6b also show the two inline wheels 120 each received within respective voids 117. Provision of separate voids 117 can strengthen the deck through the central region of the mountainboard, but may require wider spacing of the two centre inline wheels 120. In the alternative, decks may be stiffened or reinforced for strength using reinforcing portions, whether constructed integrally or being external bars 62 as shown in Figure 3b.

Figures 7a and 7b show alternative shape for the mountainboard structure 10. The forward end 11 of the deck 50 of Figure 7b is more upturned than in Figure 7a. Upturning the forward end of the deck above ground level can enable use of the board over rougher terrain and, as with providing another wheel 180 discussed above, can avoid crashes as the front end of the mountainboard is less likely to strike the ground and halt abruptly, due to the higher ground clearance. Curvature or upturn of the deck can commence in the region of the forward other wheel 30 or preferably as shown in Figure 7b can commence immediately forward of the tyre of

forward inline wheel 20, or forward of the axle of front inline wheel 20 as may be desired.

In yet further alternatives, as shown in Figure 8a a mudguard housing 70 or a cavity integrally formed in the deck 50, can be provided to receive the inline wheels 20. This may prevent mud spatter, or stones and sticks being flung up between a user's legs, as a user will usually have his feet positioned on the foot supporting portions 12,14 provided forward and rearward of the inline wheels 20.

In other alternatives, not shown, the other wheels may also be provided with mud guards or housings in similar manner. Such housings and mud guards may be integral with the deck or may be separately provided and permanently or releasably attached.

Figure 8a also shows a rail slider 68 mounted to the bottom of the deck 50 between the inline wheels 20. This enables a user to slide the mountainboard along a handrail to do tricks, without the handrail becoming jammed between the two wheels.

Figure 8b shows an embodiment in which the two inline wheels 20 have different diameters. The forward wheel 20 is larger, but mounted on the structure 10 at a higher point than rearward wheel 20, so the deck 50 is level when the mountainboard is in the neutral orientation. Using one smaller wheel can allow a user to have a narrower stance (ie the foot supporting portions to be closer together), as a smaller wheel and a larger wheel can be mounted closer together than two large wheels.

Figure 9 shows yet a further embodiment in which the structure 310 has forward and rearward foot supporting portions 312,314 and inline wheels 320 received in a void in metal plate 390, connecting the mountainboard structure. Other wheels 330 are provided mounted on stub axles.

The mountainboard may incorporate features such as upturned front and rear ends to assist in clearing rough terrain, combinations of camber, flex and side cut, which may impact on shock absorption and other handling characteristics. The mountainboard may include a deck constructed from commercially available materials including but not limiting limited to wood, fibreglass, carbon fibre etc. Stiffening and reinforcing components may be used, to adjust board characteristics for example the degree of flexion and twist. Such stiffeners and reinforcing may be particularly important or have particular effect in the area of the voids for receiving the inline wheels. Reinforcing plates or bars could be externally mounted, formed integral with the board deck, or could be formed by ridges of additional material and the like. Figure 3b shows a pair of reinforcing bars 62 mounted to the lower surface of the structure 10, providing reinforcing in the area of the void 16. This helps avoid the board deck being broken near the void area 16 and also stiffens the deck around the void area 16 so that the inline wheels 20 maintain a constant direction of travel d_s and do not move or jitter due to deck flexing.

Preferably a skid plate 66 is provided at least on the rear end of the mountainboard, as a braking surface as shown in Figure 3b. The skid plate could be a metal plate permanently affixed, or could be other forms of deck protecting materials such as adhesive synthetic materials.

The mountainboard is preferably provided with a user's preferred bindings system. However, the foot supporting portions could also be provided with anti-slip surfaces such that a user rides the mountainboard without being strapped into a retaining mechanism. A user could also apply wax as desired to the foot supporting portions.

The axle supports for the wheels may include suspension systems whether simple or complex. In particular, the stub axle mount arrangement shown in Figures 4a to 4f used to mount the other wheels 3 of Figure 1 provides a limited suspension system, with the bracket being fixed with horizontal plate 36 screwed through holes

37 onto the structure 10, and the stub axle having a vertical section 34b setting the height of the horizontal axle 34a on which the wheel 30 is mounted. The vertical section 34b is supported by a web welded to the rod section and the attachment plate 36. The geometry and materials of the axle mount provide a limited form of suspension and "give". Other forms of suspension may be provided as desired.

To enable easy adjustment of wheel positions, a mounting bracket such as shown in Figure 4 or Figure 5 may additionally be provided with a range of replaceable blocks for adjusting the height between the mounting bracket and the structure 10. As shown in Figures 2 and 3, mounting plate 36 is attached directly to an upper surface of the deck 50, but the wheels could be raised, for example by 5mm to 50mm, through provision of appropriately sized blocks. Furthermore, other attachment arrangements between the mounting bracket or the deck 50 could be provided whereby the position of inline other wheels 20,30 can be adjusted "in the field". Such attachment arrangements could be simple clip on or slide mechanisms, or could require use of hand tools such as screwdrivers or Allen keys to remove and adjust a fastener.

The term “inline” is used to describe a tandem arrangement of two or more wheels arranged in a single line and mounted so that they stay in a single line – each wheel always rotates in the same direction as the other wheel(s). The term “neutral orientation” is used to describe a vehicle or mountainboard when in a level position upon a level surface or level ground, as opposed to a tilted or angled position such as will occur when in use on a slope, or when a user tilts the mountainboard deck to change the distribution of force through various wheels and to thus cause the mountainboard to change direction.

Directional terms such as top, bottom, forward, rearward, upper, lower, height or length are used for ease of understanding and with reference to standard in-use orientation of objects. Where in any doubt, the terms are used in reference to a neutral orientation.

It will be appreciated that other embodiments of the invention can be adopted by way of different combinations of features. Such embodiments fall within the spirit and scope of this invention.

CLAIMS:

1. A vehicle for travelling across ground, the vehicle including:
   - two or more inline wheels spaced in a direction of travel;
   - other wheels including:
     - two forward wheels spaced laterally from and forward of the inline wheels;
     - two rearward wheels spaced laterally from and rearward of the inline wheels; and
   - structure carrying the wheels and defining respective forward and rearward foot supporting portions forward and rearward of the inline wheels;

   the wheels being arranged such that:
   - when the vehicle is in a neutral orientation the inline wheels bear on the ground and the other wheels clear the ground; and
   - the vehicle is manipulable by a user standing on the foot supporting portions to bring one or more of the other wheels into contact with the ground to steer the vehicle;

   the structure being shaped to receive the inline wheels whereby when the vehicle is in the neutral orientation the foot supporting portions are below an upper extent of the inline wheels.

2. A vehicle according to any one of the preceding claims wherein said inline wheels each have a respective axis of rotation and said foot supporting portions are below said inline wheels axes of rotation.

3. A vehicle according to any one of the preceding claims wherein said other wheels each have a respective axis of rotation and said foot supporting portions are below said other wheels axes of rotation.

4. A vehicle according to any one of the preceding claims wherein said structure includes one or more voids for receiving said inline wheels whereby said inline wheels extend beyond upper and lower surfaces of said structure.

5. A vehicle according to any one of the preceding claims further including one or more reinforcing portions attached to the structure to reinforce the structure.

6. A vehicle according to any one of the preceding claims wherein said other wheels are angled relative to said direction of travel.

7. A vehicle according to any one of the preceding claims wherein said forward wheels are angled between 1 to 30 degrees relative to said direction of travel.

8. A vehicle according to any one of the preceding claims wherein said rearward wheels are angled between 1 to 30 degrees relative to said direction of travel.

9. A vehicle according to any one of the preceding claims further including a respective axle for each of said inline wheels wherein said inline wheel axles are mounted above a top surface of said structure.

10. A vehicle according to any one of the preceding claims further including a respective axle for each of said other wheels wherein said other wheel axles are mounted above a top surface of said structure.

11. A vehicle according to claim 10 wherein said other wheel axles are stub axles.

12. A vehicle according to any one of the preceding claims further including an adjustable mounting arrangement for adjusting positioning of one or more of said wheels.

13. A vehicle according to any one of the preceding claims wherein said forward foot supporting portion is rearward of said two forward wheels and said rearward foot supporting potion is forward of said two rearward wheels.

14. A vehicle according to any one of the preceding claims wherein said structure is or includes an elongate deck.

15. A vehicle according to any one of the preceding claims wherein said inline wheels are of larger diameter than said other wheels.

16. A vehicle according to any one of the preceding claims further including another wheel arranged inline with the two or more inline wheels, the said another wheel arranged such that when the vehicle is in a neutral orientation the two or more inline wheels bear on the ground and said another wheel clears the ground.

17. A vehicle according to any one of the preceding claims further including bindings respectively associated with said foot supporting portions.

18. A mountainboard for travelling across ground, the mountainboard including:

- a deck having a forward and a rearward foot supporting portion for supporting respective feet of a user;
- a plurality of loadbearing wheels for supporting the deck, the loadbearing wheels arranged inline and spaced in a direction of travel; and
- a plurality of control wheels supported by the deck, the respective control wheels each laterally spaced from said loadbearing wheels;

wherein, when the mountainboard is in level orientation, at least one of said plurality of loadbearing wheels protrudes above the forward or the rearward foot supporting portion, and at least one of said plurality of loadbearing wheels protrudes below at least one of said plurality of control wheels, whereby a user

may control the mountainboard by adjusting his/her weight to control the force applied through each wheel to the ground.

19. A vehicle for travelling across ground, the vehicle including:

- at least a forward and a rearward inline wheel spaced in a direction of travel;
- other wheels including:
  - two forward wheels spaced laterally from and forward of the inline wheels;
  - two rearward wheels spaced laterally from and rearward of the inline wheels; and
- structure carrying the wheels and defining respective forward and rearward foot supporting portions forward and rearward of the inline wheels;

the wheels being arranged such that:

- when the vehicle is in a neutral orientation the inline wheels bear on the ground and the other wheels clear the ground; and
- the vehicle is manipulable by a user standing on the foot supporting portions to bring one of the forward or rearward inline wheels clear of the ground whereby the user may pivot the vehicle on the other of the forward or rearward inline wheels;

the structure being shaped to receive the inline wheels whereby when the vehicle is in the neutral orientation the foot supporting portions are below an upper extent of the inline wheels.

20. A vehicle substantially as hereinbefore described, with reference to any one of the embodiments shown in the accompanying Figures.

21. A deck to which wheels and wheel mounting structures are attachable to form a vehicle in accordance with any one of claims 1 to 20.

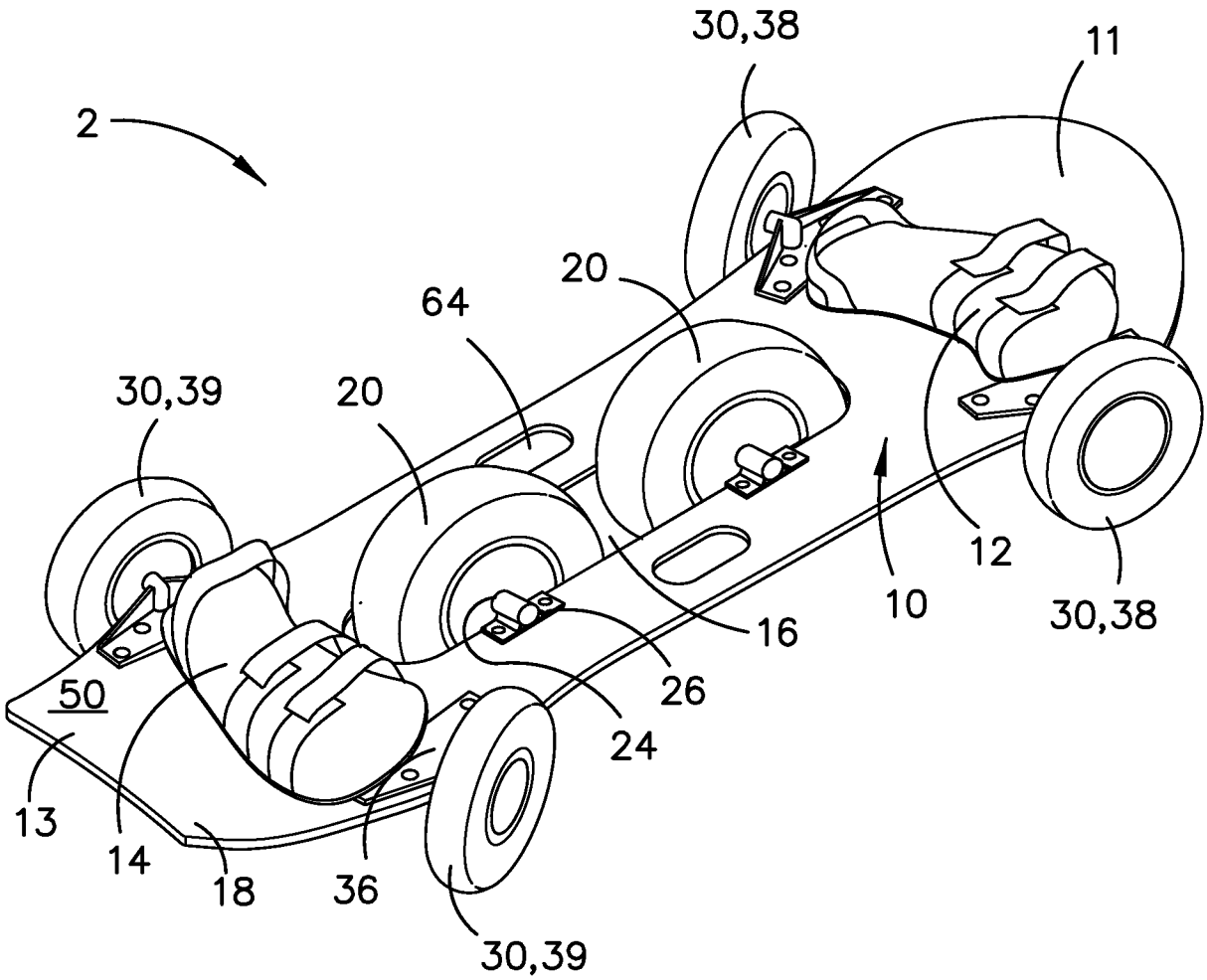
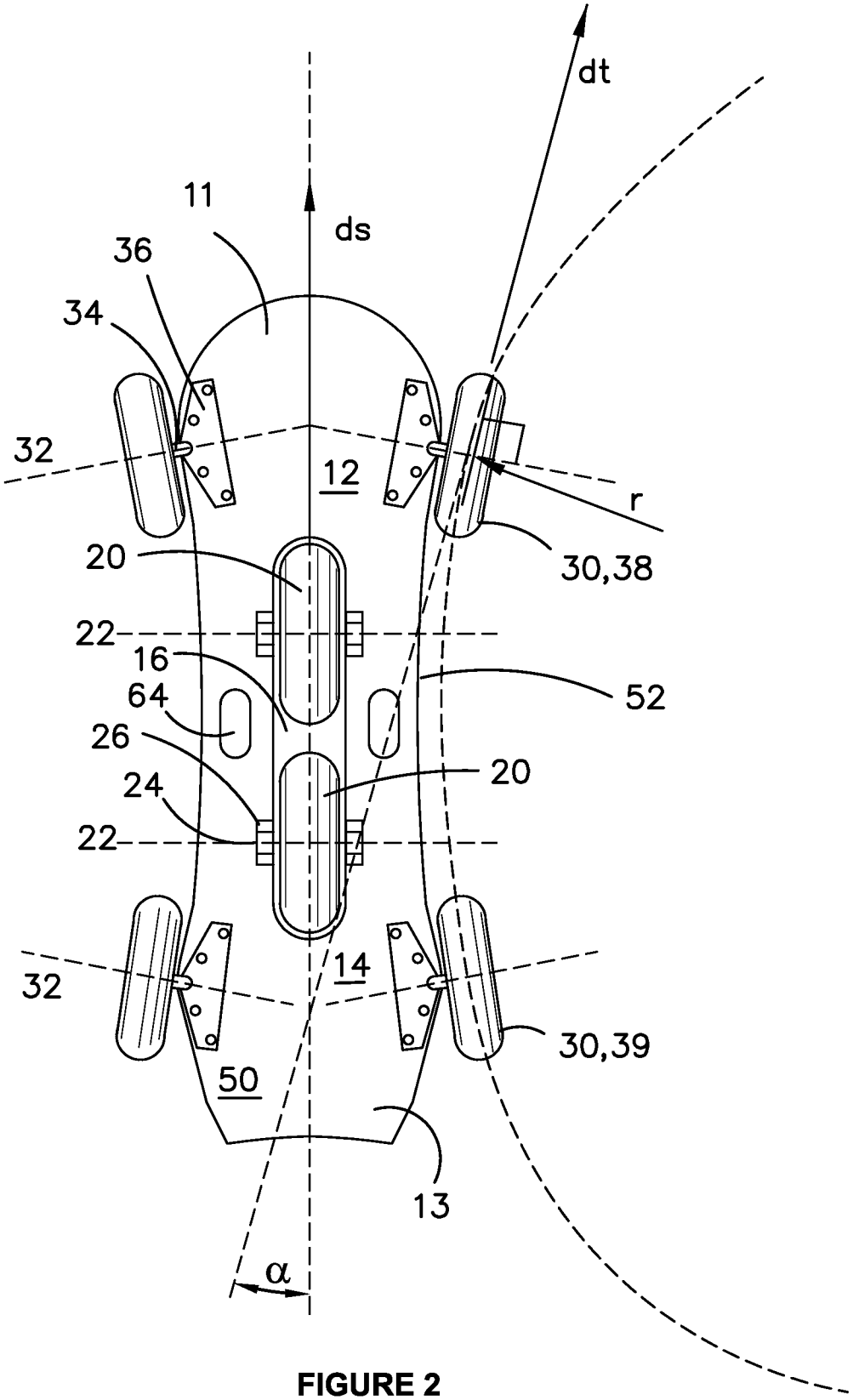


FIGURE 1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30,38
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22
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64
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24
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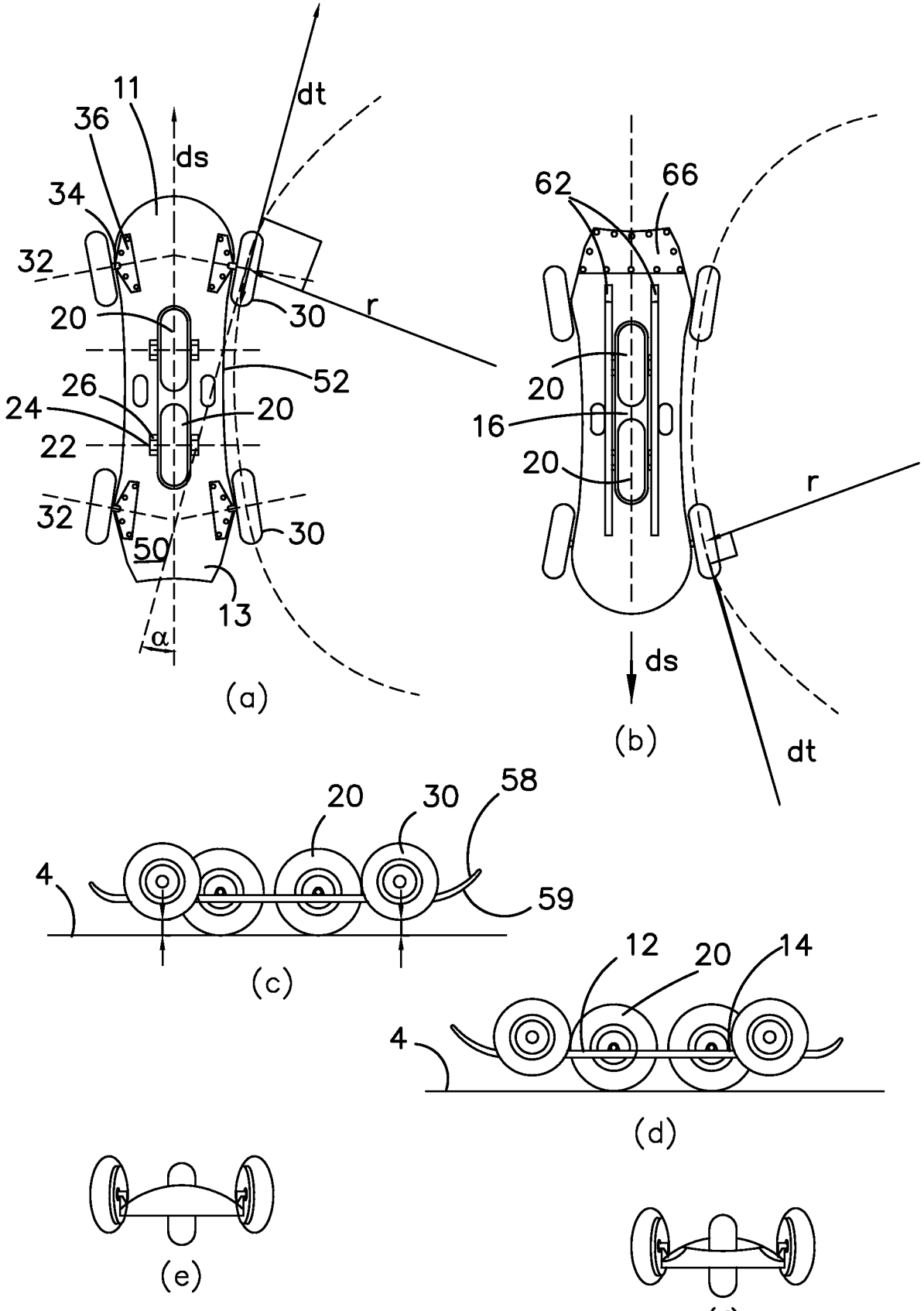
30,39
50
13
α

FIGURE 2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(a)
62
66
20
16
20
r
ds
(b)
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4
59
(c)
12
20
14
4
(d)
(e)
(f)

FIGURE 3

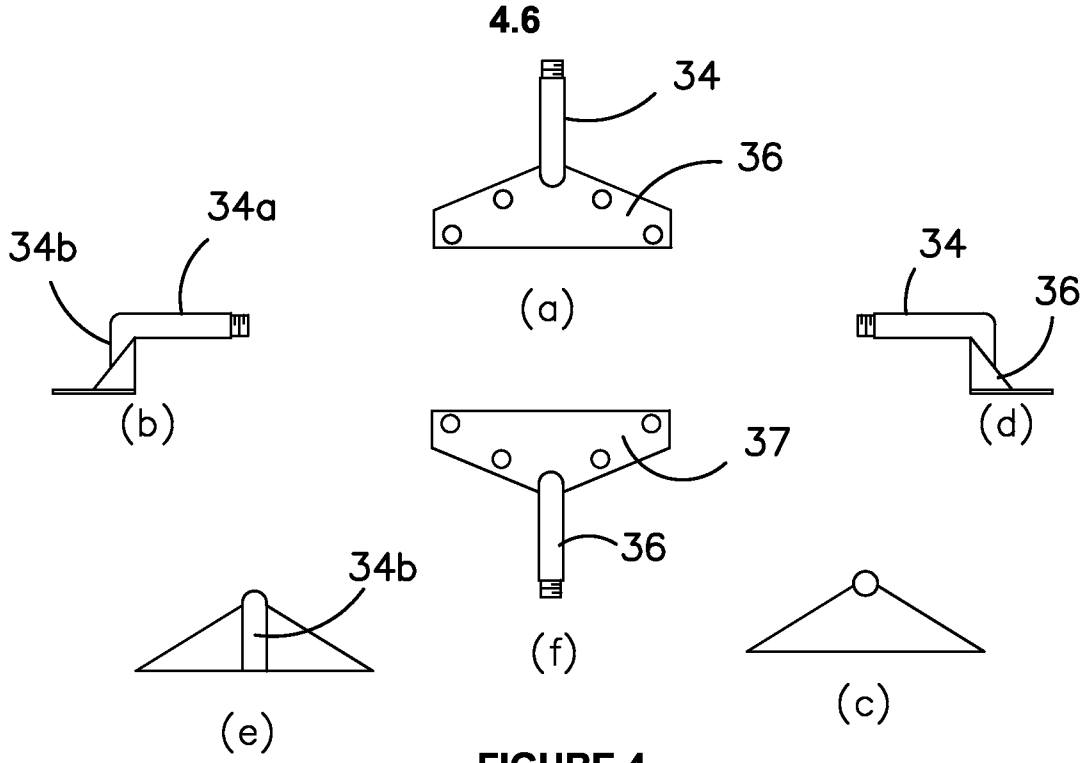

FIGURE 4

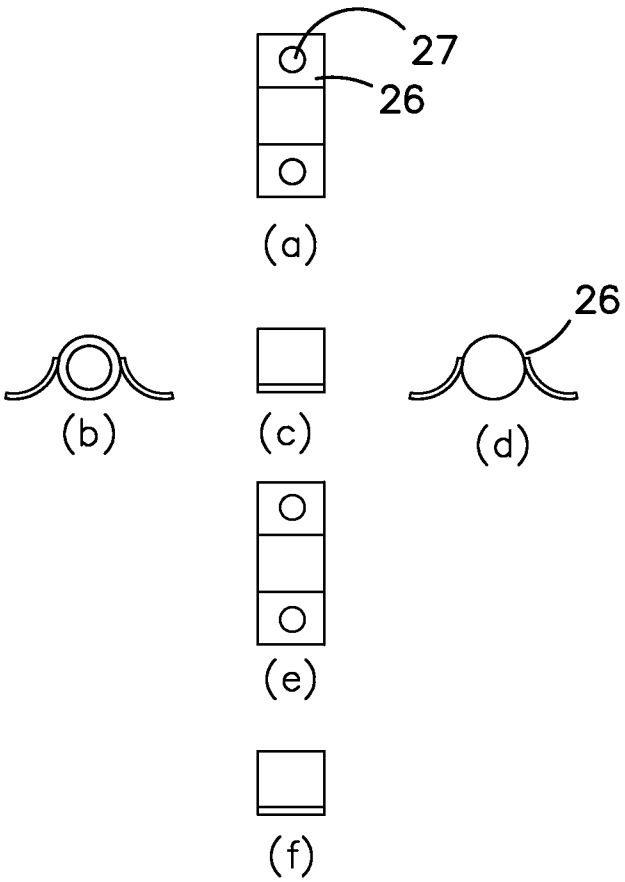

FIGURE 5

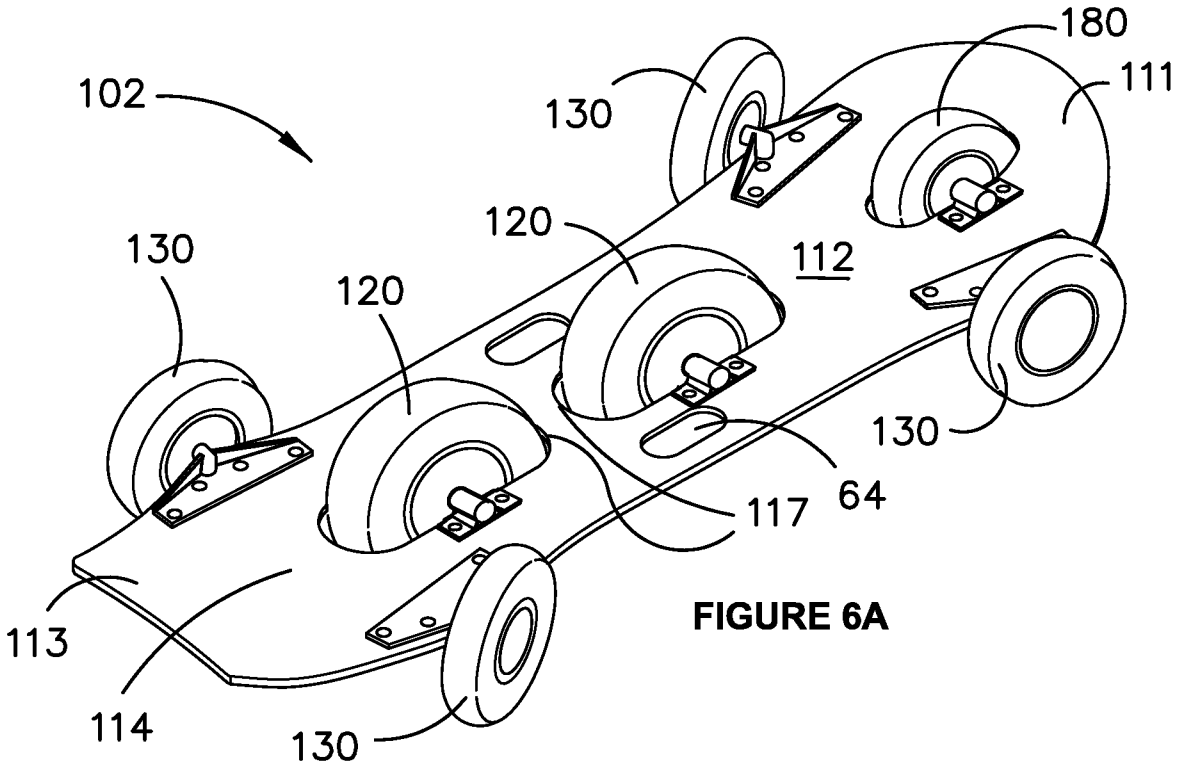

FIGURE 6A

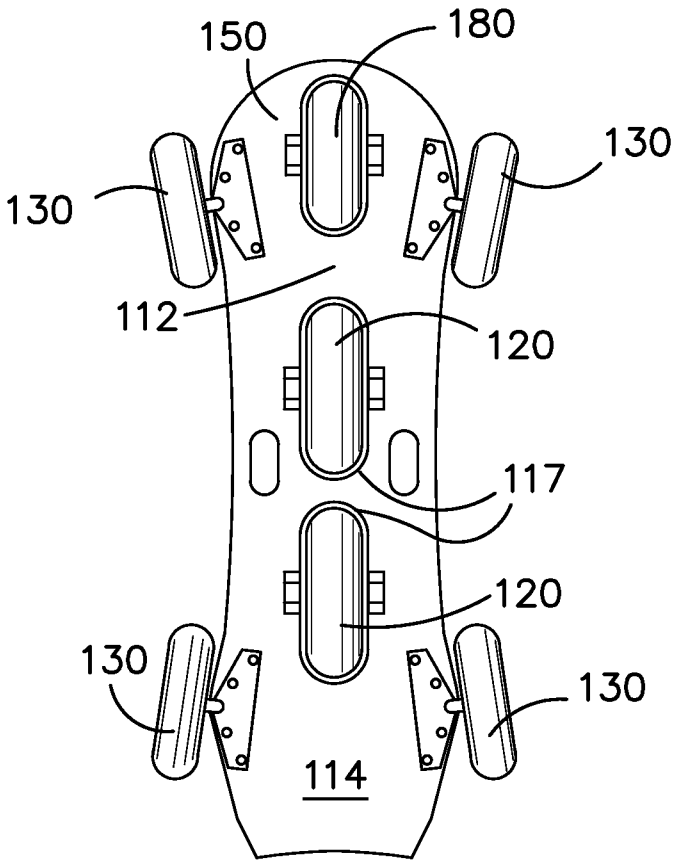

FIGURE 6B

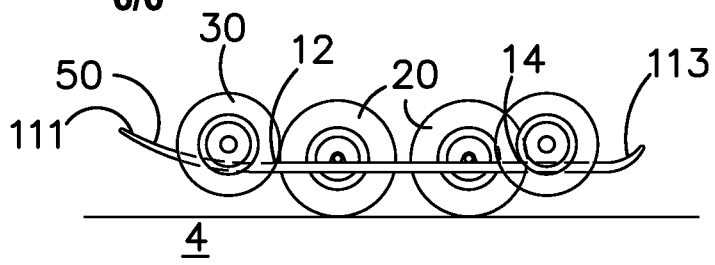

FIGURE 7A

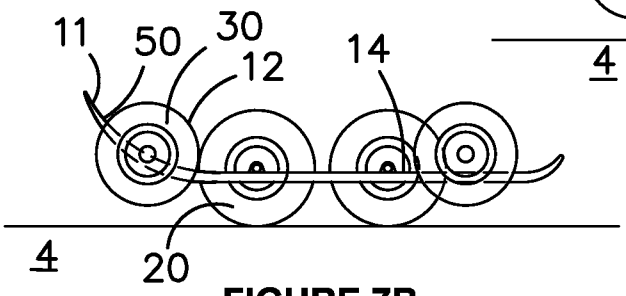

FIGURE 7B

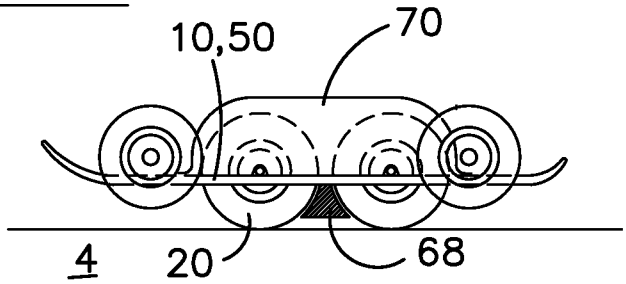

FIGURE 8A

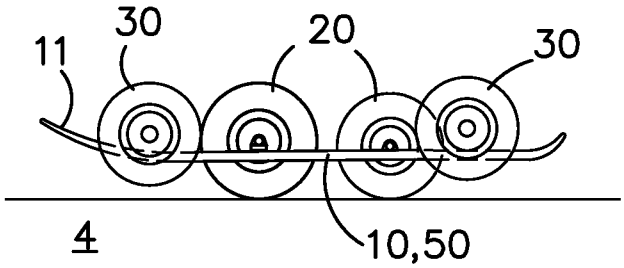

FIGURE 8B

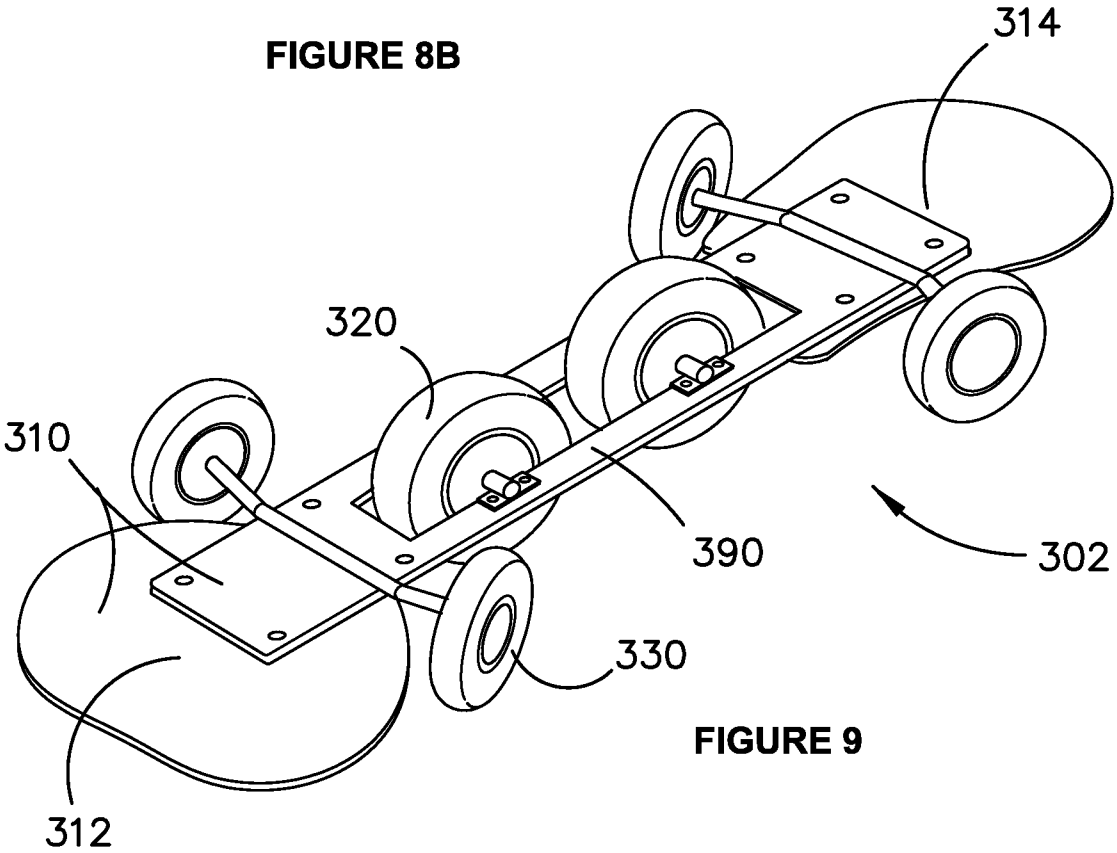

FIGURE 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000085

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. ***A63C 17/04*** (2006.01) ***B62M 1/00*** (2010.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI: /IC/EC B62M1/-, A63C17/- & Keywords (Skate, Off Road, All Terrain, Board, In Line, Central, Wheel) and similar terms; Google Patent & Keywords (Inline, Skateboard, Steer, Tilt, Outrigger) and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2465692 A (MOJAY-SINCLAE) 2 June 2010 See abstract; page 2, paragraph 4; & figures 1 to 4.	18, 21
X	US 7213823 B1 (VUJTECH) 8 May 2007 See abstract; col. 4 lines 15 to 19; col. 7, lines 10 to 15; & figures 1 to 7.	18, 21
X	WO 2010/143217 A1 (BOLDITALIA S.R.L.) 16 December 2010 See abstract; page 1, lines 35 to page 2, line 7; page 3, lines 19-20; & figures 1 to 15.	18, 21
X	WO 2007/059553 A1 (DANKERS) 31 May 2007 See abstract; page 2, paragraph 7; page 4, paragraph 11 & figures 1 to 4.	1-15, 17-19, 21

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 May 2012	10 May 2012
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **ROGER SMALL** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 3 9935 9630

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000085

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5975546 A (STRAND) 2 November 1999 See abstract & figures 1 to 12.	
A	US 5855385 A (HAMBSCH) 5 January 1999 See abstract & figures 1 to 4b.	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000085

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: **20**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
The claim does not comply with Rule 6.2(a) because it relies on references to the description and/or drawings.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2012/000085

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2465692	NONE					
US	7213823	NONE					
WO	2010143217	CA	2764765	EP	2440298	IT	RM20090287
WO	2007059553	NONE					
US	5975546	AU	44248/97	EP	1011824	US	5833252
		WO	1998011960				
US	5855385	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX