CONVERTIBLE WHEEL APPARATUS FOR A SKATING DEVICE

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ABSTRACT

A convertible wheel apparatus for a skating device including a pair of wheels, a pair of wheel supports, and a connector. Each pair of wheels has an axle and defines a coplanar virtual center and rotational plane, which are perpendicular to the axle. Each wheel support engages a respective wheel and includes a pivotal member defining a pivotal axis with at least one pivotal axis of the pivotal members located at a measurable non-zero distance from a respective virtual axis. The connector is attached to one of the pivotal members of each wheel support and concurrently positions the pivotal members. Control of the orientation of the rotational planes of the wheels is achieved by positioning features attached to a base element or by a biasing mechanism. Various skate configurations can be obtained by a choice selection and combination of connectors and axis constraints that characterize the convertible wheel apparatus.
CONVERTIBLE WHEEL APPARATUS FOR A SKATING DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to sporting goods, and particularly to skating devices. The field of the invention is that of roller skates, skateboarders, and other devices having roller wheels.

[0003] 2. Description of the Related Arts

[0004] Roller skating devices having roller wheels are used for sporting, exercising, and recreational activities. A variety of roller wheels are well known and used on traditional quad skates, in-line skates, and skateboards. These roller wheel constructions for skates generally have fixed roller wheels having fixed orientation with respect to a given reference integral of the skating device. Some skates include a foot or shoe enclosure. The wheel support portions of these skates are typically made from a fixed frame that supports the axles of the roller wheels. Each type of skate has its own particular and distinctively different frame construction in order to facilitate its wheel arrangement.

[0005] Several known devices attempt to provide flexibility for a skate type of device. One known device is a convertible running shoe/roller skate. Another known device is a shoe assembly including a flanged beam with a channel capable of bearing roller skating trucks or a blade adapted for ice skating. Still another known device is a roller skate having three control modes: one with the front wheels freely rotatable; a second permitting rotation of the fronts wheels in only a single direction; and a third where the front wheels are restrained from moving in either direction. Another variation is a known skate structure capable of interchange of ice blades and in-line rollers. Further known is a roller skate where the rollers can be installed on the shoes in several configurations. Also known is an adjustable roller skate structure with a latch on a guided track for adapting the skate to the size of the user. A further convertible skate structure is known using an adapter plate and a plurality of different attachments for providing several distinct uses of the skate.

[0006] All the above referenced known devices present some kind of skate device in one form or another. However, all of them failed to arrive at a convenient and truly convertible skating device that accomplishes conversion of the orientation of the roller wheels of the skating device without adding or removing skate parts.

[0007] U.S. Pat. No. 5,524,911 describes the inventor's prior innovative convertible in-line/parallel skates. This is the historic first invention that demonstrated convenient and convertible in-line/parallel roller skate configurations without having to add or remove or reassemble the skate components. The invention involves a skate that can be converted from an in-line wheel configuration in which all of the skate wheels are coplanar to a parallel or quad wheel configuration, and vice versa. The skate includes a foot or shoe enclosure, a wheel chassis, a wheel support, at least two wheels, and a tie rod which anchors the wheel chassis at a center point and allows the wheel chassis to pivot the wheels from an in-line to a parallel configuration. The foot enclosure includes posts which support and secure the wheel chassis, with a nut threadably engaging the post to rotatably secure the wheel chassis relative to the foot enclosure. The tie rods have a predetermined length which maintains the angular position of the wheels relative to the foot enclosure regardless of the angular position of the wheel chassis.

[0008] U.S. Pat. No. 5,775,705 describes the inventor's further various innovative approaches to construct the various convertible in-line/parallel skates based upon the invention disclosed under the aforementioned U.S. Pat. No. 5,524,911. The invention involves a skate that can be converted from an in-line wheel configuration in which all of the skate wheels are coplanar to a parallel or quad wheel configuration, and vice versa. The skate includes a foot or shoe enclosure, a wheel chassis, a wheel support, at least two wheels, and mechanisms which position the wheel chassis at a center point and allows the wheel chassis to pivot the wheels from an in-line to a parallel configuration. The positioning mechanisms include tie rods, yokes, gear sets, and externally mounted rods or panels. A post on the bottom of the enclosure may include a threaded portion which is engaged by a nut. To rotationally secure the position of the wheel chassis, or the post may include a portion of enlarged diameter supporting a spring which biases the wheel chassis into the post. A brake is provided to allow the user to slow or stop the skate in a controlled manner.

[0009] What is needed is a generalized and improved convertible wheel apparatus suitable for all variety of roller skating devices. Also needed is a structure having convertible wheel arrangements by way of simple repositioning of the components inherent to the skating device without having to remove and reattach any parts or components. A further need involves a structure capable of use on multiple skating devices including the traditional quad skate, the in-line skate and skateboards. A concurrent need is for such a structure to be cost effective in manufacturing and commercialization along with the already existing skating devices.

SUMMARY OF THE INVENTION

[0010] The convertible wheel apparatus for a skating device includes a pair of wheels including a virtual central which is defined by the wheel which also includes a rotational plane perpendicular to its axle. The rotational plane and the virtual center are coplanar. A pair of wheel supports engage a respective one of the wheels. Each wheel support includes at least one pivotal member for controlling rotation of the wheel support with respect to a virtual axis parallel to the pivotal axis of the pivotal member. Control of the orientation of the rotational planes of the pair of wheels are achieved by positioning features attached to a base element or by a biasing mechanism. Both are adapted to function in connection with a friction surface that makes contact with the wheels. Connection between the pair of wheel supports for concurrent positioning of the pivotal members are facilitated by a connector. Each pivotal axis of the pivotal members is offset and located at a measurable non-zero distance from a respective virtual axis.

[0011] To be effective for quick change of wheel orientations each of the virtual axes is located at a noticeable non-zero distance away from the vicinity of the virtual center of a respective wheel. In the case of the free rotating wheel configuration in which all the wheels and the con-
nectors are free to rotate with respect to a friction surface, the virtual axis is preferred to be close to the virtual center.

Concurrent positioning of the pivotal members results in concurrent positioning of the wheel supports and the wheels attached to them. This involves rotation of wheel supports with respect to their respective virtual axis and results in rotation of the rotational planes of the wheels with respect to their respective virtual axis.

Each wheel support could include a single pivotal member or a pair of pivotal members having their pivotal axes parallel to a respective virtual axis. In the case of a pair of pivotal members associated with each wheel support, the pivotal axes of the pivotal members are located at approximately the opposite sides across said virtual axis.

Since a skating device always involves a skating surface that makes contact with the wheels, one method for controlling the orientation of the rotational planes of the pair of wheels involves the friction surface to provide stability.

For controlling the orientation of the rotational planes of the wheels, a biasing mechanism such as a spring or a resilient polymer can be used. Such a biasing mechanism provides restoring force to secure or return the wheels to a desired position after a conversion of the wheels from one configuration to another. For connecting the pair of wheel supports, a connector having a ratio for its overall length over its minimum thickness of greater than three is desired. Short and fat connectors, though usable, will tend to take up excessive space traditionally not available in the existing skating devices.

In the case of a convertible in-line/parallel wheel apparatus, the concurrent positioning of the pair of pivotal members involves rotation of the pair of wheel supports with respect to the connector while the rotational planes of the wheels remain parallel to a predetermined orientation.

Each connector could include a provision for rotating the connector about an axis located in between its two ends and in the vicinity of a line drawn between its two ends. The connector could include a provision for attaching itself to a base element of a skating device in order for each connector to rotate with respect to the base.

The pivotal member of a wheel support can include a provision for attaching the pivotal member to a base element of a skating device in order that the pivotal members are constrained to rotate about a virtual axis fixedly attached to the base element.

The present invention provides a generalized and improved convertible wheel apparatus for a skating device which can be converted from an in-line wheel configuration to a parallel wheel configuration and vice versa. The present invention further provides a convertible wheel apparatus using the same generalized principles of operation for use on a skating device which can be converted from a traditional quad skate to an innovative skate configuration that allows the wheel to turn and simulate the turning and spinning activities typically seen in a ice figure skating device. In other words, the present invention provides a roller skate that is suitable for performing all figure skating activities without having to go to a ice skating rink. Similarly, the same generalized and improved convertible wheel apparatus can be used on a skateboard to achieve the same convertible in-line/parallel wheel configurations and the same roller figure skating activities. The only difference is that a typical skateboard usually is consisted of a single large platform as the base in lieu of a pair of skates used for roller skating.

The present invention provides a skate that can be converted from an in-line wheel configuration in which all of the skate wheels are coplanar to a parallel wheel configuration, and vice versa. In a simple operation, the wheel configuration may be manually converted using only repositioning of the equipment on the skate itself.

Both in-line and quad skates are used for sporting and recreational purposes. The traditional quad skate has enjoyed long-standing popularity, while widespread commercialization of the in-line skate is relatively recent. The quad skate is particularly suitable for use in places such as roller rinks, while the in-line skate tends to prevail in outdoor use. Generally, the places and uses of the two types of skates are characteristic to each skate. A skater's choice of an in-line or a quad skate then often depends on the type of activity in which the skater wishes to engage. Thus, a skating enthusiast would require more than one pair of skates to fulfill all skating activities in which the skater might wish to engage. The skater would thus incur the expense of buying more than one pair of skates, and the inconvenience of having to change skates depending on the activity in which the skater desires to engage at a given time.

The present invention utilizes wheel support adapted for mounting either on a base element attachable to the bottom of a skateboard or a foot or shoe enclosure for a skating device. The wheel support positions the wheel and is rotatable about a virtual axis each of which is parallel to the pivotal axis of the pivotal member. A connecting mechanism connects two wheels which are supported by the pair of wheel supports. Each of the pivotal members is rotatable between at least two positions, and the connection of the wheels to the pivotal member through the connecting mechanism ensures that the positioning of the wheels are concurrent.

Each connecting mechanism, namely a connector, has a predetermined position relative to the respective pivotal member and the wheels so that the wheels are angularly positioned relative to the pivotal member via the positioning of the pivotal member. Thus, the connector can be constructed to keep the wheels always parallel to a given predetermined orientation, or that which the wheels can be turned to different angles relative to the predetermined orientation.

By rotating the connector, the wheels may be positioned either in an in-line arrangement, wherein the rotational planes of the wheels are coextensive, and a parallel arrangement, wherein the wheels are parallel and coaxial. By rotating the wheel supports, the wheels may be turned and allowed the skate to turn and spin as desired. Using the improved convertible wheel apparatus many different varieties of foot or shoe enclosures may be utilized with the invention. The wheel supports, in conjunction with the pivotal members and the base element, provide support for the foot or shoe.
In one construction, a pair of pivotal members are used with each corresponding wheel support and each wheel support supports one wheel. This allows for a pair of in-line roller wheels to be employed, which may be readily changed to a two by two parallel wheel arrangement. One method of effecting the change is by lowering the connectors which engages a base element and then turning the connector, and releasing the connector. This in conjunction with various positioning features ensures the proper alignment with a given desired wheel orientation. Another method involves a biasing mechanism for releasing and securing the connectors. Another feature of the invention involves an aligning positioning feature attachable to the base element which secures the orientations of the wheel rotational planes relative to the base element and may define a plurality of discrete aligned positions for the wheels relative to the base.

One form of the present invention comprises a generalized and improved wheel apparatus having a pair of wheels, and each wheel engages a corresponding wheel support which is attached to a pivotal member and rotatably supports the wheels. The reaction forces necessary for a figure skate to propel forward or backward toward the direction of skating can be acquired by arranging the pair of wheels so that when both wheels are pushed by forces parallel to the direction of skating, the torques produced about the virtual axes prevent the wheel supports from turning or spinning. The wheels are oriented by the controlling mechanism in order to allow the turning of the wheels from an orientation parallel to a predetermined direction to an orientation pointing to the skating direction of the skater. In this arrangement, each of the pivotal members is attached to a base element and suited for rotating the rotational planes of the wheels about the respective virtual axis of a wheel. Such a skating device further comprises a biasing mechanism that can be used to provide a restoring force and to control the orientation of the wheels so that the wheels will tend to return to their original predetermined orientation after a turning or a spinning skating activity.

The connectors may also include several portions of varied dimensions and are not restricted to any particular shape or form. However, the predetermined length to thickness ratio is desired to have a ratio for the overall length over the minimum thickness of the connector of greater than three.

One of the orientation controlling mechanisms includes a friction surface with which the wheels make direct contact. A skater can then control the direction of the rotational planes of the wheels by dragging the wheels against the friction surface. The connector has a predetermined length which joins to control the angular position of the wheels relative to the pivotal member according to the desire of a skater regardless of the initial orientation of the wheels.

The present invention can be easily arranged to include a typical brake for a skating device. The present invention also can be easily constructed using belts, gears, yokes or other equivalent mechanical connecting means to achieve the same purpose of connecting the pair of wheels and concurrent rotation of the orientation planes of the wheels. Detail of using such positioning mechanism are presented in U.S. Pat. No. 5,775,705 issued to the inventor, the disclosure of which is explicitly incorporated by reference.

An advantage of the present invention is that a simplified generalized and improved convertible wheel apparatus can be used on all skating devices such as the traditional quad skates, the in-line skates and skateboards. Another advantage of the present invention is that the wheels of the present invention can easily and quickly be converted from an in-line to a quad skate and vice versa, or from a wheel orientation longitudinal to the base element of a skating device to a position angled at a different orientation according to the skater's choice.

An important advantage of the present invention is that the convertible wheel apparatus can be converted between various wheel configurations without removing or adding any equipment.

A further advantage of the innovative convertible wheel apparatus is that the present invention can be used in a variety of locations and under a variety of conditions calling for skates of different type with dramatically different construction.

A further advantage is that the same wheel and support system of the present invention can be used regardless of the style of the foot or shoe enclosure, or the style of the base and frame of the skating device.

Yet another advantage of the present invention is that the skate constructed according to that adapted for turning the wheels in different directions is capable of turning and spinning skating activities that are only achievable in the past by ice skates.

The present invention provides a convertible wheel apparatus for a skating device including a first rotatable wheel and a second rotatable wheel, a first wheel support and a second wheel support, and a connector connecting one of the pivotal members from each of the first and second wheel supports. Each of the first and second rotatable wheels have an axle and define a virtual center plane and a rotational plane, with the rotational plane and the virtual center plane being generally coplanar and generally perpendicular to the axle. Each of the first and second wheel supports are with a corresponding one of the rotatable wheels, define a virtual axis, and include at least one pivotal member defining a pivotal axis. Each pivotal member is attached to the wheel support for controlling rotation of the wheel support relative to the pivotal member, with at least one pivotal axis of the pivotal members being offset from a respective virtual axis. The connector and the first and second wheel supports are structured and arranged to allow the rotational planes of the first and second wheels to remain coplanar when the reaction moment acting on the first wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the first wheel support are subtractive to the reaction moment acting on the second wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the second wheel support. The connector and the first and second wheel supports are structured and arranged to allow the rotational planes of the first and second wheels to rotate when the reaction moment acting on the first wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the first wheel support are additive to the reaction moment acting on the second wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the second wheel support.
[0038] The present invention further provides a convertible wheel apparatus for a skating device including a pair of wheels with each wheel having an axle and defining a virtual center and a rotational plane, a pair of wheel supports with each wheel support engaging a wheel and defining a virtual axis and including at least one pivotal member defining a pivotal axis parallel to the virtual axis, and a connector attached to one of the pivotal members of each the wheel support and capable of concurrently positioning the pivotal members. The virtual center being located in a plane coplanar with the rotational plane, the rotational plane and virtual center being generally perpendicular to the axle. The pivotal member controlling rotation of the wheel support with respect to the virtual axis at least one pivotal axis being offset from a respective virtual axis.

BRIEF DESCRIPTION OF DRAWINGS

[0039] The above mentioned and other features and objects of this invention, and the manner of attaining them, will become more apparent and the invention itself will better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0040] FIG. 1 is a perspective, exploded view of a convertible wheel apparatus suitable for use for a skating device with in-line/parallel skate converting ability. A single wheel along with a pair of pivotal members and a pair of connectors are shown.

[0041] FIG. 2 is a cross-sectional view showing one form of a connector with varied cross sectional thickness.

[0042] FIG. 3 is a bottom plan view of the positioning features with two connectors constrained in a parallel position.

[0043] FIG. 4 is a perspective, exploded view of the convertible wheel apparatus suitable for use for a skating device with the ability to turn or spin the wheels according to the skater's choice. A single wheel along with a single pivotal member and a single connector is shown. A biasing mechanism is also included.

[0044] FIG. 5A is another perspective, exploded view of a convertible wheel apparatus suitable for use for a skating device with in-line/parallel skate converting ability. In this view a pair of wheels are shown with their respective pivotal members and connectors. A base element adapted for attaching to the connectors is also shown.

[0045] FIG. 5B is a similar perspective, exploded view of a convertible wheel apparatus as shown in FIG. 5A, except for the wheels being in an in-line position.

[0046] FIG. 6 is a series of top plan views of rotational configurations of the wheel assemblies shown in FIGS. 5A and 5B.

[0047] FIG. 7 is a perspective, exploded view of the convertible wheel apparatus suitable for use for a skating device showing a pair of wheels adapted for turning and spinning.

[0048] FIG. 8 is a series of top plan views of the skating device embodiment of the present invention showing the turning of the rotational planes of the wheels.

[0049] FIG. 9 is a series of top plan views similar to FIG. 8 except for the original orientation of the wheels and the addition of a biasing mechanism.

[0050] FIG. 10 is a series of top plan views of the convertible wheel apparatus suitable for use for a skating device with the ability to turn or spin. In this presentation the pivotal members of each wheel is constrained with respect to a respective one of the pivotal axes.

[0051] FIG. 11 is a series of top plan views similar to FIG. 10 except for the original orientation of the wheels.

[0052] FIG. 12 is a series of top plan views of the convertible wheel apparatus suitable for use for a skating device with extensive freedom to turn or spin.

[0053] FIG. 13 is a series of top plan views similar to FIG. 12 except for the original orientation of the wheels.

[0054] FIGS. 14A and 14B show two plain views of two methods of constructing positioning features for securing the orientation of the wheel.

[0055] FIG. 15A is a top plan view of a skateboard having a pair of wheel supports.

[0056] FIG. 15B is a side view taken along view lines 15B-15B of FIG. 15A showing one pair of wheels.

[0057] FIG. 15C is a side view taken along view lines 15C-15C of FIG. 15A showing one pair of wheels.

[0058] FIG. 16A is a top plan view of an in-line parallel skate wheel apparatus showing the particular manner in which the pivotal members are constructed.

[0059] FIG. 16B is a component drawing of the device of FIG. 16A.

[0060] Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of the present invention, the drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present invention. The exemplifications set out herein illustrate embodiments of the invention, in several forms, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

[0061] The embodiments disclosed below are not intended to be exhaustive or limit the invention to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. The present invention shown in some of the drawings illustrates skate configurations using a pair of wheel supports and a pair of wheels. Other drawings presents illustrate skate configurations using two pairs of wheel supports and four wheels. Alternatively, a skate defined by the present invention could have virtually any combination of skate wheels, for example combinations of 2x1 parallel and 1x2 in-line, or 2x3 parallel and 1x9 in-line, or even combinations of odd numbers of wheels for each skating device, such as 1x2x1 parallel and 1x3 in-line wheel configurations. Thus, other numbers and combinations of wheels are possible within the scope of the present invention.
[0062] The present invention involves mechanisms which position roller wheels so that the roller wheels maintain a generally parallel relative orientation, while allowing for non-parallel orientations, for facilitating forward motion and maneuvering of the device to which the roller wheels are attached. The present invention allows for movement of the wheels, and may be used on a variety of structures on which roller wheels may be mounted. The connectors of the invention are associated with the wheels so that the desired orientation is preserved. While reference to the inventor’s earlier work may provide insight into the arrangement of the present invention, the configurations illustrated in the drawings show the versatility of the present invention. Both the virtual axis and the connector axis can be constrained to rotate with respect to a base element associated with a pair of wheels. They also can be free to change their spatial positions with respect to the same base element. Selection and combination of such constraints serve as controlling means for a generalized convertible wheel apparatus. For a free skate configuration the connector axis would be constrained. For a figure skate configuration both of the virtual axes would be constrained. For an in-line parallel skate configuration both of the two connector axes would be constrained. The table 1 below summarized these alternative methods for constraining the generalized convertible wheel apparatus to achieve different skate configurations.

| TABLE 1 | Controlling Means For A Generalized Convertible Wheel Apparatus |
|---------------------------------|------------------|------------------|------------------|------------------|
| Configuration                  | Virtual Axis     | Connector Axis   | Connectors       | Axes Constrained |
| Free Skate                     | No               | Yes              | 1                | 1                |
| Figure Skate                   | Yes              | No               | 1                | 2                |
| In-line Parallel               | No               | Yes              | 2                | 2                |

[0063] FIGS. 1-5 show a wheel support configuration including base element 35, connectors 75, pivotal members 40, wheel supports 35, and biasing mechanism 70. The ends of a connector 75 are shown as 90A and 90B. Axis 85 associated with pivoting member 100 adapted to engage aperture 80. A line drawn between 90A and 90B is marked 95. Virtual center 25 is seen in the proximity of the theoretical center 30 of a wheel 10. Virtual axis 45 and pivotal axis 50 are marked along their respective theoretical center lines. Axle 20 supports the wheel 10 through two openings 30 in the wheel support 35. The rotational plane and virtual center plane of the skate wheel 10 is depicted with a plane 15 across the mid section of the wheel 10. These two planes are generally coplanar and generally perpendicular to the wheel axle. Arrow 78 points to the direction of skating which is generally in parallel to the longitudinal direction of a skate shoe. The distance between the virtual center 25 and the virtual axis 45 is marked as 52. Two pivotal members 40 on the wheel support located opposite each other across virtual axis 45 are marked 40A and 40B while the base element 60 is shown with its other side marked 110. A skating surface 55 is shown in FIG. 4. The overall length of a connector 75 is marked 76 while its thickness at the end 77. In FIG. 2. The virtual center of a wheel is defined at 25 as the center of the space volume occupied by wheel 10. The virtual axis 45 is defined as an axis parallel to a pivotal axis of pivotal member 40 which determines the orientation of wheels 10.

[0064] Since the forward or backward propelling forces are generated by the reaction forces from the wheels, in order for the figure skate configuration to work properly, there is a need of a balancing torque to prevent the wheel supports from turning when turning or spinning is not intended. This is accomplished by locating each virtual axis at a non-zero distance from a respective virtual center. As the majority of skate wheels are sized from 50 mm to 80 mm in diameter, a reasonable and effective choice of such a non-zero distance or offset would be something in the neighborhood of 5 mm. A distance of less than 5 mm may not be sufficient to yield a torque strong enough to achieve the turning and spinning functions. Equally important is such a non-zero distance or offset between the virtual center and the virtual axis in order that the magnitude of the torque couple for the pair of wheels may generate easy and smooth turning and spinning activities. The same understanding could be applied to the relationship between a pivotal axis and a respective virtual axis in that a balancing torque is needed to prevent the wheel supports from turning when not intended, thus each pivotal axis is located at least 5 mm from a respective virtual axis.

[0065] Several variations of the present invention are shown in detail below. In the construction suitable for conversion between in-line and parallel configurations, the rotational planes of the wheels are maintained parallel to each other throughout the conversion. In the construction suitable for turning and spinning the wheels in different directions, the rotational planes of the wheels are allowed to turn with respect to a given predetermined orientation, such as the longitudinal direction of a skate shoe.

[0066] To obtain the in-line skate wheel configuration shown in FIGS. 5A, 5B, and FIG. 6, the connector is rotated to a position parallel to the in-line orientation. As the wheel connector is rotated, the pivotal member pivots about the pivotal axis contemporarily pivoting wheels to a position parallel to in-line orientation. Optionally, the base element may include a notch or other such structural feature to engage the connector in a given position for securing the skate configuration desired.

[0067] To obtain the figure skate wheel configuration shown in FIGS. 7, 8, and 9, each pivotal member may be attached to a base element and is rotatable about a respective virtual axis with respect to the base element. The connector is adapted to rotate with the pivotal member to a new position parallel to its original orientation. As each wheel is turned against a friction surface the wheel support pivots about the virtual axis contemporarily pivoting the pivotal member and the connector to a new position and a new wheel orientation according to the actions and desire of the skater.

[0068] FIG. 1 shows wheel 10 with wheel support 35 and a pair of pivotal members 40A and 40B associated with a pair of connectors 75. FIG. 2 shows the configuration and general profile of connector 75. FIG. 3 shows a positioning method utilizing a series of positioning features attached to a base element. Such features can be in the form of simple notches 65A and protrusions 65B as shown or more elaborate mechanical shapes that fulfill the positioning purpose.
This is in contrast to the virtual axis shown in FIG. 1 which is not constrained to rotate about its own axis with respect to the base element.

The embodiment of FIG. 4 is similar to the embodiment of FIG. 1 described above, except for pivotal member 40 having only a single connector 75. In addition, base member 110 has a pivoting provision 120 which constrains the rotation of pivotal member 40 with respect to a virtual axis.

FIG. 5A depicts a parallel configuration of a convertible in-line/parallel skate wheel assembly. The embodiment of FIG. 5B is similar to the embodiment of FIG. 5A described above, except for that wheels 10 are aligned in an in-line configuration. To obtain such a construction one could selectively utilize a base element, two pairs of connectors and two pairs of pivotal members for each wheel support according to the present invention.

FIG. 6 shows an overhead profile of a convertible in-line/parallel skate wheel assembly in procession. As pivotal members 40A and 40B of each wheel support rotate with respect to the pivotal axis, the pivotal members and the wheel supports 35 rotate together. Such rotation implicitly can be carried out by temporarily dislodging the engagement of the pair connectors with a base element using the positioning features and then release them when a desired position has been secured. Biaxial mechanisms such as a spring or a resilient plastic cushion can be used to provide self restoring force to reposition the connections and may be connected to either the connector or the base element of the wheel support. During the entire rotation the rotational planes of the pair of wheels remain parallel to a predetermined orientation.

FIG. 7 presents perspective views of a pair of roller wheels 10 each in conjunction with a respective pivotal member 40, a respective wheel support 35, a respective connector 75, and a biasing mechanism 70. FIG. 7 shows how by implicitly turning the wheels against a friction surface 55, a skater can turn to a skating direction of his or her choice. The pair of wheels 10 are so constructed so that during such turning action, the positioning of pivotal members 40 and the resulting change of the orientation of wheels 10 are concurrent. Biaxial mechanism 70 allows wheels 10 to return to their original predefined orientation once a turning or spinning activity has been completed.

FIGS. 8 and 9 depict in more detail the procession of the turning of a roller skate device composed of two pairs of wheels constructed according to the present invention. FIG. 8 shows the concurrent turning of the wheels 10 with respect to the connectors 75 and results in the wheels being turned a slanted position then all the way to a position ninety degrees away from their original position then turned back to the original position. This innovative turning feature is a major departure from existing skate constructions that all have their wheels arranged to travel along the longitudinal direction of a skate shoe. In so doing one could notice that each pair of wheels 10 are connected through a connectors 75 in such a way that their virtual centers 25 are located both on the opposite sides of their virtual, or constraining, axis 45 or both on the same sides of their constraining axis. In FIG. 8 these two virtual centers are shown pointing away from each other with respect to connector 75. In FIG. 9 these virtual centers are shown closer together between the two ends of the connector. When the wheels are rotated with respect to their constrained axes 45 against a skating friction surface, the rotation of each pair of wheels are so that they turn in the same direction, either clockwise together or counter clockwise together, with respect to their axis of rotation 45. Thus allowing a skater to turn and spin as part of skating maneuver.

FIGS. 10 and 11 depict top plan views of two different methods for connecting a pair of wheels 10 that also allows turning of the wheel rotational planes according to the present invention. FIG. 10 starts with the pair of wheels positioned asymmetric to the connector and end up in a position where the pair of wheels are turned ninety degrees and are extended outwardly from their respective pivotal member. FIG. 11 starts with the pair of wheels positioned in parallel to each other and are perpendicular to a line drawn between the two pivotal axes of the pivotal members. These views show how the turning of the wheels resulted in their rotational planes being perpendicular to that of the original position. Both FIG. 10 and FIG. 11 demonstrated the option for the pair of wheels to turn in either of the clockwise or the counter clockwise direction. Thus the freedom of the wheels are sufficient to accomplish typical turning and spinning actions as generally observed during the turns involved in a figure skating.

In FIG. 8 and FIG. 9 one could see a first rotatable wheel 10 and a second rotatable wheel 10 are associated with each of the two pairs of the skating device mounted under the base 110. Referring back to FIGS. 1-5, each of the wheels are implicitly associated with a wheel support with at least one pivoting member 40. Each of the first and second rotatable wheels having an axle and defining a virtual center plane and a rotational plane. The rotational planes and the virtual center plane are generally coplanar and generally perpendicular to the wheel axle. Each of the first and second wheel supports are with a corresponding one of a pair of rotatable wheels and a pair of virtual axes. Each pivot member is attached to the wheel support for controlling rotation of the wheel support relative to the pivotal member. The pivotal axis of the pivotal members is offset from a respective virtual axis. A connector connects the pivotal member from each of the first and second wheel supports.

Looking at the very left pair of wheels in FIG. 8 and FIG. 9, when the pair of wheels are pushed against the skating friction surface by the skater in a direction parallel to the wheel axle, the contacting points directly under the virtual centers of each wheel will exert moment with respect to the pivotal axes. While one wheel will exert a moment that is counterclockwise with respect to its pivotal axis, the other wheel will exert a moment that is clockwise with respect to its pivotal axis. Therefore, the two moments are subtractive and work against each other. Providing these two moments are approximately equal in magnitude, since they are subtractive in nature they will prevent the wheels from being rotated and thus allowing the skater to receive a reaction force that propels the skater in a direction approximately perpendicular to the rotational planes of the wheels. Whenever the direction of skating and the longitudinal direction of a skate is at a non-zero angle a skater can use a fraction of such a reaction force to skate forward in a left push and right push alternative fashion.

In this invention the connector and the first and second wheel supports are structured and arranged to allow
the rotational planes of the first and second wheels to remain coplanar when the reaction moment acting on the first wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the first wheel support are subtractive to the reaction moment acting on the second wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the second wheel support. In this invention the connector and the first and second wheel supports are also structured and arranged to allow the rotational planes of the first and second wheels to rotate when the reaction moment acting on the first wheel support from a skating surface with respect to one of the pivotal axes of the pivotal members of the second wheel support.

[0078] This feature described above is a major departure from existing roller skate constructions that all have their wheels arranged to travel along the longitudinal direction of a skate shoe. The old traditional quad skates do so by fixing their wheels to a fix frame chassis. The newer convertible in-line/parallel skates do so by keeping the wheels parallel to the longitudinal direction of the skate shoe while allowing the chassis to rotate and reposition. This invention thus demonstrated the inventive steps in arriving at a new and useful skating device which is capable of spinning and turning like what could be done with a ice figure skate.

[0079] FIGS. 12 and 13 illustrate a method of composing the pair of wheels with the respective pivotal members and the connector. The connector may be attached to a base element of a skating device and is adapted to rotate with respect to an axis located in the vicinity of a line drawn between the two ends of a connector. Such a wheel assembly has more freedom for turning and spinning of the pair of wheels. Concurrent positioning of the pair of wheels are maintained although the rotational planes of the wheels are not necessarily maintained in parallel to each other.

[0080] FIGS. 14A and 14B show two methods of constructing positioning features for securing positions of a pair of wheels through the constraining of the pair of connectors for an in-line/parallel wheel assembly according to the present invention.

[0081] According to the present invention, the connectors are not limited to any particular geometry. The locations of the virtual axis and the pivotal axis and the rotational axis of a connector all can be located at any reasonable location within the general space defined by the wheel assembly. No symmetry is required for any of these components and their rotating axes. With the summary of the versatility of the present invention given in Table 1 in view a special case thus can be arrived by putting all these rotation axes at the respective geometry center of each component.

[0082] While this invention has been described as having a preferred design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

1. A convertible wheel apparatus for a skating device comprising:

a first rotatable wheel and a second rotatable wheel, each of said first and second rotatable wheels having an axle and defining a virtual center plane and a rotational plane, said rotational plane and said virtual center plane being generally coplanar and generally perpendicular to said axle;

a first wheel support and a second wheel support, each of said first and second wheel supports with a corresponding one of said rotatable wheels and defining a virtual axis, each said wheel support including at least one pivotal member defining a pivotal axis, each said pivotal member attached to said wheel support for controlling rotation of said wheel support relative to said pivotal member, at least one pivotal axis of said pivotal members being offset from a respective virtual axis;

a connector connecting one of said pivotal members from each of said first and second wheel supports, said connector and said first and second wheel supports being structured and arranged to allow the rotational planes of said first and second wheels to remain coplanar when the reaction moment acting on the first wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the first wheel support are subtractive to the reaction moment acting on the second wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the first wheel support to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the first wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the first wheel support are additive to the reaction moment acting on the second wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support, and to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the first wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support, and to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the first wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support, and to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the second wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support, and to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the second wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support, and to allow the rotational planes of said first and second wheels to rotate when the reaction moment acting on the second wheel support from a skating surface with respect to one of said pivotal axes of said pivotal members of the second wheel support.

2. The convertible wheel apparatus of claim 1 wherein each of said virtual axes is located at least 5 mm away from the virtual center of a respective wheel.

3. The convertible wheel apparatus of claim 1 wherein one of said pivotal axes is located at least 5 mm away from the virtual axis of a respective wheel.

4. The convertible wheel apparatus of claim 1 wherein each said wheel support includes a pair of pivotal members having pivotal axes generally parallel to a respective virtual axis.

5. The convertible wheel apparatus of claim 4 wherein said pair of pivotal members is located approximately the opposite sides across said virtual axis.

6. The convertible wheel apparatus of claim 1 further including means for controlling the orientation of the rotational planes of said pair of wheels with a biasing mechanism.

7. The convertible wheel apparatus of claim 6 wherein said biasing mechanism is attached to one of said connector and a base element associated with said wheel support.
8. The convertible wheel apparatus of claim 1 wherein one of said pivotal members further includes a pivot for rotatably attaching said pivotal member to a base of a skating device.

9. A convertible wheel apparatus for a skating device comprising:

- a pair of wheels, each said wheel having an axle and defining a virtual center and a rotational plane, said virtual center being located in a plane coplanar with said rotational plane, said rotational plane and virtual center being generally perpendicular to said axle;

- a pair of wheel supports, each said wheel support engaging a said wheel and defining a virtual axis, each said wheel support including at least one pivotal member defining a pivotal axis parallel to said virtual axis, said pivotal member controlling rotation of said wheel support with respect to said virtual axis at least one pivotal axis being offset from a respective virtual axis; and

- a connector attached to one of said pivotal members of each said wheel support, said connector capable of concurrently positioning said pivotal members.

10. The convertible wheel apparatus of claim 9 wherein the concurrent positioning of said pivotal members involves rotation of said pair of wheel supports with respect to said virtual axis of each said wheel supports and results in rotation of the rotational planes of said pair of wheels with respect to each said respective virtual axis.

11. The convertible wheel apparatus of claim 9 wherein each said wheel support includes at least a pair of pivotal members having pivotal axes generally parallel to a respective virtual axis.

12. The convertible wheel apparatus of claim 11 wherein said pair of pivotal members is located approximately opposite each other across said virtual axis.

13. The convertible wheel apparatus of claim 12 wherein one of said pair of pivotal members has a pivotal axis which coincides with a line parallel to one said virtual axis and proximate to one said virtual center.

14. The convertible wheel apparatus of claim 9 further including means for controlling the orientation of said rotational planes of said pair of wheels with a friction surface that makes contact with said pair of wheels.

15. The convertible wheel apparatus of claim 9 further including means for controlling the orientation of said rotational planes of said a pair of wheels with an element having discrete number of positioning features.

16. The convertible wheel apparatus of claim 9 further including means for controlling the orientation of said rotational planes of said a pair of wheels with a biasing mechanism.

17. The convertible wheel apparatus of claim 16 wherein said biasing mechanism is attachable to one of said connector and a base element associated with said wheel support.

18. The convertible wheel apparatus of claim 9 wherein said concurrent positioning of said a pair of pivotal members involves rotation of said pair of wheel supports with respect to said connector while said rotational planes of said pair of wheels remain parallel to a predetermined orientation.

19. The convertible wheel apparatus of claim 18 wherein said connector further includes a rotational pivot for rotating said connector about an axis located between its two ends and proximate to a line defined between its two ends.

20. The convertible wheel apparatus of claim 18 wherein said connector further includes a pivot for attaching said connector to a base of a skating device.

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