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Langston et al.

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(54) **TRACK DRIVE WITH SPRING-BIASED FEET**

(71) Applicant: **United States of America as represented by the Secretary of the Navy**, Arlington, VA (US)

(72) Inventors: **Tye Langston**, Lynn Haven, FL (US); **Dane Maglich**, Panama City Beach, FL (US)

(73) Assignee: **United States of America as represented by the Secretary of the Navy**, Washington, DC (US)

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B62D 55/06 (2006.01)

(52) **U.S. Cl.**
CPC ***B62D 55/265*** (2013.01); ***B62D 55/06*** (2013.01)

(58) **Field of Classification Search**
CPC B62D 55/215; B62D 55/265
See application file for complete search history.

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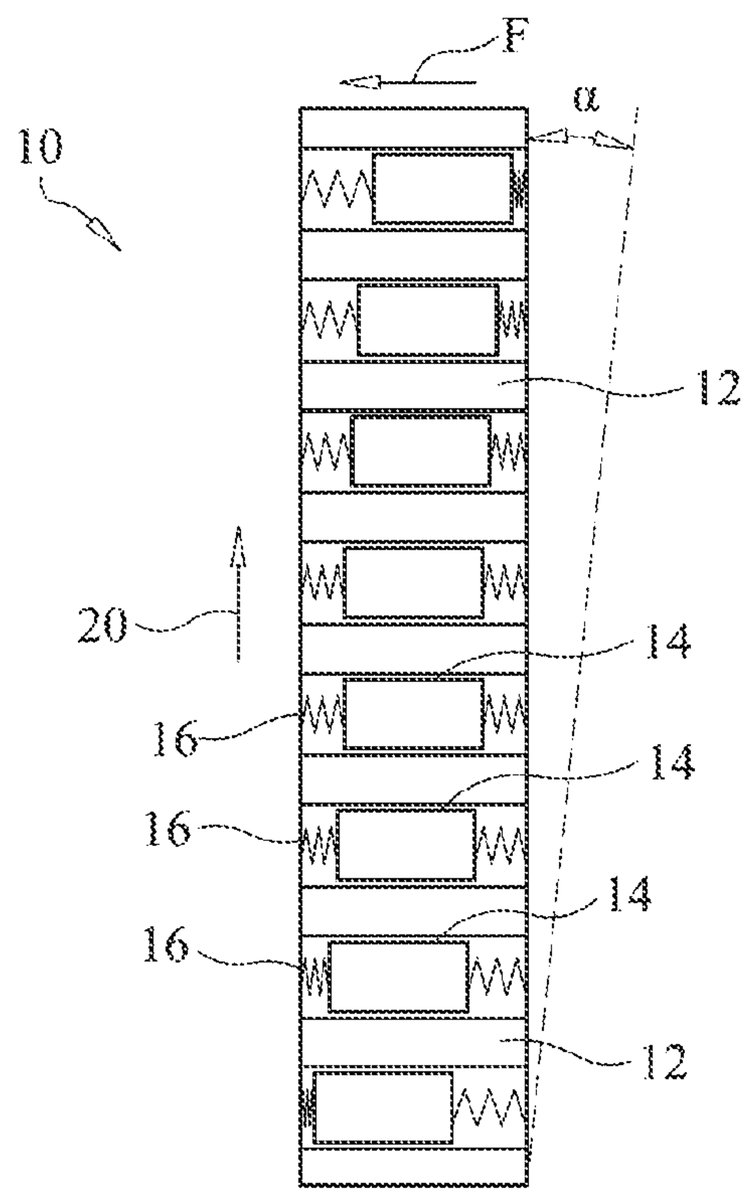
Primary Examiner — Kevin Hurley
Assistant Examiner — Hosam Shabara
(74) *Attorney, Agent, or Firm* — James T. Shepherd

(57) **ABSTRACT**

An endless track drive that can be coupled to a vehicle includes a plurality of track feet wherein each track foot is adapted to periodically contact a surface on which the vehicle is to travel as the endless track drive is rotated. At least one spring is coupled to each track foot. The spring(s) apply a biasing force to the track foot that positions the track foot in a neutral position relative to the endless track drive when the track foot is not in contact with the surface. The biasing force is less than a frictional force experienced by the track foot when the track foot is in contact with the surface.

18 Claims, 3 Drawing Sheets



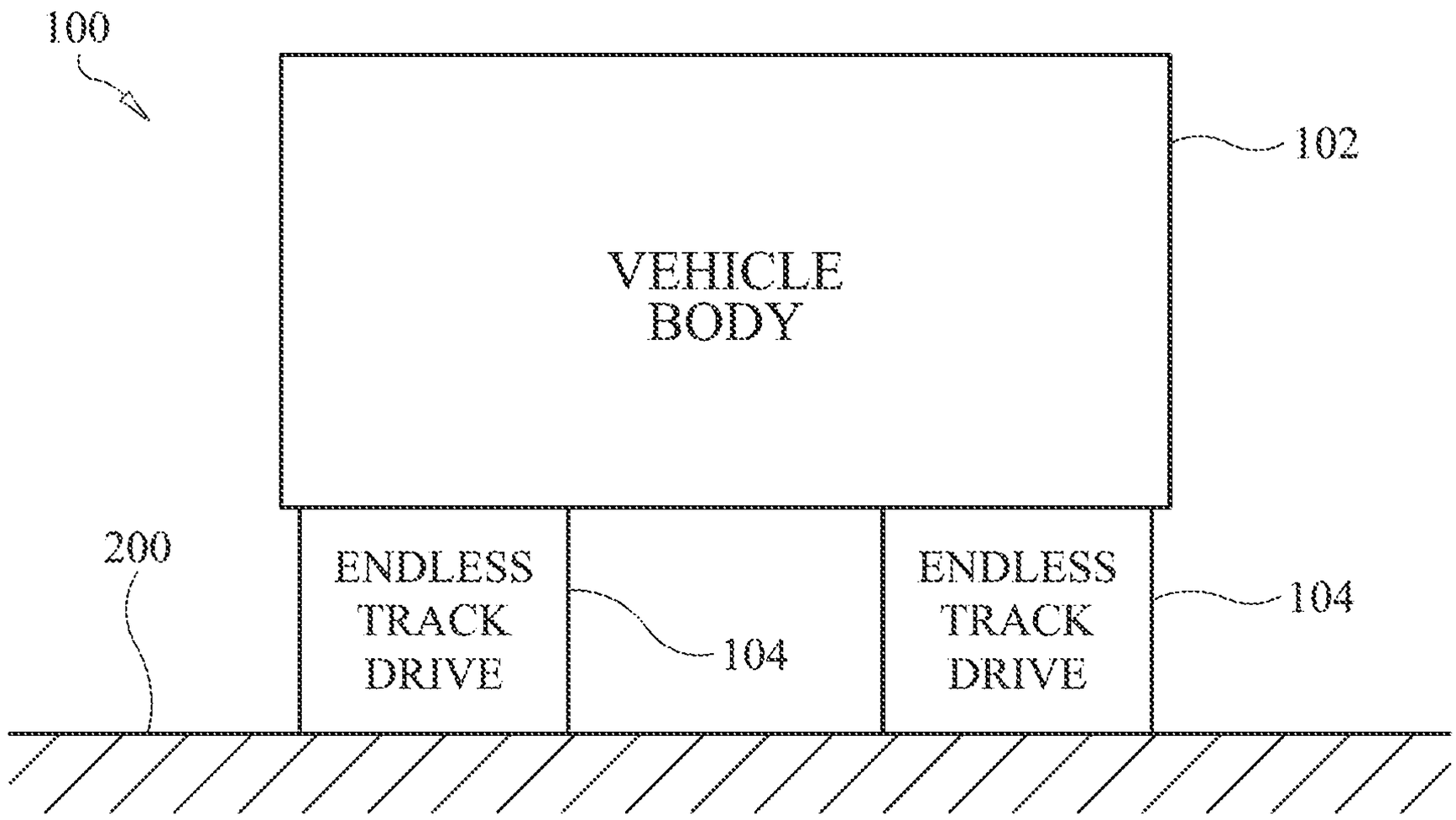


FIG. 1
(PRIOR ART)

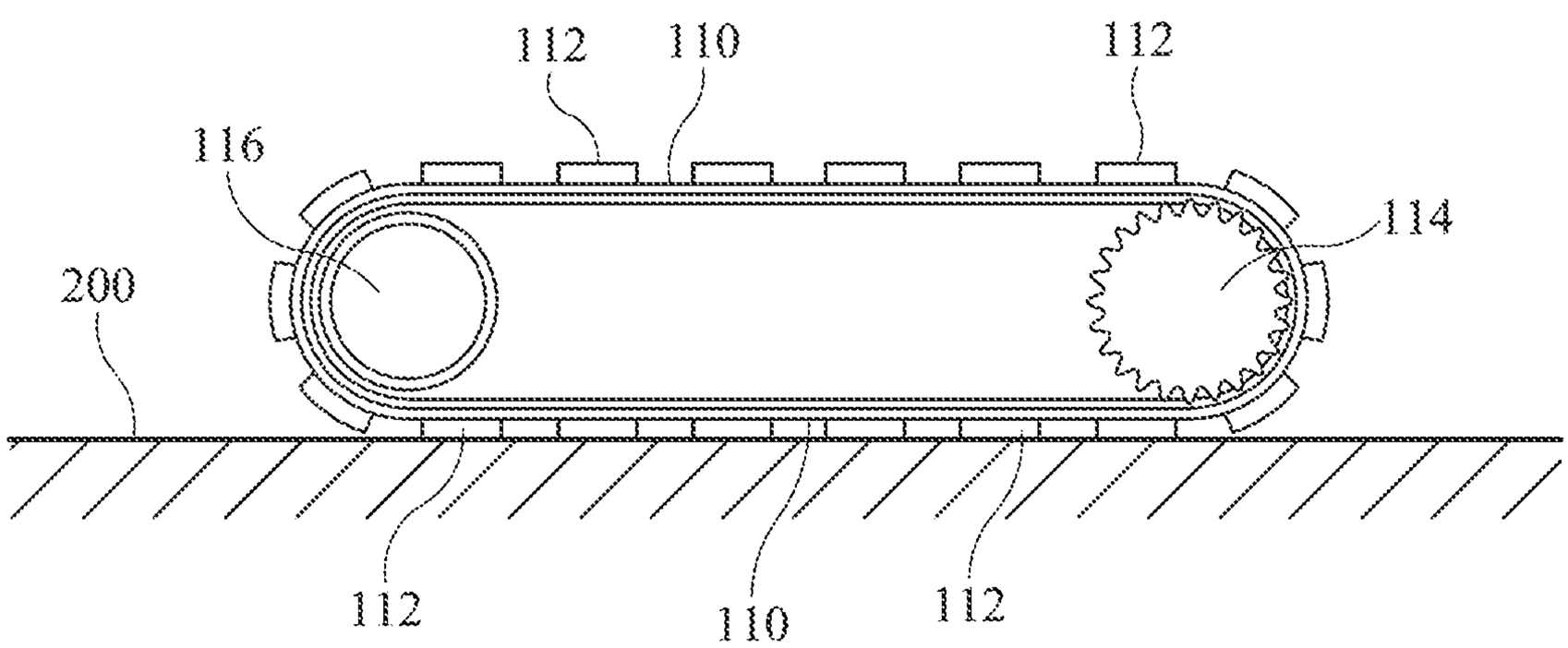


FIG. 2
(PRIOR ART)

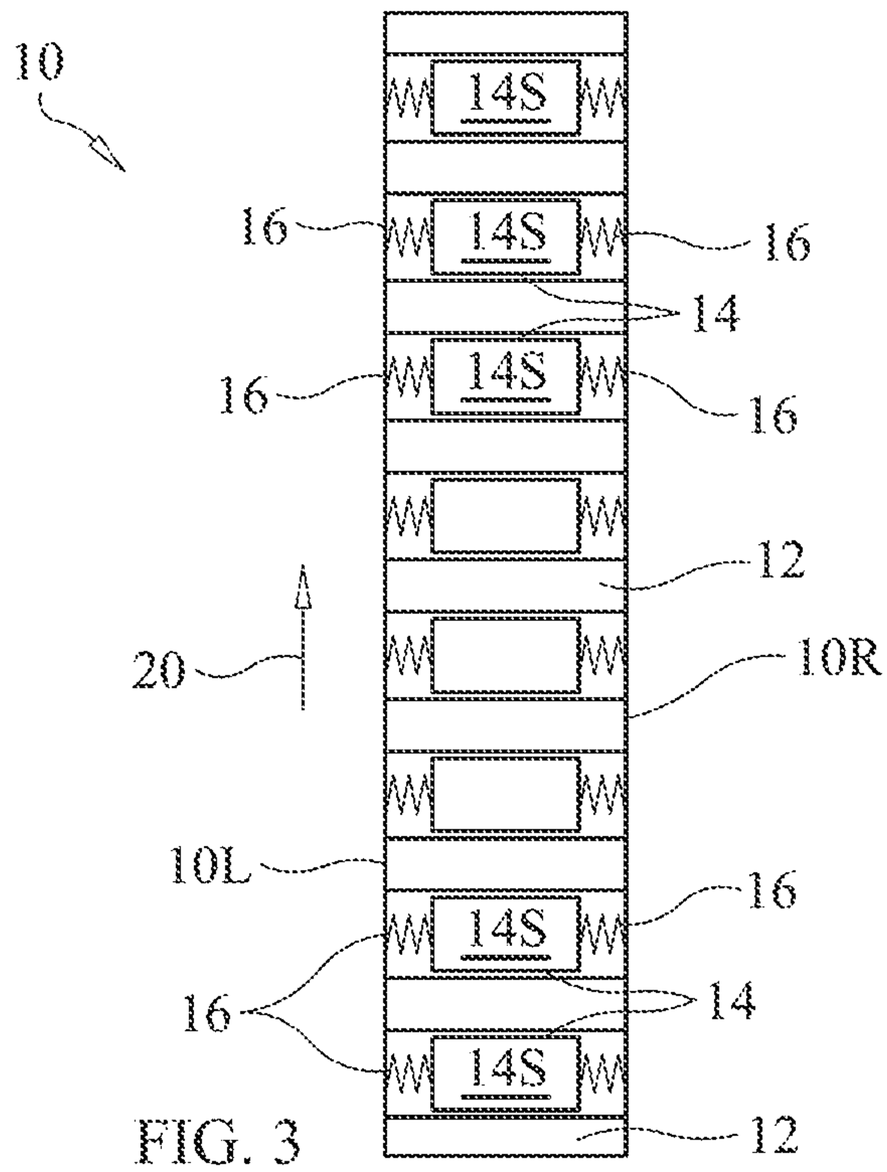


FIG. 3

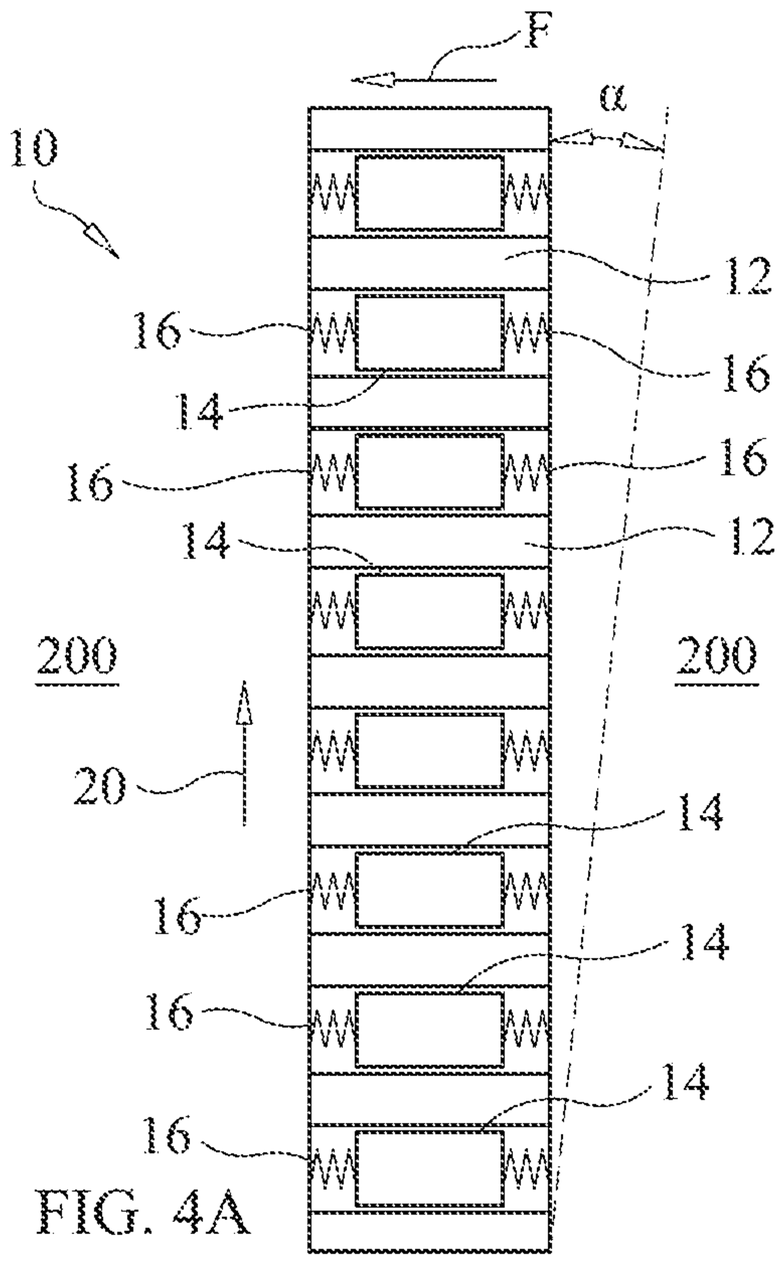


FIG. 4A

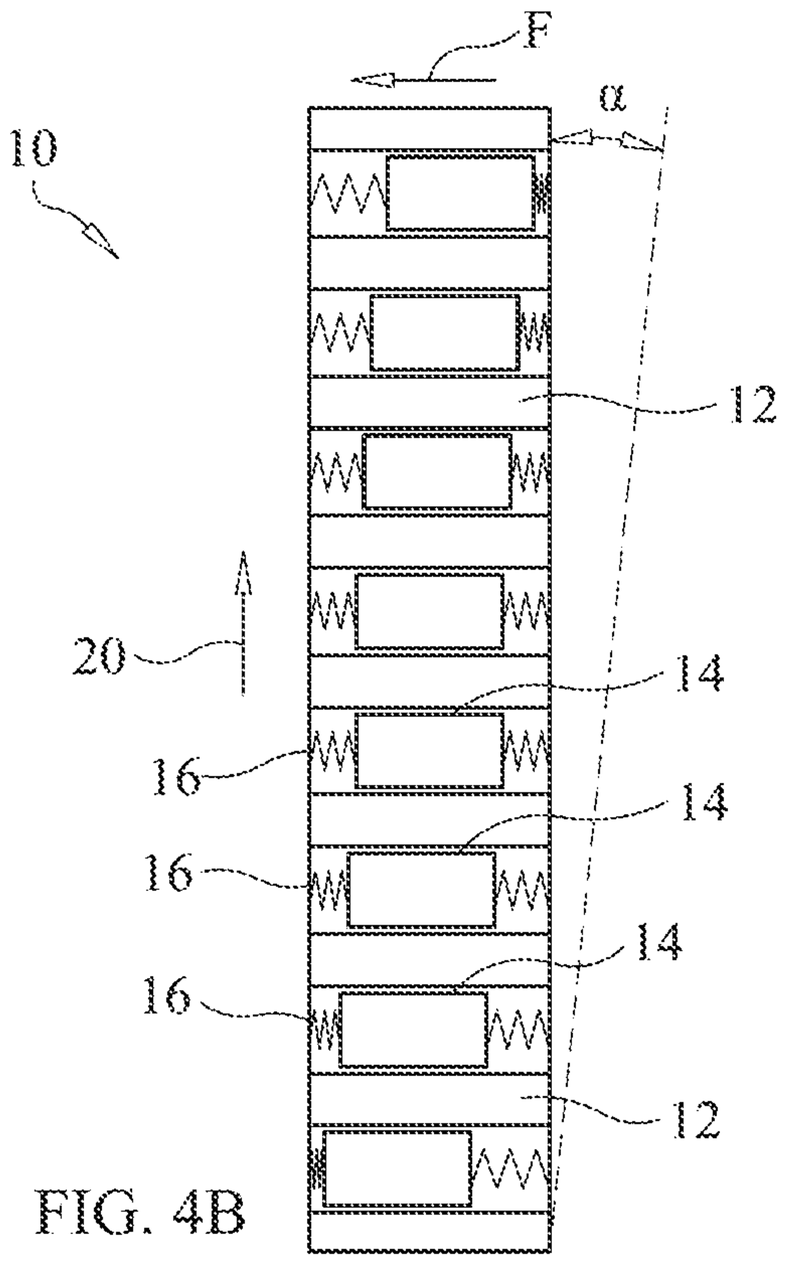


FIG. 4B

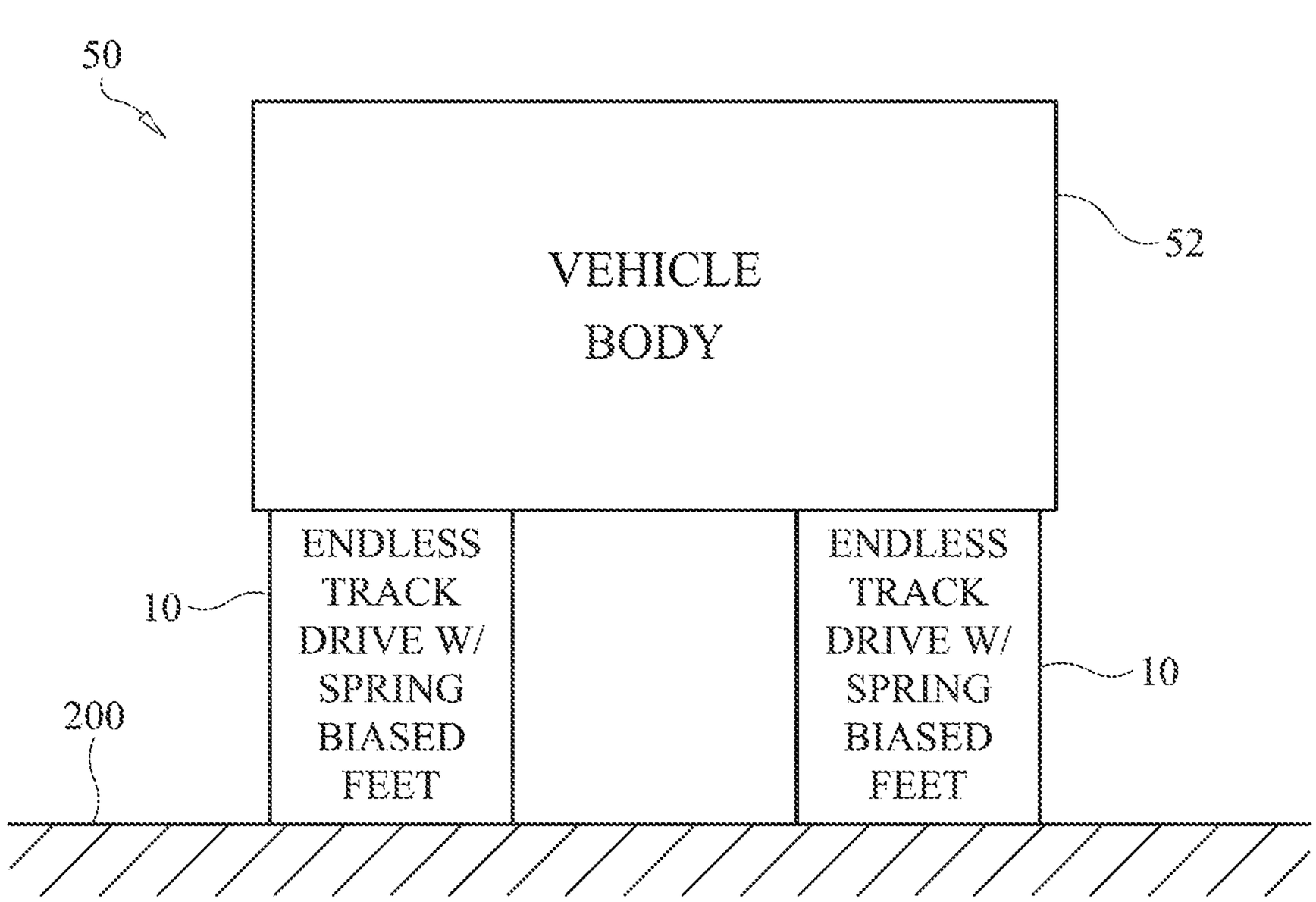

50
VEHICLE BODY
52
ENDLESS TRACK DRIVE W/ SPRING BIASED FEET
10
ENDLESS TRACK DRIVE W/ SPRING BIASED FEET
10
200

FIG. 5

TRACK DRIVE WITH SPRING-BIASED FEET

ORIGIN OF THE INVENTION

FIELD OF THE INVENTION

The invention relates generally to endless track drives, and more particularly to an endless track drive whose feet are spring-biased to support a no-skid turning operation of a track drive vehicle equipped with two of the track drives.

BACKGROUND OF THE INVENTION

Vehicles that operate on two track drives (e.g., tanks, construction equipment, crawlers, etc.) typically turn by driving one track drive faster than the other to achieve what is known as differential steering or "skid-steer" turning. As the name suggests, this type of turning results in the track drives sliding (or skidding) across the surface they are on, which is usually not desired. Skid-steer turning damages the surface the track drives are operating on and/or the track drives themselves as the fixed orientation track drives drag on the surface. For example, a skid-steer loader will significantly tear up a lawn or dirt surface during a turning operation. When a track drive vehicle operates on a hard surface like pavement or concrete, the sliding action quickly wears away the track material. In cases where there is high friction between the track drives and the operating surface, skid-steer turning requires significant energy and puts additional stress on a track drive's surface-contacting feet, endless belt, axles, sprockets and motor.

In addition to the above-described drawbacks associated with skid-steer turning, using a magnetic track drive vehicle on a vertical or overhanging surface presents unique problems. For example, developers of track drive-based magnetic crawlers know that allowing a track drive to slip or skid during turning is contrary to the need to maximize the holding force on the surface and yet not have to overcome that force in order to turn.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a track drive and track drive system that avoids the problems associated with track drive systems and vehicles that rely on skid steering.

Another object of the present invention is to provide a track drive vehicle that reduces damage to surfaces on which the track drive vehicle must traverse.

Still another object of the present invention is to provide a track drive vehicle for use on vertical surfaces.

Other objects and advantages of the present invention will become more obvious hereinafter in the specification and drawings.

In accordance with the present invention, a track drive is provided for use in a track drive system and track drive vehicle using two of the track drives. The track drive is an endless track drive adapted to be coupled to a vehicle. The endless track drive includes a plurality of track feet wherein each track foot is adapted to periodically contact a surface on which the vehicle is to travel as the endless track drive is rotated. At least one spring is coupled to each track foot. The spring(s) apply a biasing force to the track foot that positions the track foot in a neutral position relative to the endless track drive when the track foot is not in contact with the surface. The biasing force is less than a frictional force experienced by the track foot when the track foot is in contact with the surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become apparent upon reference to the following description of the preferred embodiments and to the drawings, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

FIG. **1** is a schematic view of a conventional track drive vehicle having two track drives coupled to a vehicle body;

FIG. **2** is an isolated side schematic view of a conventional track drive on an operating surface;

FIG. **3** is a schematic plan view of a track drive with its track feet biased to a neutral position in accordance with an embodiment of the present invention;

FIG. **4**A is schematic view of the top or non-surface engaging portion of the track drive shown in FIG. **3** when the track drive is subjected to a side force induced during a turning operation;

FIG. **4**B is a schematic view of the bottom or surface engaging portion of the track drive shown in FIG. **3** when the track drive is subjected to the side force induced during the turning operation; and

FIG. **5** is a schematic view of a track drive vehicle having two track drives with spring-biased feet in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a conventional track drive vehicle is illustrated schematically in FIG. **1** and is referenced generally by numeral **100**. As is well-understood in the art, track drive vehicle **100** includes a vehicle body **102** and two spaced-apart endless track drives **104** coupled to vehicle body **102**. Typically, track drives **104** are parallel to one another. As used herein, the term "vehicle" includes manned and unmanned vehicles, robots, surface-traversing equipment, etc.

As shown in FIG. **2**, each conventional endless track drive **104** includes an endless belt **110** having a plurality of surface-contacting feet **112** fixedly coupled thereto. Endless belt **110** is driven to rotation by, for example, a drive sprocket **114** coupled to a motor drive (not shown). One or more free wheels **116** are provided to keep endless belt **110** properly tensioned and to support rotation of endless belt **110** as drive sprocket **114** is rotated as is well-known in the art.

Briefly, as track drive vehicle **100** is driven on an operating surface **200** (e.g., horizontal surface, sloped surface, vertical surface), a portion of feet **112** are in contact with surface **200** and a remainder of feet **112** are not in contact with surface **200**. When track drive vehicle **100** is to be turned on surface **200**, one of endless track drives **104** shown in FIG. **1** is rotated at a faster speed while the other is rotated at a slower speed thereby causing vehicle **100** to essentially slide or skid through an arc. More specifically, side forces are applied to portions of the rotating endless track drives causing the drives to slide or skid on surface **200**. As a result,

the feet **112** of the skidding portions of the track drives that are in contact with surface **200** are dragged across the surface. The sliding/skidding feet subject the operating surface to damage, while the track drives and their various parts are subjected to substantial stress.

The present invention reduces or eliminates the side slide/skid associated with the turning of track drive vehicles. The novelty of the present invention will be explained herein for a single track drive. However, it is to be understood that a typical track drive vehicle would have two of the present invention's track drives coupled thereto, each of which will be configured with the present invention's novel features.

Referring now to FIG. **3**, a plan schematic view of a single track drive in accordance with an embodiment of the present invention is shown and is referenced generally by numeral **10**. As will be explained further below, two of track drive **10** will typically be used to construct a track drive system that can be coupled to a vehicle body to thereby construct a track drive vehicle. Since both such track drives would incorporate the present invention's novel features, it is sufficient to describe those features for a single track drive. Although not shown, it is to be understood that drive mechanisms would be coupled to track drive **10** in order to drive it into rotation as would be well understood in the art.

Track drive **10** is an endless track drive that includes an endless belt **12** having a plurality of surface-engaging feet **14** spaced apart along belt **12** and coupled to belt **12**. As belt **12** is rotated in a direction **20**, a portion of feet **14** engage an operating surface **200**, while a remainder of feet **14** do not as is well understood in the art. The surface **14**S of each foot **14** that will engage an operating surface can include three-dimensional or relief features that aid in gripping the operational surface. If an operating surface is one that is magnetically attractive, each surface **14**S (or all of each foot **14**) could be magnetic. In other embodiments, feet **14** could be magnetic with their surface **14**S also including three-dimensional surface gripping features. For other embodiments, some of feet **14** could have three-dimensional surfaces **14**S, while others of feet **14** have magnetic surfaces **14**S without departing from the scope of the present invention. Still other or additional grip enhancing features could include suction cups or chemical forms of adhesion without departing from the scope of the present invention.

In accordance with the present invention, each of feet **14** has one or more springs or spring-like devices **16** coupled thereto. When no force is applied to a foot **14**, the foot's corresponding spring(s) **16** bias the foot to a neutral position on track drive **10**. In the above-noted neutral position, a foot **14** can be moved towards either lateral side (i.e., side **10**L or side **10**R) of track drive **10** if the biasing force applied by spring(s) **16** is overcome. Accordingly, when track drive **10** is deployed on an operating surface with belt **12** being driven to rotation in (for example) direction **20**, any of feet **14** not engaging the operating surface will be in their above-described neutral position.

Referring now simultaneously to FIGS. **4**A and **4**B, a turning operation for track drive **10** will be explained. For purpose of this explanation, it is assumed that a track drive system encompassing two of track drive **10** is coupled to a vehicle body (not shown). FIG. **4**A illustrates the positions of feet **14** that are not engaging an operating surface **200** during the turning operation, while FIG. **4**B illustrates the position of feet **14** that are engaging the operating surface (not visible in this view) during the turning operation.

As is known in the art of track drive systems/vehicles undergoing a turning operation, one of two track drives is rotated faster than the other of the two track drives. In FIGS. **4**A and **4**B, it is assumed that the illustrated track drive **10** is the one being rotated in direction **20** at a slower rate than its parallel/opposing track drive (not shown). When this occurs, those of feet **14** engaged on the operating surface (FIG. **4**B) will experience a skidding or sliding friction force F that is perpendicular to direction **20**, while those of feet **14** not engaged on the operating surface (FIG. **4**A) will not experience the friction force F. Accordingly, feet **14** in FIG. **4**A are maintained in their neutral position by springs **16**. However, as shown in FIG. **4**B, when friction force F exceeds the biasing force applied by springs **16** of a foot **14**, springs **16** yield (e.g., via expansion, contraction, and/or flexion) to the larger friction force F whereby each such foot **14** does not slide or skid on the operating surface. Instead, each such foot **14** maintains its position on the operating surface as track drive **10** pivots through an angle α during the turning operation.

As mentioned above, two of track drives **10** will generally comprise a track drive system that can be coupled to vehicle body for a track drive vehicle. This is illustrated schematically in FIG. **5** where a track drive vehicle **50** in accordance with an embodiment of the present invention has two of track drives **10** coupled to a vehicle body **52** for deployment on a horizontal, sloped, or vertical operating surface **200**.

The advantages of the present invention are numerous. Well-known track drive vehicles can be improved to provide non-skid turning operations that preserve the integrity of an operating surface. The spring-biased feet can be configured for operation on a variety of surfaces and surface orientations.

Although the invention has been described relative to specific embodiments thereof, there are numerous variations and modifications that will be readily apparent to those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A track drive system for a vehicle, comprising:

two endless track drives adapted to be coupled to a vehicle at opposing sides of the vehicle, each of said endless track drives including a plurality of track feet wherein each track foot from said plurality of track feet is adapted to periodically contact a surface on which the vehicle is to travel as its corresponding one of said endless track drives is rotated; and

at least one spring coupled to each said track foot for applying a biasing force to said track foot that positions said track foot in a neutral position relative to its corresponding one of said endless track drives when said track foot is not in contact with the surface, wherein said biasing force is less than a frictional force experienced by said track foot when said track foot is in contact with the surface.

2. A track drive system as in claim **1**, wherein said track foot is magnetic.

3. A track drive system as in claim **1**, wherein said track foot includes a face for engaging the surface on which the vehicle is to travel, wherein said face includes three-dimensional features adapted to grip the surface.

4. A track drive system as in claim **3**, wherein said track foot is magnetic.

5. A track drive system as in claim **1**, wherein said at least one spring comprises two springs.

6. A track drive system as in claim **1**, wherein said endless track drives have a direction of rotation associated therewith

when said endless track drives are rotated, and wherein said biasing force is perpendicular to said direction of rotation.

7. A track drive vehicle, comprising:

a vehicle body;

two endless track drives coupled to said vehicle body at opposing sides of said vehicle body, each of said endless track drives including a plurality of track feet wherein each track foot from said plurality of track feet is adapted to periodically contact a surface on which the vehicle is to travel as its corresponding one of said endless track drives is rotated; and

at least one spring coupled to each said track foot for applying a biasing force to said track foot that positions said track foot in a neutral position relative to its corresponding one of said endless track drives when said track foot is not in contact with the surface, wherein said biasing force is less than a frictional force experienced by said track foot when said track foot is in contact with the surface.

8. A track drive vehicle as in claim **7**, wherein said track foot is magnetic.

9. A track drive vehicle as in claim **7**, wherein said track foot includes a face for engaging the surface on which the vehicle is to travel, wherein said face includes three-dimensional features adapted to grip the surface.

10. A track drive vehicle as in claim **9**, wherein said track foot is magnetic.

11. A track drive vehicle as in claim **7**, wherein said at least one spring comprises two springs.

12. A track drive vehicle as in claim **7**, wherein said endless track drives have a direction of rotation associated therewith when said endless track drives are rotated, and wherein said biasing force is perpendicular to said direction of rotation.

13. A track drive, comprising:

an endless track drive adapted to be coupled to a vehicle, said endless track drive including a plurality of track feet wherein each track foot from said plurality of track feet is adapted to periodically contact a surface on which the vehicle is to travel as said endless track drive is rotated; and

at least one spring coupled to each said track foot for applying a biasing force to said track foot that positions said track foot in a neutral position relative to said endless track drive when said track foot is not in contact with the surface, wherein said biasing force is less than a frictional force experienced by said track foot when said track foot is in contact with the surface.

14. A track drive as in claim **13**, wherein said track foot is magnetic.

15. A track drive as in claim **13**, wherein said track foot includes a face for engaging the surface on which the vehicle is to travel, wherein said face includes three-dimensional features adapted to grip the surface.

16. A track drive as in claim **15**, wherein said track foot is magnetic.

17. A track drive as in claim **13**, wherein said at least one spring comprises two springs.

18. A track drive as in claim **13**, wherein said endless track drive has a direction of rotation associated therewith when said endless track drive is rotated, and wherein said biasing force is perpendicular to said direction of rotation.

* * * * *