

ELECTROMAGNETIC ACTUATION SYSTEM

Technical Field

The present application is directed to an actuation system.

Background

Sortation forms an important part of the cycle of warehouse management where articles on a main conveyor belt are directed towards a specific point where articles for a particular order are collated. There are several mechanisms for directing the articles from the main conveyor belt to the specific point such as manual implementation or by use of paddle diverters, pushers, pop-up chain, belt transfer assemblies, and the like.

Summary of the Disclosure

According to an embodiment of the present disclosure, there is provided an electromagnetic actuation system. The electromagnetic actuation system includes a shaft, a first rotating member, and a first contacting member. The first rotating member is connected to the shaft and configured to rotate the shaft when passing through a first magnetic field. The first contacting member is connected to the shaft and configured to engage a second contacting member to transfer rotational energy from the shaft to the second contacting member.

According to an embodiment, there is provided a carriage. The carriage includes a carrier, a shaft, a first rotating member, a first contacting member, and a second contacting member. The carrier is configured to carry an object and move the object in at least one direction. The first rotating member is connected to the shaft and configured to rotate the shaft when passing through a first magnetic field. The first contacting member is connected to the

shaft and configured to engage the second contacting member to transfer rotational energy from the shaft to the second contacting member. Further, the second contacting member is configured to directly or indirectly transfer the rotational energy from the shaft to the carrier.

According to an embodiment of the present disclosure, there is provided a conveyor system. The conveyor system includes a plurality of carriages, a conveyor, and a first magnetisable element. Each of the carriages includes a carrier, a shaft, a first rotating member, a first contacting member, and a second contacting member. The carrier is configured to carry an object and move the object in at least one direction. The first rotating member is connected to the shaft and configured to rotate the shaft when passing through a first magnetic field. The first contacting member is connected to the shaft and configured to engage the second contacting member to transfer rotational energy from the shaft to the second contacting member. The second contacting member is configured to directly or indirectly transfer the rotational energy from the shaft to the carrier. The conveyor is configured to transport the plurality of carriages along a predetermined path. Further, the first magnetisable element is disposed at a predetermined position of the predetermined path and configured to generate the first magnetic field.

According to an embodiment of the present disclosure, there is provided a method for driving a carrier. The method includes transporting by a conveyor the carriage, including the carrier, along a predetermined path and applying, by a first magnetisable element, a first magnetic field at a predetermined position of the predetermined path. The first magnetic field causes a first rotating member connected to a shaft of the carriage to rotate the shaft when the first rotating member passes through the first magnetic field. Further, a rotational energy from the shaft is transferred to the carrier directly or indirectly by a plurality of contacting members.

According to an embodiment of the present disclosure, there is provided a non-transitory computer-readable medium storing instructions which, when executed by a computer, cause the computer to implement a method for driving a carrier. The method includes transporting the carriage, including the carrier, along a predetermined path and applying, by a first magnetisable element, a first magnetic field at a predetermined position of the predetermined path. The first magnetic field causes a first rotating member connected to a shaft of the carriage to rotate the shaft when the first rotating member passes through the first magnetic field. Further, a rotational energy from the shaft is transferred to the carrier by a plurality of contacting members.

Brief Description of Drawings

Figure 1 illustrates a side view of a first embodiment of a carriage;

Figure 2 illustrates several views of an embodiment of a rotating member;

Figure 3 illustrates an embodiment of a base;

Figure 4 illustrates an embodiment of the base, including magnetisable elements;

Figure 5 illustrates an embodiment of a magnetisable element connected to a pair of wires;

Figures 6A-6I illustrate different views of an example of the carriage in the first embodiment;

Figure 7 illustrates a second embodiment of a carriage;

Figure 8 illustrates some components of the carriage in the second embodiment;

Figure 9 illustrates the second embodiment of the rotating members;

Figure 10 illustrates the second embodiment of a pair of magnetisable elements without wires;

Figure 11 illustrates a flowchart of an exemplary method for driving a carrier and for sorting items included in the carriage;

Figure 12 illustrates a hardware description of a device according to exemplary implementations; and

Figure 13 illustrates an embodiment of a conveyor system, which includes one or a plurality of carriages.

Figures 14A-14J illustrate different views of an example of the carriage in the first embodiment;

Figures 15A-15I illustrates different views of an example of the carriage in the second embodiment;

Figures 16A-16H illustrate different views of another example of the carriage in the second embodiment.

Detailed Description of the Disclosure

While the present disclosure is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail specific embodiments, with the understanding that the present disclosure of such embodiments is to be considered as an example of the principles and not intended to limit the present disclosure to the specific embodiments shown and described. In the description below, like reference numerals are used to describe the same, similar or corresponding parts in the several views of the drawings.

Embodiments of the present disclosure include actuation systems that are configured to drive a carrier, which is configured to carry and move one or more objects. The carrier may be included in a carriage that is transported on a main conveyor system. The main conveyor system transports the carriage along a predetermined path. When the carriage reaches a specific point on the predetermined path, the carrier moves the one or more objects to unload the one or more

objects from the main conveyor system and the carriage. The specific point may correspond to where the one or more objects are to be collated (e.g., one or more articles for a particular order).

Figure 1 illustrates a first embodiment of a carriage utilizing an electromagnetic actuation system. The carriage is configured, for example, to sort articles on a conveyor (e.g., a main conveyor belt) towards specific points for article collation and/or order fulfillment in the management of articles in a warehouse. The carriage is transported along a predetermined path according to one embodiment, as illustrated in Figure 13 which is further described below.

The carriage includes a rotating member (e.g., a multi spoke magnetic wheel) 1 with magnetic spokes connected, or formed on, a shaft (e.g., an axle) 2. The rotating member 1 remains relatively stationary until driven by one or more magnetic fields. The magnetic spokes may be permanently or temporarily magnetized (e.g., induced by a trigger and/or battery). The carriage is a load carrying unit that travels on a conveyor including rails 6 and base 4 (which is illustrated in Figure 3). Although a conveyor in the embodiment illustrated in Figure 1 includes rails 6, it should be understood that the rails could be replaced with any other track system that can be used for a conveyor.

A pair of magnetic strips (e.g., an array of magnetic elements, such as electromagnets) 3 are positioned on the base 4 and configured to produce at least one magnetic field. In one embodiment, the at least one magnetic field is generated in response to receiving current. The magnetic field generated by the magnetic strips 3 can be changed by using an AC/DC voltage or current source. Specifically, each magnetic strip 3 can be connected to a relay system, which controls the amount of AC/DC voltage or current supplied to each magnetic strip 3. The relay system can be programmed so that the amount of AC/DC voltage or current and/or the timing of supply of the AC/DC voltage or current can be preset based on sorting needs. Alternatively, the

amount of AC/DC voltage or current and/or the timing of supply of the AC/DC voltage or current can be manually adjusted (or be programmed to be adjusted) after the sorting process has begun.

The pair of magnetic strips 3 are mounted on the base 4 and arranged in parallel. When the carriage approaches the pair of magnetic strips 3, the pair of magnetic strips 3 are set with different polarities such that they attract each other. When the rotating member 1 enters the magnetic field generated by the pair of magnetic strips 3, magnetic spokes in the rotating member 1 are attracted to one magnetic strip 3 and repelled by the other magnetic strip 3. This sets the rotating member 1 in motion and it starts gaining speed while traveling between the pair of magnetic strips 3 and along the base 4. This motion is then transferred to a carrier 5 (for example, a roller, a belt, PVC, other polymer belt, or modular belt) for sortation purposes.

The number of rotations of the rotating member 1 can be controlled. A hall sensor can be mounted on the base 4 to detect the number of rotations of the rotating member 1. The magnetic strips 3 can be demagnetized based on a signal from the hall sensor, and therefore, such a signal from the hall sensor can be used to control the number of rotations of the rotating member 1. Control of the number of rotations of the rotating member 1 allows for more precise placement or sorting of items located on the carrier 5. Accordingly, multiple items may be placed on a single carrier and each of the items may be separately sorted. For example, after a first item is loaded onto a center of the carriage, the carrier 5 may be moved such that the item is shifted towards the side of the carriage to allow a second item to subsequently be loaded onto the center of the carriage. By allowing multiple items to be placed on the carrier 5, the throughput of the carriage is increased. In other words, the number of items that can be sorted by the carriage per unit time is increased. For example, Figs. 6A-6I (which will be described later in further detail)

illustrate different views of the carriage. Each carriage includes a carrier 5 on which an item is placed for sorting. As noted above, multiple items can be placed on the carrier 5 and each of the multiple items can be sorted separately. Accordingly, by controlling the number of rotations of the rotating member 1, the items on the carrier 5 can either be sorted or can be moved from one side of the carrier 5 to another side of the carrier 5 to accommodate another item. Two or more items can be placed on the carrier 5 for sorting purposes by controlling the number of rotations of the rotating member 1.

In another embodiment, a braking mechanism may be used to slow down or stop the rotation of the rotating member 1. For example, the braking mechanism maybe powered by an electric motor and battery disposed on the carriage. Alternatively, the polarity of one or more of the pair of magnetic strips 3 maybe changed to slow down or stop the rotation of the rotating member 1.

Although embodiments of the present disclosure use two magnetic strips 3 as an example, it should be understood that a single magnetic strip 3 or more than two magnetic strips 3 can be used to attract and repel the rotating member 1. The rotating member 1 can be set in motion at different rotation speeds based on an amount of attraction and repulsion by the magnetic strip 3, the amount of attraction and repulsion by the magnetic strip 3 varying based on the amount of AC/DC voltage or current supplied to the magnetic strips 3 and/or the timing of supply of the AC/DC voltage or current to the magnetic strip 3 from the relay system.

Specifically, in one embodiment, the motion of the rotating member 1 causes the shaft 2 to rotate (see Figure 1 for an example of a rotation direction of the shaft 2). One or more contacting members (e.g., gears, such as bevel gears) 7, as illustrated for example in Figure 6F, transfer the motion of the rotating member 1 and the rotational energy from the shaft 2 to rotate a

shaft 8 (see Figure 1 for an example of a rotation direction of shaft 8) and a wheel 9 connected to the shaft 8 (the rotation direction of the wheel 9 is the same as the rotation direction of shaft 8). The wheel 9 contacts the carrier 5 such that the rotation of the wheel 9 causes the carrier 5 to move. Further, the movement direction of the carrier 5 is different when the rotating member 1 rotates in a different direction according to certain embodiments.

As illustrated in Figure 2, in one embodiment, the rotating member 1 is a multi-spoke magnetic wheel. Although Figure 2 illustrates three sets of spokes on the rotating member 1, it should be understood that the number of sets of spokes on the rotating member 1 can be one or more. The rotating member 1 also includes a shaft 2. The shaft 2 is attached to a contacting member (e.g., gear 7 as illustrated in Figure 6F) that transfers the motion of the rotating member 1 to the carrier 5 of the carriage to sort items on the carrier 5. Additionally, different shaped spokes and a different number of spokes may be used than what is illustrated in Figure 2. Different shaped spokes result in different shapes of magnetic fields around each spoke.

Figure 3 illustrates a base 4 for the electromagnetic actuation system according to an embodiment. Specifically, the base 4 provides frames on which the magnetic strips 3 are mounted. Although the structure of the base 4 is illustrated as being a rectangular cuboid, it should be understood that any other shape suitable to form the base 4 can be used (for example, a cylindrical shape).

Figure 4 illustrates the base 4, including magnetic strips 3 mounted on the inside of the side walls of the base 4. However, it should be understood that the magnetic strips 3 can be placed in any strategic location within/outside/above the housing of the base 4 such that a magnetic field can be generated by the magnetic strips 3 in order to rotate the rotating member 1 when passing through the base 4.

Figure 5 illustrates a magnetic strip 3 connected to a pair of wires. In Figure 5, the polarity of the magnetic strips 3 can be changed by supplying an AC/DC voltage or current to a magnetic strip 3 using wires.

Figures 6A-6I illustrate different views of a carriage utilizing an electromagnetic actuation system. For example, Figures 6A-6C illustrate top views of the carriage, Figures 6D-6F illustrate side views of the carriage, and Figure 6G-6I illustrate bottom views of the carriage. The functions and structure of the carriage illustrated in Figures 6A-6I are similar to the functions and structure of the carriage described, for example, in Figure 1.

Figure 7 illustrates a second embodiment of a carriage utilizing an electromagnetic actuation system. The carriage is configured, for example, to sort articles on a conveyor (e.g., a main conveyor belt) towards specific points for article collation and/or order fulfillment in the management of articles in a warehouse. The carriage is transported along a predetermined path according to one embodiment, as illustrated in Figure 13 which is further described below.

The carriage includes a rotating member (e.g., a magnetic wheel illustrated in Figure 9) 1 with magnetic spokes connected, or formed on, both sides of a shaft (e.g., an axle) 2. The rotating member 1 remains relatively stationary until driven by one or more magnetic fields. The magnetic spokes may be permanently or temporarily magnetized (e.g., induced by a trigger and/or battery). The carriage is a load carrying unit that travels on a conveyor including rails 6 and base 4. Although a conveyor according to the embodiment illustrated in Figure 7 includes rails 6, it should be understood that the rails could be replaced with any other track system that can be used for a conveyor.

A pair of magnetic strips (e.g., an array of magnetic elements, such as electromagnets) 3 are positioned on the base 4 and configured to produce at least one magnetic field. In one

embodiment, the at least one magnetic field is generated in response to receiving current. The magnetic field generated by the magnetic strips 3 can be changed by using an AC/DC voltage or current source. Specifically, each magnetic strip 3 can be connected to a relay system (not shown), which controls the amount of AC/DC voltage or current supplied to each magnetic strip 3. The relay system can be programmed so that the amount of AC/DC voltage or current and/or the timing of supply of the AC/DC voltage or current can be preset based on sorting needs. Alternatively, the amount of AC/DC voltage or current and/or the timing of supply of the AC/DC voltage or current can be manually adjusted (or be programmed to be adjusted) after the sorting process has begun.

The pair of magnetic strips 3 are mounted on the base 4 and arranged, as illustrated in Figure 7. When the carriage approaches the pair of magnetic strips 3, the pair of magnetic strips 3 are set such that the rotating member 1 is either attracted to the pair of magnetic strips 3 or is repelled by the pair of magnetic strips 3. When the rotating member 1 enters the magnetic field generated by the pair of magnetic strips 3, magnetic spokes in the rotating member 1 are either attracted to the pair of magnetic strips 3 or are repelled by the pair of magnetic strips 3. Such an attraction or repulsion by the pair of magnetic strips 3 sets the rotating member 1 in motion and it starts gaining speed while traveling between the pair of magnetic strips 3 and along the base 4. This motion is then transferred to a carrier 5 (for example, a roller, a belt, PVC, other polymer belt, or modular belt) for sortation purposes.

The number of rotations of the rotating member 1 can be controlled. A hall sensor can be mounted on the base 4 to detect the number of rotations of the rotating member 1. The magnetic strips 3 can be demagnetized based on a signal from the hall sensor, and therefore, such a signal from the hall sensor can be used to control the number of rotations of the rotating member 1.

Control of the number of rotations of the rotating member 1 allows for more precise placement or sorting of items located on the carrier 5. Accordingly, multiple items may be placed on a single carrier and each of the items may be separately sorted. For example, after a first item is loaded onto a center of the carriage, the carrier 5 may be moved such that the item is shifted towards the side of the carriage to allow a second item to subsequently be loaded onto the center of the carriage. By allowing multiple items to be placed on the carrier 5, the throughput of the carriage is increased. In other words, the number of items that can be sorted by the carriage per unit time is increased. For example, Figs. 15A-15I (which will be described later) illustrate different views of the carriage according to the second embodiment. Each carriage includes a carrier 5 on which an item is placed for sorting. As noted above, multiple items can be placed on the carrier 5 and each of the multiple items can be sorted separately. Accordingly, by controlling the number of rotations of the rotating member 1, the items on the carrier 5 can either be sorted or can be moved from one side of the carrier 5 to another side of the carrier 5 to accommodate another item. Two or more items can be placed on the carrier 5 for sorting purposes by controlling the number of rotations of the rotating member 1.

In another embodiment, a braking mechanism may be used to stop the rotation of the rotating member 1. For example, the braking mechanism may be powered by an electric motor and battery disposed on the carriage. Alternatively, the polarity of one or more of the pair of magnetic strips 3 may be changed to slow down or stop the rotation of the rotating member 1.

Although embodiments of the present disclosure use two magnetic strips 3 as an example, it should be understood that a single magnetic strip 3 or more than two magnetic strips 3 can be used to attract and repel the rotating member 1. The rotating member 1 can be set in motion at different rotation speeds based on an amount of attraction and repulsion by the magnetic strip 3,

the amount of attraction and repulsion by the magnetic strip 3 varying based on the amount of AC/DC voltage or current supplied to the magnetic strips 3 and/or the timing of supply of the AC/DC voltage or current to the magnetic strip 3 from the relay system.

Specifically, in one embodiment, the motion of the rotating member 1 causes the shaft 2 to rotate (see Figure 7 for an example of a rotation direction of the shaft 2). Contacting members (e.g., bevel gears) 71 and 72 transfer the motion of the rotating member 1 and the rotational energy from the shaft 2 to rotate the shaft 8 (see Figures 15A-15I for details) connected to the contacting member 71 and wheel 9 (see Figures 15A-15I for details) connected to the shaft 8 (see Figure 7 for an example of a rotation direction of the contacting member 71 – the rotation directions of the shaft 8 connected to the contacting member 71 and the wheel 9 connected to the shaft 8 are the same as the rotation direction of the contacting member 71). The wheel 9 contacts the carrier 5 such that the rotation of the wheel 9 causes the carrier 5 to move. Further, the movement direction of the carrier 5 is different when the rotating member 1 rotates in a different direction according to certain embodiments.

Although two bevel gears 71 and 72 are described above, any other mechanism can be used to sort items on the carrier 5.

Figure 8 illustrates an example of the second embodiment of the carriage, including the rotating member 1, magnetic strips 3, and base 4. As noted above, when an AC/DC voltage or current is supplied to the magnetic strips 3, a magnetic field is generated by the magnetic strips 3, and when the rotating member 1 enters the magnetic field of the magnetic strips 3, the rotating member 1 is set in motion by being attracted or repelled by the pair of magnetic strips 3. As illustrated in Figures 7 and 8, the rotating member 1 has two magnetic wheels on opposite ends of the shaft 2.

In certain embodiments, the polarities of the different magnetic strips 3 may not be the same. In this case, when there is no phase shift (i.e., when the polarities are the same) between the magnetic wheels on opposite ends of the shaft 2, one magnetic strip 3 can be made to attract the rotating member 1 and another magnetic strip 3 can be made to repel the rotating member 1 (or vice versa), thereby, assisting the rotating member 1 to rotate in either direction. By allowing one magnetic strip 3 to attract the rotating member 1 and another magnetic strip to repel the rotating member 1, the speed and direction of rotation of the rotating member 1 can be controlled. The polarities of the magnetic strips 3 can be switched in order to set the rotating member 1 in motion in a particular direction or to stop the rotating member 1 from being in motion in a particular direction. On the other hand, when there is a phase shift (i.e., when the polarities are different) between the magnetic wheels on opposite ends of the shaft 2, the rotating member 1 is set in motion by being attracted to or repelled by the pair of magnetic strips 3. Again, the polarities of the magnetic strips 3 can be switched in order to set the rotating member 1 in motion in a particular direction or to stop the rotating member 1 from being in motion in a particular direction. Further, the polarities of the different magnetic strips 3 can be the same and can be used to set the rotating member 1 in motion in a particular direction or to stop the rotating member 1 from being in motion in a particular direction by being attracted to or repelled by the pair of magnetic strips 3.

Figure 9 illustrates an example of the second embodiment of the rotating member 1. For example, Figure 9 illustrates two different views of the rotating member 1. Figure 10 illustrates an exemplary arrangement of magnetic strips 3 in the second embodiment.

Figure 11 illustrates a flowchart of an exemplary method for driving a carrier 5 and for sorting items using an electromagnetic actuation system. In Step 1101, a carriage, including the

carrier 5, is transported along a predetermined path. In Step 1102, an activation signal is received by a relay system based on which direction the carrier 5 needs to be moved to sort item(s) and based on what position on the predetermined path the carrier 5 needs to be moved to sort the item(s). In Step 1103, a relay system supplies an AC/DC voltage or current to the magnetic strips 3 in response to receiving the activation signal. The activation signal can be received from a computer system/circuitry that is programmed to provide the activation signal to the relay system. The activation signal can be programmed to be sent to the relay system at different time intervals, and can include information regarding the amount of AC/DC voltage or current that needs to be supplied to the magnetic strips 3 or timing for supply of the AC/DC voltage or current to the magnetic strips 3. The activation signals can also be generated by the relay system.

When the magnetic strips 3 receive the AC/DC voltage or current, the magnetic strips 3 apply a magnetic field at a predetermined position of the predetermined path in in Step 1104. The strength of the magnetic field can vary based on the amount of AC/DC voltage or current that is supplied to the magnetic strips 3. Additionally the size of the magnetic strips 3 can also be modified to change the strength of the magnetic field generated by the magnetic strips 3. Additionally, although not illustrated in the figures, a magnetic field detector can be placed near the magnetic strips 3 to provide a user/computer system with instant updates on the value of the magnetic field generated by the magnetic strips 3. The results of the magnetic field detector can be supplied to the computer system using wired or wireless communication. Based on such information, a user/computer system can provide another activation signal to the relay system indicating a need to change the magnetic field. In view of such a signal, the relay system will

alter the amount of AC/DC voltage or current and/or timing of the AC/DC voltage or current supplied to the magnetic strips 3.

Further, when the rotating member 1 enters the magnetic field of the magnetic strips 3, the rotating member 1 is set in motion (rotation), thereby setting in motion a shaft (for example, shaft 2 in Figure 1) connected to the rotating member 1 in Step 1105 by being attracted to one magnetic strip 3 and being repelled by another magnetic strip 3 in the first embodiment and by being attracted to or being repelled by a pair of magnetic strips 3 in the second embodiment. As noted above, the rotating member 1 can be set in motion at different rotation speeds based on an amount of attraction and/or repulsion by the magnetic strips 3, the amount of attraction and/or repulsion by the magnetic strips 3 varying based on the amount of AC/DC voltage or current and/or the timing of supply of the AC/DC voltage or current to the magnetic strips 3 from the relay system. Further, as noted above, a hall sensor can be mounted on the base 4 to detect the number of rotations of the rotating member 1, and based on such information, the number of rotations of the rotating member 1 can be changed by magnetizing/demagnetizing the magnetic strips 3.

A motion detector (mounted to the base 4 or included in the carriage) can be used to detect the speed of rotation of the rotating member 1. If there is a need to change the speed of rotation of the rotating member 1, the motion detector can send a signal (wired or wirelessly) to a computer system to alter the speed of rotation of the rotating member 1. In accordance with such a signal, the computer system (which includes circuitry and/or processor) can issue another activation signal including information regarding the amount of AC/DC voltage or current to be supplied to the magnetic strips 3 and/or the timing of supply of the AC/DC voltage or current to the magnetic strips 3 from the relay system. The results of the magnetic field detector and the

motion detector will help assess whether the electromagnetic actuation system is functioning properly and whether replacement or maintenance of the components of the electromagnetic actuation system is required.

In Step 1106, the rotating motion (i.e., the rotational energy) from the shaft (for example, shaft 2 in Figure 1) connected to the rotating member 1 is transferred to the carrier 5 directly or indirectly using, for example, shaft 8, contacting members 7 (or 71 and 72), and wheel 9 to sort items on the carrier 5, as described above with regard to Figures 1 and 7.

Next, a hardware description of a device according to exemplary implementations is described with reference to Figure 12. The structure of the device illustrated in Figure 12 is an exemplary computer system as mentioned herein. Although the specific description provided below regarding Figure 12 pertains to a computer system, it should be appreciated that corresponding structures or components can be provided in the other devices discussed herein, and not all of the components or connections illustrated in Figure 12 may be provided in particular devices.

In Figure 12, the device includes a CPU 1200 which performs/executes the processes and algorithms described herein. Process data and instructions may be stored in memory 1202. Processes and instructions may also be stored on a storage medium disk 1204 such as a hard drive (HDD) or portable storage medium or may be stored remotely. Further, executable instructions are not limited by the form of the computer-readable media on which the instructions of the process are stored. For example, the instructions may be stored on CDs, DVDs, in FLASH memory, RAM, ROM, PROM, EPROM, EEPROM, hard disk or any other information processing device with which the device communicates, such as a server or computer.

Further, executable instructions may be provided as a utility application, background daemon, or component of an operating system, or combination thereof, executing in conjunction with CPU 1200 and an operating system such as Android, iOS, Windows Mobile, Windows Phone, Microsoft Windows 7 or 8, UNIX, Solaris, LINUX, Apple MAC-OS and other operating systems.

CPU 1200 may be a Xenon or Core processor from Intel of America or an Opteron processor from AMD of America, especially in implementations where the device is a computer or a server. Other processors can be utilized when the device is, e.g., a mobile phone, a smartphone, a tablet, a battery-operated device, or a portable computing device. For example, a Qualcomm Snapdragon or ARM-based processor can be utilized. The CPU 1200 may be implemented on an FPGA, ASIC, PLD or using discrete logic circuits, as one of ordinary skill in the art would recognize. Further, CPU 1200 may be implemented as multiple processors cooperatively working in parallel to perform the instructions of the processes described above, and the CPU 1200 may incorporate processing circuitry other than generic processing circuitry, whereby the CPU 1200 includes circuitry to execute specific display and user interface controls that may otherwise be provided for by other discrete circuitry.

The device in Figure 12 also includes a network controller 1206, such as an Intel Ethernet PRO network interface card from Intel Corporation of America, for interfacing with network 1277 when the device is a computer or a server, for example. When the device is a portable electronic device, the network controller 1206 includes a radio that may be incorporated into the CPU 1200. The radio may incorporate various wireless communication technologies as separate circuits or shared circuitry, and the technologies can incorporate LTE, GSM, CDMA, WiFi, Bluetooth, NFC, infrared, FM radio, AM radio, ultrasonic, and/or RFID circuitry. The network

1277 can be a public network, such as the Internet, or a private network such as an LAN or WAN network, or any combination thereof and can also include PSTN or ISDN sub-networks. The network 1277 can also be wired, such as an Ethernet network, or can be wireless such as a cellular network including EDGE, 3G and 4G wireless cellular systems. The network 1277 may be connected to a server to allow the device to download and install application software to implement aspects of this disclosure. The wireless network can also be WiFi, Bluetooth, or any other wireless form of communication. In the exemplary implementations discussed herein, the network 1277 can include both the Internet and a Bluetooth communication channel, but this is not limiting as other combinations are applicable when a different short-range communication technology is utilized.

The device further includes, when the device is a computer or a server, a display controller 1208, such as a NVIDIA GeForce GTX or Quadro graphics adaptor from NVIDIA Corporation of America for interfacing with display 1210, such as a Hewlett Packard HPL2445w LCD monitor. A general purpose I/O interface 1212 interfaces with a keyboard and/or mouse 1214 as well as a touch screen panel 1216 on or separate from display 1210. General purpose I/O interface also connects to a variety of peripherals 1218 including printers and scanners. When the device is, e.g., a smartphone, the display 1210 can be integrated into the device and can be a touchscreen display. Further, the display controller 1208 can be incorporated into the CPU 1200.

A sound controller 1220 is also provided in the device, such as Sound Blaster X-Fi Titanium from Creative, to interface with speakers/microphone 1222 thereby providing sounds and/or music. The sound controller 1220 can also be incorporated into the CPU 1200 when the device is, e.g., a smartphone.

The general purpose storage controller 1224 connects the storage medium disk 1204 with communication bus 1226, which may be an ISA, EISA, VESA, PCI, or similar, for interconnecting all or some of the components of the device. A description of the general features and functionality of the display 1210, keyboard and/or mouse 1214, as well as the display controller 1208, storage controller 1224, network controller 1206, sound controller 1220, and general purpose I/O interface 1212 is omitted herein for brevity.

Figure 13 illustrates a top view of an exemplary system, which includes a plurality of carriages on a main conveyor belt. An article is redirected by a carriage that is driven by an electromagnetic actuations system, for example as described with regard to any of Figures 1-12 and 14-16.

Further, Figure 13 illustrates directions for sorting items (directions a) relative to directions of motion of the transport track (directions b). It is noted that the carriages move along any of directions b with the conveyor belt. When an activation signal is received by the electromagnetic actuations systems, the carrier 5 of the carriage is directed to move in one of the directions a, while continuing to move in one of the directions b. Additionally, the conveyor belt is mounted on top of base 4, which houses the magnetic strips 3. The magnetic strips 3 are fixed on the base 4 and generates a magnetic field to rotate a rotating member 1 (which is in motion along with other parts of the carriage) when the rotating member 1 enters the magnetic field of the magnetic strips 3. Different shapes of the conveyor belt system and electromagnetic actuations systems can be used. Figure 13 illustrates a top view of the carriages (see, for example, Figures 6A-6C for details).

Although embodiments of the present disclosure are described using one or more magnetic fields for driving the carriages, other contactless methods of driving the carriage may

be utilized in other embodiments. For example, a gas or a liquid may be directed at rotating member 1 to cause the rotating member 1 to rotate. Further, embodiments of the present disclosure are not limited to the use of a carriage. For example, the actuation system may be used to drive a paddle, a pusher, etc.

Figures 14A-14J illustrate different views of an exemplary carriage. Specifically, Figures 14A-14J illustrate a modification of (or an addition to) the first embodiment illustrated by Figures 1 and 6A-6I. For instance, shaft 8 is further connected to a ratchet head 10 and a handle 11. Based on a position of the handle 11, the shaft 8 is restricted in motion (see Figures 14C and 14G). For example, in Figure 14A, the handle 11 is in a left position, which allows the shaft 8 to rotate in a clockwise motion and restricts rotation of the shaft 8 in a counter clockwise motion. Further, in Figure 14G, the handle 11 is in a right position, which allows the shaft 8 to rotate in a counter clockwise motion and restricts rotation of the shaft 8 in a clockwise motion. Other than the ratchet head 10 and handle 11, the functions and structure of the carriage illustrated in Figure 14A-14J are similar to the functions and structure of the carriage described, for example, in Figure 1. Although the ratchet head 10 and handle 11 are described with respect to the first embodiment, it is noted that the ratchet head 10 and handle 11 may be implemented in any of the other embodiments of the present disclosure. Handle 11 is, for example, made of a soft core and is deflected from its original position using a magnet.

Figures 15A-15I illustrate different views of another exemplary carriage. Specifically, Figures 15A-15I illustrate a modification of (or an addition to) the second embodiment illustrated by Figure 7. For instance, the contacting members 7 (on the shaft 2 of the rotating member 1) are assembled using a freewheel as an interface (see Figs. 15H and 15I – for example, portion A in Figure 15H (which is zoomed into in Figure 15I) illustrates a freewheel). Such a

freewheel facilitates motion of the shaft 2 in one direction and restricts motion of the shaft 2 in another direction. Other than a modification of the contact members 7 in Figures 15A-15I, the functions and structure of the carriage illustrated in Figures 15A-15I are similar to the functions and structure of the carriage described, for example, in Figure 7. The concept of a freewheel illustrated in this figure is similar to a component/mechanism used in bicycles where one can peddle in a forward direction to move forward, but cannot peddle in a reverse direction to move backwards. The freewheel can be employed in any of the embodiments described in the present application

Figures 16A-16H illustrate different views of another exemplary carriage. Specifically, Figures 16A-16H illustrate a modification of the second embodiment illustrated by Figures 7 and 15A-15I. For instance, the contacting members 7 are illustrated with a modification. Specifically, only one contact member (e.g., bevel gear) is attached to the shaft 2. However, any number of contact members may be attached to the shaft 2 in other embodiments. Other than a modification of the contact members 7 in Figures 16A-16H, the functions and structure of the carriage illustrated in Figures 16A-16H are similar to the functions and structure of the carriage described, for example, in Figure 7.

Although the description and discussion were in reference to certain exemplary embodiments of the present disclosure, numerous additions, modifications and variations will be readily apparent to those skilled in the art. The scope of the invention is given by the following claims, rather than the preceding description, and all additions, modifications, variations and equivalents that fall within the range of the stated claims are intended to be embraced therein.

Thus, the foregoing discussion discloses and describes merely exemplary implementations. As will be understood by those skilled in the art, the present disclosure may be

embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the present disclosure is intended to be illustrative, but not limiting of the claims. The disclosure, including any readily discernible variants of the teachings herein, defines, in part, the scope of the foregoing claim terminology such that no inventive subject matter is dedicated to the public.

Claims

1. An electromagnetic actuation system, comprising:
 - a shaft;
 - a first rotating member connected to the shaft and configured to rotate the shaft when passing through a first magnetic field; and
 - a first contacting member connected to the shaft and configured to engage a second contacting member to transfer rotational energy from the shaft to the second contacting member.

2. The electromagnetic actuation system according to claim 1, wherein
 - the first rotating member is configured to rotate in two directions, and
 - the first rotating member rotates in one of the two directions based on a direction of the first magnetic field.

3. The electromagnetic actuation system according to claim 1, further comprising:
 - a first magnetisable element configured to generate the first magnetic field, wherein
 - a longitudinal axis of the first magnetisable element is perpendicular to a rotation axis of the first rotating member.

4. The electromagnetic actuation system according to claim 3, further comprising:
 - a second magnetisable element disposed parallel to the first magnetisable element and configured to generate a second magnetic field, wherein
 - the rotating member is configured to rotate while passing between the first and second magnetisable elements.

5. The electromagnetic actuation system according to claim 3, further comprising:
control circuitry configured to supply a voltage to the first magnetisable element.

6. The electromagnetic actuation system according to claim 5, wherein
the first magnetisable element is configured to generate the first magnetic field based on
the supplied voltage.

7. The electromagnetic actuation system according to claim 1, further comprising:
a second rotating member connected to the shaft and configured to rotate the shaft when
passing through a second magnetic field.

8. A carriage, comprising:
a carrier configured to carry an object and move the object in at least one direction;
a shaft;
a first rotating member connected to the shaft and configured to rotate the shaft when
passing through a first magnetic field;
a first contacting member connected to the shaft and configured to engage a second
contacting member to transfer rotational energy from the shaft to the second contacting member;
and
the second contacting member configured to directly or indirectly transfer the rotational
energy from the shaft to the carrier.

9. The carriage according to claim 8, wherein
the first rotating member is configured to rotate in two directions, and
the first rotating member rotates in one of the two directions based on a direction of the first magnetic field.

10. The carriage according to claim 8, further comprising:
a second rotating member connected to the shaft and configured to rotate the shaft when passing through a second magnetic field.

11. A conveyor system, comprising:
a plurality of carriages, each of the carriages including
a carrier configured to carry an object and move the object in at least one direction;
a shaft;
a first rotating member connected to the shaft and configured to rotate the shaft when passing through a first magnetic field;
a first contacting member connected to the shaft and configured to engage a second contacting member to transfer rotational energy from the shaft to the second contacting member; and
the second contacting member configured to directly or indirectly transfer the rotational energy from the shaft to the carrier;
a conveyor configured to transport the plurality of carriages along a predetermined path; and

a first magnetisable element disposed at a predetermined position of the predetermined path and configured to generate the first magnetic field.

12. A method for driving a carrier, the method comprising:
transporting a carriage, including the carrier, along a predetermined path; and
applying, by a first magnetisable element, a first magnetic field at a predetermined position of the predetermined path, wherein
the first magnetic field causes a first rotating member connected to a shaft of the carriage to rotate the shaft when the first rotating member passes through the first magnetic field, and
a rotational energy from the shaft is transferred to the carrier directly or indirectly by a plurality of contacting members.

13. The method according to claim 12, wherein the step of generating the voltage comprises:
supplying a first voltage to the first magnetisable element when the first rotating member is to be rotated in a clockwise direction to move the carrier in a first direction; and
supplying a second voltage to the first magnetisable element when the first rotating member is to be rotated in a counter-clockwise direction to move the carrier in a second direction.

14. A non-transitory computer-readable medium storing instructions which, when executed by a computer, cause the computer to implement a method for driving a carrier, the method comprising:

transporting a carriage, including the carrier, along a predetermined path; and
applying, by a first magnetisable element, a first magnetic field at a predetermined position of the predetermined path, wherein
the first magnetic field causes a first rotating member connected to a shaft of the carriage to rotate the shaft when the first rotating member passes through the first magnetic field, and
a rotational energy from the shaft is transferred to the carrier directly or indirectly by a plurality of contacting members.

15. The non-transitory computer-readable medium according to claim 14, wherein the step of supplying the voltage comprises:

supplying a first voltage to the first magnetisable element when the first rotating member is to be rotated in a clockwise direction to move the carrier in a first direction; and

supplying a second voltage to the first magnetisable element when the first rotating member is to be rotated in a counter-clockwise direction to move the carrier in a second direction.

16. The electromagnetic actuation system according to claim 1, further comprising:

a ratchet head connected to a handle and another shaft, wherein the handle prevents motion of the another shaft in one direction and allows the motion of the another shaft in another direction based on a position of the handle.

17. The electromagnetic actuation system according to claim 16, wherein the another shaft is connected to the second contacting member.

18. The electromagnetic actuation system according to claim 1, wherein the first contacting member is a freewheel that facilitates motion of the shaft in one direction and restricts the motion of the shaft in another direction.