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REFUSE LOADING MECHANISM WITH FLEXIBLE MEMBER

Abstract

A refuse collection system includes a refuse-receiving container and a refuse loading mechanism. The refuse loading mechanism is coupled to the refuse-receiving container and transfers refuse into the refuse-receiving container. The refuse loading mechanism includes a guide assembly, a flexible member coupled to the guide assembly, a reciprocating member, a rotatable element, and a drive unit. The flexible member is coupled to the guide assembly at a first location and a second location. The reciprocating member translates relative to the guide assembly. The rotatable element is coupled to the reciprocating member and engaged with the flexible member. The drive unit turns the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application claims the benefit under 35 U.S.C. § 119 (c) of U.S. Patent Application No. 63/552,294, entitled “Refuse Loading Mechanism With Flexible Member,” filed Feb. 12, 2024, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Refuse collection vehicles are typically used to pick up quantities of refuse for hauling to a determined area, such as a landfill, transfer station, or material recovery facility. Refuse collection vehicles are sometimes modified to collect recyclables or other materials for transport.

[0003] Some refuse collection systems use large trucks having compaction capabilities, extending their effective range and capacity between unloadings. The refuse collection vehicles can include collection/intermediate containers (or “cans”). The intermediate container allows a refuse vehicle designed for the collection of large waste containers, such as dumpsters, to collect smaller, non-commercial waste containers.

SUMMARY

[0004] Implementations of the present disclosure are generally directed to refuse handling mechanisms for refuse collection vehicles and methods of operating such systems.

[0005] In a general aspect of the disclosure, a refuse collection system includes a refuse-receiving container and a refuse loading mechanism coupled to the refuse-receiving container. The refuse loading mechanism is configured to transfer refuse into the refuse-receiving container. The refuse loading mechanism includes a guide assembly, a flexible member, a reciprocating member, a rotatable element, and a drive unit. The flexible member is coupled to the guide assembly at a first location and a second location. The reciprocating member is configured to translate relative to the guide assembly. The rotatable element is coupled to the reciprocating member and engaged with the flexible member. The drive unit is configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.

[0006] In some implementations, a grabber device coupled to the reciprocating member.

[0007] In some implementations, the drive unit is configured to move the reciprocating member between a retracted position and at least one other position.

[0008] In some implementations, wherein the drive unit includes an electric motor.

[0009] In some implementations, the drive unit includes a hydraulic motor.

[0010] the reciprocating member includes a slide member configured to move in and out relative to the guide assembly.

[0011] In some implementations, the flexible member includes a belt.

[0012] In some implementations, the flexible member includes a belt, wherein the rotatable element is configured to engage the belt.

[0013] In some implementations, the rotatable element includes two or more teeth configured to engage the flexible member.

[0014] In some implementations, the guide assembly includes one or more tracks, and the reciprocating member includes a slider beam configured to translate on the track.

[0015] In some implementations, the guide assembly includes one or more rollers, and the reciprocating member is configured to translate on at least one of the one or more rollers.

[0016] In some implementations, the refuse collection system further includes one or more guides configured to guide the flexible member.

[0017] In some implementations, the one or more guides include one or more idlers. The idlers are configured to guide the flexible member to promote engagement of the belt with the rotatable element.

[0018] In some implementations, the one or more guides includes a first guide configured to engage the flexible member on one side of the rotatable element and a second guide configured to engage the flexible member on the other side of the rotatable element.
[0019] In some implementations, at least one of the one or more guides includes a tensioning device.
[0020] In some implementations, the refuse collection system further includes one or more tensioning devices configurable to alter tension on the flexible member.
[0021] In some implementations, the reciprocating member is configured to translate on the guide assembly such that the rotatable element travels along the guide assembly at least a portion of the way between an extended position and a retracted position.
[0022] In some implementations, the refuse collection system further includes a grabber device coupled to the reciprocating member and including one or more arms operable to couple with a curbside container.
[0023] In some implementations, the refuse collection system further includes a grabber device coupled to the reciprocating member and including one or more electric motors operable to engage one or more arms of the grabber device with a curb-side container.
[0024] In some implementations, the refuse collection system further includes an arm coupled to the reciprocating member and operable to lift refuse toward an opening in the refuse-receiving container.
[0025] In some implementations, the refuse collection system further includes a refuse collection vehicle to which the refuse-receiving container and the refuse loading mechanism are coupled, and one or more grabber devices coupled to the reciprocating member. The one or more grabber devices are operable to collect refuse on both sides of the vehicle.
[0026] In some implementations, the guide assembly includes an upper rail and a lower support element, wherein the upper rail and the lower support element cooperate to support an overhanging load on the guide assembly.
[0027] In some implementations. the guide assembly includes an upper track and a lower support clement including one or more lower rollers. The slide assembly includes one or more upper rollers and a lower track. The upper rollers roll on the upper rail and the lower rollers roll on the lower track when the slide assembly translates on the guide assembly.
[0028] In some implementations, the refuse collection system further includes a control unit configured to operate the drive unit to move to the slider assembly in and out on the guide assembly.
[0029] In some implementations, the drive unit includes an outrunner/hub motor system. The outrunner/hub motor system is configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.
[0030] In another general aspect of the disclosure, a refuse collection system includes a vehicle and a refuse handling mechanism coupled to the vehicle. The refuse handling mechanism is configured to handle refuse on or in the vehicle. The refuse handling mechanism includes a guide assembly, a flexible member, a reciprocating member, a rotatable element, and a drive unit. The flexible member is coupled to the guide assembly at a first location and a second location. The reciprocating member is configured to translate relative to the guide assembly. The rotatable element coupled to the reciprocating member and engaged with the flexible member. The drive unit is configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.
[0031] In some implementations, the refuse handling mechanism is configured to load refuse onto or into the vehicle.
[0032] In some implementations, the refuse handling mechanism is configured to move refuse from one location on the vehicle to another location on the vehicle.
[0033] In some implementations, the refuse handling mechanism is configured to eject refuse from

the vehicle.
[0034] In some implementations, the refuse handling mechanism is configured to compact refuse on the vehicle.
[0035] In some implementations, the flexible member is coupled to the guide assembly at a first location and a second location. The rotatable element is movable on the flexible member between the first location and the second location.
[0036] In some implementations, the drive unit includes an electric motor.
[0037] In some implementations, the flexible member includes a belt.
[0038] In another general aspect of the disclosure, a method of handling refuse on a refuse collection vehicle includes: turning a rotatable element engaged with a flexible member that is coupled to a guide assembly such that the reciprocating member translates relative to the guide assembly; and operating a refuse handling device coupled to the reciprocating member to handle refuse.
[0039] In some implementations, turning a rotatable element includes drawing the reciprocating member from a retracted position on a refuse collection vehicle to an extended position on the refuse collection vehicle.
[0040] In some implementations, turning a rotatable element includes drawing the reciprocating member from an extended position on a refuse collection vehicle to a retracted position on the refuse collection vehicle.
[0041] In some implementations, the method further includes maintaining a first portion of the flexible member at a first location relative to the guide assembly; and maintaining a second portion of the flexible member at a second location relative to the guide assembly.
[0042] In some implementations, the flexible member is coupled to the guide assembly at a first location and a second location. Turning the rotatable element includes moving the rotatable element along the flexible member between the first location and the second location.
[0043] In some implementations, operating the refuse handling device includes loading refuse into or onto the refuse collection vehicle.
[0044] In some implementations, operating the refuse handling device includes loading refuse from a curb-side container into a refuse-receiving container.
[0045] In some implementations, the method further includes moving refuse from the refuse-receiving container into another container on the refuse collection vehicle.
[0046] In some implementations, operating the refuse handling device to handle refuse includes moving refuse from one location on the vehicle to another location on the vehicle.
[0047] In some implementations, operating the refuse handling device to handle refuse includes ejecting refuse from the vehicle.
[0048] In some implementations, operating the refuse handling device to handle refuse includes compacting refuse on the vehicle.
[0049] Particular implementations of the subject matter described in this specification can be implemented so as to realize one or more of the following advantages.
[0050] Implementations of the present disclosure may reduce the need for expensive, heavy, and/or complex components with high maintenance costs.
[0051] Implementations of the present disclosure may make a refuse collection system easier to maintain.
[0052] Implementations of the present disclosure may increase reliability, sustainability, and effectiveness of a refuse collection system.
[0053] Implementations of the present disclosure may make collection of refuse more energy-efficient.
[0054] Implementations of the present disclosure may allow a refuse collection system to collect more materials.
[0055] The details of one or more implementations of the present disclosure are set forth in the

accompanying drawings and the description below. Other features and advantages of the present disclosure will be apparent from the description and drawings, and from the claims.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0056] FIG. **1** illustrates a refuse collection vehicle on which systems and methods as described herein can be implemented.

[0057] FIG. **2** illustrates a refuse collection system with a refuse collection mechanism and a refuse-receiving container.

[0058] FIG. **3** is a perspective view illustrating a slider assembly that reciprocates on a guide assembly.

[0059] FIG. **4** is a perspective view from below illustrating a refuse loading mechanism according to some implementations.

[0060] FIG. **5** is a perspective view illustrating a slider assembly according to some implementations.

[0061] FIG. **5** is a perspective view illustrating a slider assembly according to some implementations.

[0062] FIG. **6** is a rear view of a slider assembly the slider assembly shown in FIG. **5**.

[0063] FIG. **7** illustrates is a detail view illustrating drive unit and drive pulley with the slider assembly in an extended position.

[0064] FIG. **8** illustrates a tensioning device according to implementations.

[0065] FIG. **9** illustrates another example of a tensioning device.

[0066] FIG. **10** is an end view of the refuse loading mechanism illustrating engagement of the upper and lower rollers on their corresponding tracks.

[0067] FIG. **11** illustrates a slider assembly in a retracted position in a guide assembly.

[0068] FIGS. **12**A-**12**C are rear views of a refuse collection system illustrating use of the refuse collection system to collect refuse from a curb-side container.

[0069] FIGS. **13**A-**13**C are top views of a refuse collection system illustrating use of the refuse collection system to grab and lift a curb-side container.

[0070] FIG. **14** illustrates a refuse loading mechanism that can load refuse on either side of a vehicle

[0071] FIG. **15** schematically illustrates a refuse loading mechanism having an outrunner/hub motor arrangement according to some implementations.

[0072] FIG. **16** depicts an example computing system, according to implementations of the present disclosure.

DETAILED DESCRIPTION

[0073] Implementations of the present disclosure are directed to systems, devices, and methods for collecting refuse.

[0074] Some implementations include a refuse loading mechanism having a rotary drive that is attached to a reciprocating member. The rotary drive can include an electric motor. The reciprocating member can move within a guide assembly that is attached to a vehicle-mounted container. A flexible member, such as a belt, can be fixed in two spaced-apart locations on the guide assembly, and arranged to engage a rotatable element coupled to the rotary drive. The rotary drive can be operated to turn the rotatable element to move along the flexible member, which translates the reciprocating member in the guide assembly. The reciprocating member can be moved to position a refuse collecting device, such as a grabber device, to engage with a residential-sized refuse container near the vehicle. The refuse collecting device can be operated to place the contents of the residential-sized refuse container into the vehicle-mounted container.

[0075] FIG. **1** illustrates a refuse collection vehicle on which systems and methods as described herein can be implemented. Refuse collection vehicle **110** includes cab **112**, chassis **114**, and primary container **116**. A drivetrain including wheels **118** moves the refuse collection vehicle **110**.
[0076] Refuse collection vehicle **110** includes a front loading arm assembly having a pair of front loading arms **120**, **122**. Front loading arms **120**, **122** are coupled between refuse collection vehicle **110** and intermediate container **124**. Intermediate container **124** includes collection bin **126**.
[0077] Front-loading arms **120**, **122** may have an overall U-shaped configuration. The arms may terminate at connection end **128**. In some aspects, the intermediate container **124** is pivotally coupled at the connection end **128**. Lift cylinders are connected between the arm bosses and the front loading arms **120**, **122**.
[0078] Refuse collection vehicle **110** includes refuse loading mechanism **130**. Refuse loading mechanism **130** includes grabber device **132**. Grabber device **132** is positioned on a side of the collection bin **126**. Grabber device **132** can be operated to grab residential-sized containers (e.g., curb-side containers) and load the contents of the residential-sized container into intermediate container **124**.
[0079] In some implementations, refuse loading system **130** is used to load refuse into intermediate container **124**. Intermediate container **124** can be used to receive refuse from one or more curb-side containers at repeated stops along a refuse collection route. Subsequently, arms **120**, **122** and container **124** can be lifted and rotated to dump the refuse that has been received into intermediate container **124** into primary container **116**.
[0080] FIG. **2** illustrates a refuse collection system with a refuse collection mechanism and a refuse-receiving container. Refuse collection system **200** can be installed on a vehicle, such as refuse collection vehicle **110** described above relative to FIG. **1**.
[0081] Refuse collection system **200** includes intermediate container **124**, refuse loading mechanism **130**, base **202**, power system **204**, and control unit **206**. Intermediate container **124** is mounted on base **202**. In some implementations, base **202** is mounted on refuse collection vehicle **110** by way a fork on a loading mechanism of the refuse collection vehicle.
[0082] Intermediate container **124** includes collection bin **210** and screens **212**. Screens **212** are secured to collection bin **210** and arranged near the main opening at the top of collection bin **210**. Collection bin **210** defines receiving volume **214**.
[0083] Refuse loading mechanism **130** includes slider assembly **216**, guide assembly **218**, and belt **220**. Guide assembly **218** is attached to collection bin **210** on the rear of the collection bin.
[0084] Slider assembly **216** includes slider beam **222**, drive unit **224**, drive pulley **226**, and idler assembly **228**. Grabber device **132** is mounted slider beam **222**.
[0085] Guide assembly **218** includes upper rail assembly **232**, lower support device **234**, street-side belt attachment device **236**, curb-side belt attachment device **238**, and belt tensioning device **240**. As used herein, a “guide assembly” includes a combination of components that define a guide, slot or passage that another component (e.g., a reciprocating member) can move through. A slot or passage for the component can be open or closed. A slot can extend over the width of a container or a portion of the container.
[0086] Power system **204** includes batteries **250**. Batteries **250** are coupled to control unit **206** and drive unit **224**. Control unit **206** is operable to control drive unit **224**.
[0087] Upper guard **252** is provided above upper rail assembly **232**. Lower guard **254** is provided below the slot for slider beam **222**. Bars **256** are coupled between a rear surface of intermediate container **124** and a top surface of base **202**. Bars **256** are spaced from left to right on vehicle and pass over base **202**. Bars **256** can provide protection from damage to refuse loading mechanism **130**.
[0088] Belt **220** is secured to street-side belt attachment device **234** at one location on refuse loading mechanism **130** and curb-side belt attachment device **236** at a second location on refuse loading mechanism **130**.

[0089] In the system illustrated in FIG. **2**, slider beam **222** serves as a reciprocating member for refuse loading mechanism **130**. Slider beam **222**, along with the other components of slider assembly **216** moves in and out on guide assembly **218**, as guide assembly **218** remains fixed relative to intermediate container **124**.
[0090] Drive unit **224** can be operated to turn drive pulley **226** on belt **220**. As drive pulley **226** turns on belt **206**, slider assembly **216** translates in and out on guide assembly **218**. As slider assembly **216** moves in and out on guide assembly **218**, grabber device **132** is positioned relative to the intermediate container **124** and the vehicle on which refuse collection system **200** is installed. For example, slider assembly **216** can be extended far enough from the vehicle to pick up a residential sized container and load the contents into intermediate container **124**.
[0091] FIG. **3** is a perspective view illustrating a slider assembly that reciprocates on a guide assembly. Refuse loading mechanism **130** includes slider assembly **216**, guide assembly **218**, and belt **220**. Slider assembly **216** includes slider beam **222**, drive unit **224**, drive pulley **226**, and idler assembly **228**. Drive unit **224** and grabber device **132** are mounted slider beam **222**. Drive unit **224** can be operated to rotate drive pulley **226**. Drive unit **224** can include a rotary electric motor and a gearbox. The gearbox output can be coupled to drive pulley **226**. Drive unit **224** can be communicatively coupled to control unit **206**. Drive pulley **226** can be turned to move across belt **220**.
[0092] In the system illustrated in FIG. **3**, belt **220** serves as a flexible member. In other implementations, other components can serve as a flexible member. As examples, a flexible member can be a chain, a cable, or a cord. In some implementations, a flexible member has slots, grooves, holes, or ridges for receiving or engaging with complementary elements on a rotatable element, such as teeth on a drive sprocket. In some implementations, the flexible member is a flat belt. In some implementations, the flexible member is a timing belt.
[0093] In the system illustrated in FIG. **3**, drive pulley **226** serves as a rotatable element that engages on a flexible member. In other implementations, other components can serve as a rotatable element. As examples, a rotatable element can be a sprocket, a gear, or a wheel. The rotatable element can include teeth or other elements that engage on or in complementary elements of a flexible member. In implementations, the rotatable element includes a groove, such as a V-groove.
[0094] Slider beam **222** translates in guide assembly **218**. In FIG. **3**, slider beam **222** is in an extended position on base **202**. Arm **300** of grabber device **132** can pivot (e.g. swing up and down) on slider beam **222**. Grabber mechanism **302** can be operated to open and close arms **304**. Arms **304** can be moved toward a closed position to grab residential-sized containers.
[0095] Grabber mechanism **302** can be electrically powered (e.g., by batteries **250** shown in FIG. **2**). Grabber mechanism **302** can include electric motors to open and close the opposing arms of the grabber mechanism and/or to raise and arm **300**. In some implementations, grabber mechanism **302** is communicatively coupled to a control unit (e.g., control unit **206** shown in FIG. **2**).
[0096] FIG. **4** is a perspective view from below illustrating a refuse loading mechanism according to some implementations. Slider assembly **216** is supported in guide assembly **218**. Slider assembly **216** includes lower track **400**. Lower track **400** is attached to the bottom of slider beam **222**. In the example shown in FIG. **4**, lower track **400** is in the form of a “V”. Slider assembly **216** is supported on lower support device **234**. Lower support device **234** includes rollers **402**. Rollers **402** have a V groove that is complementary to the shape of lower track **400**. As slider beam **222** moves in and out, rollers **402** engage lower track **400** and support slider assembly **216** on guide assembly **218**. Rollers **402** can include bearings.
[0097] Upper rail assembly **232** includes an upper track **404**. Upper track **404** is located on the bottom of upper rail assembly **232**. Slider assembly **216** can include rollers (e.g., rollers **500** shown and described below relative to FIG. **5**). As slider beam **222** moves in and out, the rollers on slider assembly **216** can roll on upper track **404**. The upper and lower rollers can cooperate to support the cantilevered load of slider assembly **216**, including the weight of slide beam **222** and grabber

device **132**.
[0098] FIG. **5** is a perspective view illustrating a slider assembly according to some implementations. In this example, slider assembly **216** includes upper rollers **500**, upper clevis **502**, lower roller **504**, and lower clevis **506**. Upper clevis **502** and lower clevis **504** are mounted on body **508** of slider beam **222**. Upper rollers **500** are mounted on upper clevis **502**. Lower roller **504** is mounted on lower clevis **506**. Upper rollers **500** can engage on upper track **404** described above relative to FIG. **4**.
[0099] FIG. **6** is a rear view of a slider assembly the slider assembly shown in FIG. **5**. In the example shown in FIG. **6**, lower track **400** is on the bottom of the slider beam and extends the length of the slider beam and has a V-shape. A track can be in other locations (such as on the side or top of the slider beam) or have other shapes (such as curved or rectangular).
[0100] In some implementations, a refuse loading mechanism includes a braking device. The braking device can be used to stop or inhibit motion of a reciprocating member, such as slider beam **220**. The braking device can be operably coupled to a control unit, such as control unit **206** described above relative to FIG. **2**. In one implementation, a braking device is provided at the location of roller **504**.
[0101] FIG. **7** illustrates is a detail view illustrating drive unit and drive pulley with the slider assembly in an extended position. Drive pulley **226** is attached to an electric motor in drive unit **224**. Idler assembly **228** is coupled on the front of a housing assembly for drive unit **224**. Idler assembly **228** includes mounting bracket **700**, street-side idler pulley **702**, curb-side idler pulley **704**, and connecting member **706**. Street-side idler pulley **702** and curb-side idler pulley **704** cooperate to maintain belt **220** in engagement with drive pulley **226**.
[0102] Belt tensioning device **240** can be used to adjust tension on belt **220**. In some implementations, belt tensioning device **240** includes tension adjustment rods that can be positioned. A tensioner can be mounted at either end of belt (e.g., proximal or distal). The tensioner can be vertically mounted, horizontally mounted, or at other angles. In one implementation, the belt tensioning device is a heavy-duty belt tensioner with a tension arm and an idler shaft. The tensioner maintains the idler in contact with the belt. Rollers on the drive unit can engage the belt to keep it wrapped around the drive pulley. FIG. **8** illustrates a tensioning device according to implementations. Refuse loading mechanism **800** includes slider assembly **216**, guide assembly **218**, belt **220**, and tensioner **802**. The angle of tension arm **804** of tensioner **802** can be adjusted to change tension on belt **220**. In one case, the tension arm is about 5 inches.
[0103] In some implementations, the tensioner can include a base, an arm coupled to the base that can be pivoted with respect to the base, and an idler coupled at the end of the arm. FIG. **9** illustrates another example of a tensioning device. Refuse loading mechanism **900** includes slider assembly **216**, guide assembly **218**, belt **220**, and tensioner **902**. Tensioner **902** includes base **904**, tension arm **906**, and idler **908**. In some implementations, the tensioner is an automotive-style belt tensioner.
[0104] In some implementations, the drive unit rollers are used to adjust belt tension. Adjustments to tension can be made manually, automatically, or a combination thereof. In some implementations, the axes of the a pair of idler rollers (e.g., street-side idler pulley **702**, curb-side idler pulley **704**) are drawn toward one another to increase tension on the belt. Conversely, the pair of idler rollers can be spread apart from one another to decrease tension. A tensioner can be actuated manually, automatically, or a combination thereof. A tensioner can be actuated electrically (e.g., by a motor or linear actuator), mechanically, hydraulically, or pneumatically, or other manner.)
[0105] Curb-side attachment device **238** is used to secure the curb-side end of belt **220**. In the example, includes a pair of plates between which the end of the belt can be sandwiched and bolted down. A similar arrangement can be used on the street-side attachment device.
[0106] In combination with lower rollers **402**, upper rollers **500** can bear the cantilevered load of

slider assembly **216**. The cantilevered load includes the loads of portion of the slider beam that extends beyond the rollers, the grabber device, and any residential sized container that is picked up from time to time by the grabber device.

[0107] FIG. **10** is an end view of the refuse loading mechanism illustrating engagement of the upper and lower rollers on their corresponding tracks. During extension and retraction, upper rollers **500** roll on upper track **404**, and rollers **402** roll on lower track **400**.

[0108] FIG. **11** illustrates a slider assembly in a retracted position in a guide assembly (the grabber device and associated lift arm have been omitted from FIG. **11** for clarity). In the illustration of FIG. **11**, slider assembly **216** is retracted toward the street side of the mechanism. As slider beam **222** is retracted to the position shown in FIG. **11**, idler assembly **228** maintains belt **220** in engagement on drive pulley **226**.

[0109] FIGS. **12**A-**12**C are rear views of a refuse collection system illustrating use of the refuse collection system to collect refuse from a curb-side container. Initially, slider assembly **216** is in a retracted position on guide assembly **218**. (FIG. **12**A). Refuse collection mechanism **130** can be operated to extend slider assembly to an extended position relative to intermediate container **124** and the vehicle to which the collection system is attached. To extend slider assembly **216**, drive unit **224** is operated to turn drive pulley **226** on belt **220**.

[0110] Grabber device **132** can be operated to grab the curb-side container **1200** (FIG. **12**B). Grabber device **132** can be operated (for example, by rotating arm **300** up on slider beam **222**) to lift container **1200** so that the contents of container **1200** can be emptied into intermediate container **124**. (FIG. **12**C).

[0111] FIGS. **13**A-**13**C are top views of a refuse collection system illustrating use of the refuse collection system to grab a curb-side container. Initially, slider assembly **216** is in a retracted position on guide assembly **218**. (FIG. **13**A). Refuse collection mechanism **130** can be operated to extend slider assembly to an extended position relative to intermediate container **124** and the vehicle to which the collection system is attached. To extend slider assembly **216**, drive unit **224** (shown in FIG. **12**A) is operated to turn drive pulley **226** (shown in FIG. **12**A) on belt **220** (shown in FIG. **12**A). Grabber device **132** can be operated to close arms **304** of grabber device **132**. (FIG. **13**B). Grabber device **132** can be operated to close arms **304** until grabber device **132** is holding curb-side container **1000** (FIG. **13**C).

[0112] In various implementations described above, a refuse collection system includes a refuse loading mechanism that picks up refuse containers on one side of a vehicle. In some implementations, however, a refuse collection system includes a refuse loading mechanism that can pick up refuse on both sides a vehicle. FIG. **14** illustrates a refuse loading mechanism that can load refuse on either side of a vehicle. The refuse loading mechanism can be operated to extend a grabbing device on either side vehicle. Refuse collection system **1200** includes container **1402**, refuse loading mechanism **1404**. Refuse loading mechanism includes slider assembly **1206**, guide assembly **1408**, belt **220**, and grabber devices **1412**, **1414**. Drive unit **224** can be operated rotate a drive pulley coupled to drive unit **224** to alternatively extend grabber device **1412** or grabber device **1414** (for example, on the street-side and curb-side of a refuse collection vehicle).

[0113] In the system illustrated in FIG. **14**, the drive unit can be operated to move the slider beam to alternately position a curb-side grabbing device and a street-side grabbing device. In another implementation, a refuse collection system includes a mechanism for positioning a single grabber device on either side of a refuse collection vehicle, such as by way of a slide rail or a swinging arm coupled to a reciprocating member. In still another implementation, a refuse loading mechanism is mounted in front of an intermediate container. (Such a mechanism can be mirrored relative to what is shown in FIGS. **13**A-**13**C such that the mechanism still loads on the curb-side of the vehicle.)

[0114] In various implementations described above, a rotatable element on a reciprocating assembly is driven on a flexible member (e.g., a belt), with fixed ends to move the reciprocating member to position a refuse-loading device. A rotatable element can be driven on a flexible

member fixed ends to effect other processes on a refuse collection vehicle. A rotatable element can be moved on a flexible member to effect linear motion in other mechanisms, such as to pack refuse in, or eject refuse from, a container of a vehicle. As other examples, in some implementations, a rotatable element can be moved on a flexible member to lift refuse out of a container in a refuse collection vehicle, or to move refuse from one location to another in the refuse collection vehicle.
[0115] In the example shown in FIG. **7**, a rotating assembly includes a drive pulley that can be mounted to a motor drive shaft of the drive unit. A loading mechanism can, in other implementations, include other drive unit arrangements that turn to drive the loading mechanism. In some implementations, a drive unit of the packing device includes an outrunner/hub motor arrangement. In this implementation, the rotor of the electric motor is positioned outside the stator. FIG. **15** schematically illustrates a refuse loading mechanism having an outrunner/hub motor arrangement according to some implementations. Refuse loading mechanism **1500** includes reciprocating member **1502**, guide assembly **1504**, electric motor assembly **1506**, drive pulley **1508** and belt **1510**. Electric motor assembly **1506** is coupled to reciprocating member **1502**. Electric motor assembly **1506** includes stator unit **1512** and shell **1514**. Shell **1514** can rotate around stator unit **1514**. Drive pulley **1508** is coupled to shell **1514**. Electric motor assembly **1506** can be operated to turn drive pulley **1508** such that drive pulley **1508** moves along belt **1510** to move reciprocating member **1502** in or out on guide assembly **1504**. In some implementations, drive pulley **1508** is installed over the top of shell **1514**.
[0116] In some implementations, a shell of an outrunner motor as includes teeth, grooves, or other features on the outer surface of the shell that directly engage on a belt. In this case, the drive pulley can be omitted.
[0117] In various implementations described above, a flexible member is attached at its ends below a reciprocating member (e.g., slider beam **222**). In other implementations, the attachment locations for a flexible are above the reciprocating member. Arranging the attachment locations of a can, in some cases, improve access to the reciprocating member or other components of a mechanism.
[0118] Sensors can be included on various components of a refuse collection system, including, for example, a reciprocating member or a grabber device. A refuse collection system can include other sensors. For example, a refuse loading mechanism can include load sensors, position sensors, angle sensors, or pressure sensors. Operation of the refuse loading mechanism or other systems can be controlled based on the information provided by the sensors. In some implementations, a refuse collection system includes sensors to sense position, angle, load or other characteristics about the system. As an example, a sensor can sense position of a reciprocating member. As another example, a sensor can sense load imparted by a slider assembly (e.g., cantilevered load) on one or more structural elements of a guide assembly or container.
[0119] Control of a refuse collection device may be carried out manually, automatically, or a combination thereof. In some implementations, a control system collects data from refuse collection system sensors and/or other operational sensors and controls the refuse collection system or other components of vehicle based on the information. For example, a control system may automatically shut down or reduce the speed of a drive system if a compression load (or another measured characteristic of the refuse vehicle's system) is outside an established range or exceeds an established threshold.
[0120] In some implementations, torque, speed or other parameters are adjusted based on the position, load, or other characteristics of one or more members of a refuse loading mechanism. For example, in certain implementations, the torque of the motor, energy consumption, or other operating parameters are adjusted to account for different loads. Operation of loading mechanism for collecting recycled material can, for example, be different than operation of the loading mechanism for collecting trash. In some implementations, the rate of motion of the reciprocating member can be controlled. The control unit can implement optimized current curves for battery life vs. power, feedback control for heavy vs. light loads, etc. In some implementations, the control

system coordinates motion between in/out motor and grabber/lift motor(s).
[0121] In some implementations, a system includes interlocks to prevent unintended or un-commanded movement (e.g., operating lift/grabber with beam in parked position).
[0122] In some implementations, the control system receives position feedback from motor movement (e.g., using a sensored motor in time with the belt, position of in/out can be determined mathematically from rotation/partial rotation of motor and belt pitch).
[0123] In some implementations, belt slip is monitored. In one example, belt slip is monitored using end-of-travel position/sensors.
[0124] In various implementations described above, devices are powered electrically. In certain implementations, however, devices used to operate components of a mechanism a refuse loading mechanism (such as a grabber device lift arm, or a reciprocating member) can be activated or powered in other manners, such as pneumatically, mechanically, or hydraulically.
[0125] Control units and/or computing devices as described herein can include or use one or more computing systems. FIG. **16** depicts an example computing system, according to implementations of the present disclosure. The system **1600** may be used for any of the operations described with respect to the various implementations discussed herein. The system **1600** may include one or more processors **1610**, a memory **1620**, one or more storage devices **1630**, and one or more input/output (I/O) devices **1650** controllable via one or more I/O interfaces **1640**. The various components **1610**, **1620**, **1630**, **1640**, or **1650** may be interconnected via at least one system bus **1660**, which may enable the transfer of data between the various modules and components of the system **1600**. In some implementations, a control system may be coupled to an operator display and control panel (for example, located in a cab of the vehicle.)
[0126] The processor(s) **1610** may be configured to process instructions for execution within the system **1600**. The processor(s) **1610** may include single-threaded processor(s), multi-threaded processor(s), or both. The processor(s) **1610** may be configured to process instructions stored in the memory **1620** or on the storage device(s) **1630**. For example, the processor(s) **1610** may execute instructions for the various software module(s) described herein. The processor(s) **1610** may include hardware-based processor(s) each including one or more cores. The processor(s) **1610** may include general purpose processor(s), special purpose processor(s), or both.
[0127] The memory **1620** may store information within the system **1600**. In some implementations, the memory **1620** includes one or more computer-readable media. The memory **1620** may include any number of volatile memory units, any number of non-volatile memory units, or both volatile and non-volatile memory units. The memory **1620** may include read-only memory, random access memory, or both. In some examples, the memory **1620** may be employed as active or physical memory by one or more executing software modules.
[0128] The storage device(s) **1630** may be configured to provide (e.g., persistent) mass storage for the system **1600**. In some implementations, the storage device(s) **1630** may include one or more computer-readable media. One or both of the memory **1620** or the storage device(s) **1330** may include one or more computer-readable storage media (CRSM). The CRSM may include one or more of an electronic storage medium, a magnetic storage medium, an optical storage medium, a magneto-optical storage medium, a quantum storage medium, a mechanical computer storage medium, and so forth. The CRSM may provide storage of computer-readable instructions describing data structures, processes, applications, programs, other modules, or other data for the operation of the system **1600**. In some implementations, the CRSM may include a data store that provides storage of computer-readable instructions or other information in a non-transitory format. The CRSM may be incorporated into the system **1600** or may be external with respect to the system **1600**. The CRSM may include read-only memory, random access memory, or both. One or more CRSM suitable for tangibly embodying computer program instructions and data may include any type of non-volatile memory, including but not limited to: semiconductor memory devices, such as EPROM, EEPROM, and flash memory devices; magnetic disks such as internal hard disks

and removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. In some examples, the processor(s) **1610** and the memory **1620** may be supplemented by, or incorporated into, one or more application-specific integrated circuits (ASICs). The system **1600** may include one or more I/O devices **1650**.

[0129] Implementations and all of the functional operations described in this specification may be realized in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. Implementations may be realized as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer readable medium for execution by, or to control the operation of, data processing apparatus. The computer readable medium may be a machine-readable storage device, a machine-readable storage substrate, a memory device, a composition of matter effecting a machine-readable propagated signal, or a combination of one or more of them. The term “computing system” encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus may include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them. A propagated signal is an artificially generated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal that is generated to encode information for transmission to suitable receiver apparatus.

[0130] A computer program (also known as a program, software, software application, script, or code) may be written in any appropriate form of programming language, including compiled or interpreted languages, and it may be deployed in any appropriate form, including as a standalone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program may be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program may be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0131] The processes and logic flows described in this specification may be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows may also be performed by, and apparatus may also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

[0132] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any appropriate kind of digital computer. Generally, a processor may receive instructions and data from a read only memory or a random-access memory or both. Elements of a computer can include a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer may also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Moreover, a computer may be embedded in another device, e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio player, a Global Positioning System (GPS) receiver, to name just a few. Computer readable media suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-

ROM disks. The processor and the memory may be supplemented by, or incorporated in, special purpose logic circuitry.
[0133] In various implementations described above, refuse loading mechanisms have been described for use on a residential front-loader. Implementations can, however, be employed with respect to any suitable type of RCV, with any suitable type of body and/or hopper variants. For example, the RCV can be an automated side loader vehicle. As another example, the RCV can be a commercial front loader (e.g., for dumpster type containers). A front loader can be provided with or without an intermediate collection device.
[0134] As used herein, a “drive unit” includes any device, mechanism, or system that imparts force to mechanically drive one or more components. Examples of a drive unit include a hydraulic motor, an electric motor, or an engine. A driver may also include gearboxes, belts, cables, chain drives, or other power transmission devices.
[0135] While this specification contains many specifics, these should not be construed as limitations on the scope of the disclosure or of what may be claimed, but rather as descriptions of features specific to particular implementations. Certain features that are described in this specification in the context of separate implementations may also be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation may also be implemented in multiple implementations separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination may in some examples be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.
[0136] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results.
[0137] A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. For example, various forms of the flows shown above may be used, with steps re-ordered, added, or removed. Accordingly, other implementations are within the scope of the following claim(s).

Claims

1. A refuse collection system, comprising: a refuse-receiving container; and a refuse loading mechanism coupled to the refuse-receiving container and configured to transfer refuse into the refuse-receiving container, the refuse loading mechanism comprising: a guide assembly; a flexible member coupled to the guide assembly at a first location and a second location; a reciprocating member configured to translate relative to the guide assembly; a rotatable element coupled to the reciprocating member and engaged with the flexible member, and a drive unit configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.
2. The refuse collection system of claim 1, further comprising a grabber device coupled to the reciprocating member.
3. The refuse collection system of claim 1, wherein the drive unit is configured to move the reciprocating member between an retracted position and at least one other position.
4. The refuse collection system of claim 1, wherein the drive unit comprises an electric motor.
5. The refuse collection system of claim 1, wherein the drive unit comprises a hydraulic motor.
6. The refuse collection system of claim 1, wherein the reciprocating member comprises a slide member configured to move in and out relative to the guide assembly.
7. The refuse collection system of claim 1, wherein the flexible member comprises a belt.
8. The refuse collection system of claim 1, wherein the flexible member comprises a belt, wherein

the rotatable element is configured to engage the belt.
9. The refuse collection system of claim 1, wherein the rotatable element comprises two or more teeth configured to engage the flexible member.
10. The refuse collection system of claim 1, wherein: the guide assembly comprises one or more tracks; and the reciprocating member comprises a slider beam configured to translate on the track.
11. The refuse collection system of claim 1, wherein: the guide assembly comprises one or more rollers, and the reciprocating member is configured to translate on at least one of the one or more rollers.
12. The refuse collection system of claim 1, further comprising one or more guides configured to guide the flexible member.
13. The refuse collection system of claim 1, wherein the one or more guides comprise one or more idlers, wherein the idlers are configured to guide the flexible member to promote engagement of the belt with the rotatable element.
14. The refuse collection system of claim 1, wherein the one or more guides comprises a first guide configured to engage the flexible member on one side of the rotatable element and a second guide configured to engage the flexible member on the other side of the rotatable element.
15. The refuse collection system of claim 13, wherein at least one of the one or more guides comprises a tensioning device.
16. The refuse collection system of claim 1, further comprising one or more tensioning devices configurable to alter tension on the flexible member.
17. The refuse collection system of claim 1, wherein the reciprocating member is configured to translate on the guide assembly such that the rotatable element travels along the guide assembly at least a portion of the way between an extended position and a retracted position.
18. The refuse collection system of claim 1, further comprising a grabber device coupled to the reciprocating member and comprising one or more arms operable to couple with a curbside container.
19. The refuse collection system of claim 1, further comprising a grabber device coupled to the reciprocating member and comprising one or more electric motors operable to engage one or more arms of the grabber device with a curb-side container.
20. The refuse collection system of claim 1, further comprising an arm coupled to the reciprocating member and operable to lift refuse toward an opening in the refuse-receiving container.
21. The refuse collection system of claim 1, further comprising: a refuse collection vehicle to which the refuse-receiving container and the refuse loading mechanism are coupled; and one or more grabber devices coupled to the reciprocating member, wherein the one or more grabber devices are operable to collect refuse on both sides of the vehicle.
22. The refuse collection system of claim 1, wherein the guide assembly comprises an upper rail and a lower support element, wherein the upper rail and the lower support element cooperate to support an overhanging load on the guide assembly.
23. The refuse collection system of claim 1, wherein: the guide assembly comprises: an upper track; and a lower support element comprising one or more lower rollers, the slide assembly comprises: one or more upper rollers; and a lower track; and the upper rollers roll on the upper rail and the lower rollers roll on the lower track when the slide assembly translates on the guide assembly.
24. The refuse collection system of claim 1, further comprising a control unit configured to operate the drive unit to move to the slider assembly in and out on the guide assembly.
25. The refuse collection system of claim 1, wherein: the drive unit comprises an outrunner/hub motor system; and the outrunner/hub motor system is configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.
26. A refuse collection system, comprising: a vehicle; a refuse handling mechanism coupled to the vehicle and configured to handle refuse on or in the vehicle, the refuse handling mechanism

comprising: a guide assembly; a flexible member coupled to the guide assembly at a first location and a second location; a reciprocating member configured to translate relative to the guide assembly; and a rotatable element coupled to the reciprocating member and engaged with the flexible member, and a drive unit configured to turn the rotatable element on the flexible member such that the reciprocating member translates on the guide assembly.

27. The refuse collection system of claim 26, wherein the refuse handling mechanism is configured to load refuse onto or into the vehicle.

28. The refuse collection system of claim 26, wherein the refuse handling mechanism is configured to move refuse from one location on the vehicle to another location on the vehicle.

29. The refuse collection system of claim 26, wherein the refuse handling mechanism is configured to eject refuse from the vehicle.

30. The refuse collection system of claim 26, wherein the refuse handling mechanism is configured to compact refuse on the vehicle.

31. The refuse collection system of claim 26, wherein: the flexible member is coupled to the guide assembly at a first location and a second location; and the rotatable element is movable on the flexible member between the first location and the second location.

32. The refuse collection system of claim 26, wherein the drive unit comprises an electric motor.

33. The refuse collection system of claim 26, wherein the flexible member comprises a belt.

34. A method of handling refuse on a refuse collection vehicle, comprising: turning a rotatable element engaged with a flexible member that is coupled to a guide assembly such that the reciprocating member translates relative to the guide assembly; and operating a refuse handling device coupled to the reciprocating member to handle refuse.

35. The method of claim 34, wherein turning a rotatable element comprises drawing the reciprocating member from a retracted position on a refuse collection vehicle to an extended position on the refuse collection vehicle.

36. The method of claim 34, wherein turning a rotatable element comprises drawing the reciprocating member from an extended position on a refuse collection vehicle to a retracted position on the refuse collection vehicle.

37. The method of claim 34, further comprising: maintaining a first portion of the flexible member at a first location relative to the guide assembly; and maintaining a second portion of the flexible member at a second location relative to the guide assembly.

38. The method of claim 34, wherein: the flexible member is coupled to the guide assembly at a first location and a second location, and turning the rotatable element comprises moving the rotatable element along the flexible member between the first location and the second location.

39. The method of claim 34, wherein operating the refuse handling device comprises loading refuse into or onto the refuse collection vehicle.

40. The method of claim 34, wherein operating the refuse handling device comprises loading refuse from a curb-side container into a refuse-receiving container.

41. The method of claim 40, further comprising moving refuse from the refuse-receiving container into another container on the refuse collection vehicle.

42. The method of claim 34, wherein operating the refuse handling device to handle refuse comprises moving refuse from one location on the vehicle to another location on the vehicle.

43. The method of claim 34, wherein operating the refuse handling device to handle refuse comprises ejecting refuse from the vehicle.

44. The method of claim 34, wherein operating the refuse handling device to handle refuse comprises compacting refuse on the vehicle.