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Inventor(s)	Geesey; Daniel

ADJUSTABLE SLEDGE FOR ROUND BALER

Abstract

A rotary baler includes a frame defining an expandable bale-forming chamber. A sledge assembly forms at least part of the expandable bale-forming chamber. The sledge assembly includes an arm and one or more rollers that are mounted to the arm. The one or more rollers are configured to assist in forming a bale within the chamber. The arm is pivotable relative to the frame about a pivot axis. The arm is also translatable in the fore to aft direction of the rotary baler relative to the frame, which changes a position of the pivot axis in the fore to aft direction.

Inventors: **Geesey; Daniel (Bethel, PA)**

Applicant: **CNH Industrial America lLLC** (New Holland, PA)

Family ID: **1000007698456**

Assignee: **CNH Industrial America LLC (New Holland, PA)**

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Background/Summary

FIELD OF THE INVENTION

[0001] The present invention relates to a round (rotary) baler, which is used for agricultural

purposes.
BACKGROUND OF THE INVENTION
[0002] As is described in U.S. Pat. No. 7,437,866 (the '866 patent), which is incorporated by reference herein in its entirety, round (rotary) balers typically include an expandable bale-forming chamber. Bale-forming means, commonly referred to as a sledge, is/are positioned in the bale-forming chamber to assist in forming the bale within the chamber. The sledge includes a set of rollers, which may also be referred to herein as rolls. The rollers of the sledge are typically arranged in an arc formation, whereby the arc has a fixed diameter.
[0003] The entire sledge typically pivots about a single fixed pivot point (such as the pivot point at reference character **26** in FIG. **1**). Due to the geometric constraints of such a sledge, the sledge can only have one rotational position where the arc formation of the sledge rollers (e.g., rollers **21-23** in FIG. **1**) matches the arc formation of the other rollers (e.g., rollers **30** and **18** in FIG. **1**) of the baler. This can result in an air gap or pocket formed between the sledge rollers and the perimeter of the bale that is being formed in the bale-forming chamber. Such a gap is shown in FIG. **2** at roller **23**. The gap can result in an area where material can accumulate and without being pressed into the bale. This issue may be more pronounced for smaller diameter bales that are formed in balers designed for larger bales. It would be desirable to reconfigure the fixed pivot point of the sledge so that it is adjustable so as to avoid the aforementioned disadvantages of the above described conventional balers.
SUMMARY OF THE INVENTION
[0004] According to one example, a rotary baler includes a frame defining an expandable bale-forming chamber. A sledge assembly forms at least part of the expandable bale-forming chamber. The sledge assembly includes an arm and one or more rollers that are mounted to the arm. The one or more rollers are configured to assist in forming a bale within the chamber. The arm is pivotable relative to the frame about a pivot axis. The arm is also translatable in the fore to aft direction of the rotary baler relative to the frame, which changes a position of the pivot axis in the fore to aft direction.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0005] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:
[0006] FIG. **1** is a side elevational view of a round baler.
[0007] FIG. **2** is similar to FIG. **1** with the bale-forming chamber of the baler in its partly full position.
[0008] FIG. **3** is similar to FIG. **1** with the bale-forming chamber of the baler in its full bale position.
[0009] FIG. **4** is a schematic view of an alternative movable sledge for the baler of FIGS. **1-3**, wherein the sledge is shown in an initial position.
[0010] FIG. **5** is a view similar to that of FIG. **4**, but showing said movable sledge in an extended position.
[0011] FIG. **6** is a detailed view of the baler of FIGS. **4** and **5** showing an actuator for biasing the movable sledge, wherein the sledge is shown in the initial position corresponding to FIG. **4**.
[0012] FIG. **7** is a view similar to FIG. **6** with the sledge shown in the extended position corresponding to FIG. **5**.
[0013] Corresponding reference characters indicate corresponding parts throughout the several

views. The exemplifications set out herein illustrate embodiments of the invention and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The terms “longitudinal”, “transverse”, “forward” (or fore), “rearward” (or aft), “left” and “right” used in connection with the bale and/or components thereof are determined with reference to the direction of forward operative travel of the baler and should not be considered as limiting. Also, the terms “upper” and “lower” are used principally throughout this specification for convenience and it should be understood that these terms equally are not intended to be limiting.

[0015] FIGS. **1-3** show a rotary or round baler **10** having an expandable chamber defined in part by belts and rollers. It should be understood at the outset that the details, features and functions of baler **10** described hereinafter can vary greatly. The details of baler **10** are provided hereinafter as background because they relate to the segment of the baler that is shown in FIGS. **4** and **5**.

[0016] As is described in the '866 patent, baler **10** has a main frame **11**, including a pair of side walls **19** (only side wall **19** shown), supported by a pair of wheels **12** (only one wheel **12** shown). As used herein, a rotary or round baler **10** is a baler that produces a substantially cylindrical bale having a substantially round or circular cross section. A forwardly mounted tongue **13** is provided on main frame **11** for connection to a tractor (not shown). Pivotally connected to a side wall **19** by a pair of stub shafts **15** is a tailgate **14** which is closed during bale formation. A pickup **16**, mounted on main frame **11**, includes tines **17** movable in a predetermined path to lift crop material from the ground and deliver it to a floor roller **18**, rotatably mounted on main frame **11**.

[0017] A sledge assembly **20** for forming the bales is disposed at the perimeter of the bale forming chamber. The sledge assembly **20** comprises transversely extending rollers **21**, **22**, **23** journaled at their ends in a pair of spaced arms **24**, one of which is shown. These arms **24** are pivotally mounted on stub shafts **26** for providing rotational movement of sledge assembly **20** from the bale starting position shown in FIG. **1** through the partly full position shown in FIG. **2** to the full bale position shown in FIG. **3**. Simply stated, arm **24** rotates about shaft **26**. Stub shafts **26** are stationary, the relevance of which will be described in greater detail with reference to FIGS. **4-7**. Rollers **21**, **22**, **23** are driven in a counter-clockwise direction by conventional means coupled to a drive shaft **28**. A starter roller **30**, mounted on main frame **11**, is also driven counter-clockwise. A freely rotatable idler roller **31**, carried by arms **24**, moves in an arcuate path with sledge assembly **20**.

[0018] The bale-forming chamber is further defined by an apron **32** comprising a plurality of continuous side-by-side belts supported by guide rollers **33**, **34**, **35**, **36**, **37** rotatably mounted in tailgate **14**. Apron **32** is also supported by drive roller **38**, mounted on main frame **11**. Although apron **32** passes between roller **21** and idler roller **31**, it is in engagement only with idler roller **31** and not roller **21**. Suitable coupling means (not shown) connected to drive shaft **28** provide rotation of drive roller **38** causing movement of apron **32** in the directions indicated by the arrows in FIGS. **1**, **2** and **3**. An additional guide roller **40** in the main frame **11** ensures proper engagement between apron **32** and drive roller **38**. A pair of take up arms **41** (only one shown) is pivotally mounted on main frame **11** by a cross shaft **42** for movement between inner, intermediate and outer positions shown in FIGS. **1**, **2** and **3**, respectively. Take up arms **41**, which carry additional guide rollers **43**, **44** for supporting apron **32**, are resiliently urged toward their inner positions (FIG. **1**).

[0019] When the elements of round baler **10** are disposed as shown in FIG. **1**, an inner course **66** of apron **32** extends between guide roller **37** and idler roller **31** to form the rear wall of the core starting chamber, while the inwardly facing surfaces of rollers **21**, **22**, **23** define in a general manner, a rearwardly inclined front wall. Floor roller **18** defines the bottom of the chamber, and with starter roller **30**, provides an inlet for crop material.

[0020] Turning now to operation of baler **10**, when round baler **10** travels across a field, pickup tines **17** lift crop material from the ground and deliver it through the inlet. The crop material is conveyed by floor roller **18** into engagement with apron inner course **66** (FIG. **1**) which urges the crop material upwardly and forwardly into engagement with the rollers on sledge assembly **20**. In this manner, crop material is coiled in a clockwise direction to start a bale core. Continued feeding of crop material into the chamber by pickup tines **17** causes apron inner course **66** to expand in length around a portion of the circumference of the bale core as the diameter increases (FIG. **2**). Take up arms **41** rotate from their inner position, shown in FIG. **1**, toward their outer position, shown in FIG. **3**, to accommodate expansion of the inner course **66** of the apron in a well-known manner, i.e., an outer course **68** of apron **32** is diminished in length while the inner course **66** increases a like amount. After a bale has been formed and wrapped, tailgate **14** is opened and the bale is ejected rearwardly. Subsequent closing of tailgate **14** returns the inner and outer courses **66**, **68** of apron **32** to the locations shown in FIG. **1**.

[0021] A sensor **45** continuously monitors the outer surface of a bale being formed, and communicates the same to a controller of the baler **10**. Sensor **45** may be, for example, an optical sensor, a contact sensor having a wiper, a force sensor, a potentiometer, or any other sensor that is known in the art for either directly or indirectly sensing the bale diameter. Sensor **45** communicates its measurement to a controller of the baler, and the controller (in the form of a computer having a processor, receiver, transmitter, memory, etc.) is configured to interpret the sensed bale diameter.

[0022] During bale formation, sledge assembly **20** rotates about stub shaft **26** (one shown) between a bale starting position (FIG. **1**) to a full bale position (FIG. **3**). This movement causes idler roller **31** to move along an arcuate path while maintaining apron **32** in close proximity to roller **21**, thereby allowing roller **21** to strip crop material from the belts. Sledge assembly **20** is rotated outwardly about shaft **26** towards its full bale position during bale formation as the crop material expands against rollers **21**, **22**, **23** and then subsequently is rotated inwardly about shaft **26** by apron **32** to the position shown in FIG. **1**.

[0023] As noted above, due to the geometric constraints of sledge **20**, the sledge can only have one position where the arc formation of the sledge rollers aligns with the arc formation of the other rollers **18** and **30** that are not directly attached to the sledge **20**. This can result in a gap or pocket forming between the sledge rolls and the perimeter of the bale being formed in the bale-forming chamber. Such a gap is shown in FIG. **2** at roller **23**. The gap can result in an area where material can accumulate without being pressed into the bale. This problem may be more pronounced for smaller diameter bales if the baler is designed for larger bales. As noted above, it would be desirable to reconfigure the fixed pivot point of the sledge **20** so that it is adjustable so to avoid the aforementioned disadvantages. Such a reconfigured sledge is shown in FIGS. **4** and **5**.

[0024] Turning now to FIGS. **4** and **5**, depicted is an alternative sledge assembly **400** for the round baler **10**. Sledge assembly **400** is analogous to sledge assembly **20**. It should be understood that all of the other details provided above with respect to the baler of FIGS. **1-3** are (or may be) applicable to the baler shown in FIGS. **4** and **5**. It should also be understood that in the example of FIGS. **4** and **5**, an opposing side of baler is depicted such that the component locations are reversed (i.e., mirror images). Lastly, it should also be understood that while the number and arrangement of rollers on the balers shown in FIGS. **1** and **4** differ, such differences have no effect on the spirit of the invention. For example, sledge assembly **400** has only two large rollers **408** and **409** wherein the sledge assembly **20** includes four rollers.

[0025] Sledge assembly **400** generally includes an arm **404** (analogous to arm **24**). One or more rollers **408** and **409** are connected to arm **404**. Roller **408** is analogous to roller **23**. Roller **408** is mounted on a movable stub shaft **411**. Stub shaft **411** is analogous to stub shaft **26**, with the exception that stub shaft **411** is translatable (or otherwise moveable) as will be described with reference to FIGS. **6** and **7**.

[0026] The entire sledge assembly **400** is pivotable about the stub shaft **411** (see rotational arrows in FIG. **4**). Axis **412** represents both the pivot axis of the sledge assembly **400** and the rotational axis **412** of roller **408**. It should be understood that roller **408** is capable of rotation about axis **412** irrespective of the pivoting action of sledge assembly **400** about axis **412**. While the sledge assembly **400** is only shown in one rotational position in FIGS. **4** and **5**, it should be understood that assembly **400** is capable of the rotational range of the sledge that is shown in FIGS. **1-3**. One or more stationary rollers **402** are positioned beneath sledge assembly **400**, and all of the rollers **402**, **408**, **409**, etc. together form an arc.

[0027] Furthermore, unlike the sledge assembly **20** of FIG. **1**, the sledge assembly **400** is translatable in the forward/rearward (i.e., fore to aft) directions along axis **410**. FIG. **5** depicts the sledge assembly **400** in an extended position (i.e., extended along axis **410**), whereas FIG. **4** depicts the sledge assembly **400** in initial or starting position along axis **410**. Although not shown, sledge assembly **400** may be reconfigured so that the axis **412** is adjustable in various other directions, and is not limited to translating along axis **410**.

[0028] Turning now to FIGS. **6** and **7**, stub shaft **411** is connected to a hub **405**, and hub **405** may be positioned within an elongated slot or channel **416** that is formed in a wall **420** of the baler. Wall **420** may be analogous to wall **19**. Hub **405** and its stub shaft **411** are capable of translating within channel **416** along axis **410** between the positions shown in FIGS. **6** and **7**. These two positions may represent the limits of translation of sledge assembly **400**.

[0029] An actuator **430** is connected to shaft **411** for translating shaft **411** (as well as the entire sledge assembly **400**) along axis **410**. Actuator may have a piston and cylinder arrangement, as shown, or actuator **430** may be a solenoid, for example. One end of actuator **430** is mounted to a stationary object, such as wall **420**, while the moveable end of actuator **430** is either directly or indirectly mounted to shaft **411** such that extension or retraction of actuator **430** causes translation of shaft **411** along axis **410**. The actuator **430** may be powered either hydraulically, electrically or pneumatically, for example. The actuator **430** may comprise an internal spring for biasing purposes. As an alternative to the piston and cylinder arrangement, the actuator **430** may be replaced by a mechanical linkage.

[0030] The baler of FIGS. **4** and **5** includes the above-described sensor **45** and a controller **450** (shown schematically in FIG. **4**). Sensor **45** communicates its bale diameter measurement to controller **450**, and the controller **450** is configured to (i) interpret the sensed bale diameter and (ii) control actuator **430** based upon that interpretation of the sensed bale diameter. Simply stated, controller **450** actuates actuator **430** to translate sledge assembly **400** along axis **410** based upon the bale diameter sensed, measured or otherwise interpreted by sensor **45**. Stated another way, controller **450** is configured to control the position of the pivot point **412** of the sledge **400** based on the current bale diameter. As the bale grows in diameter, the sledge pivot axis **412** is adjusted by actuator **430** to better match the bale diameter. Actuator **430** is also configured to lock the position of the pivot axis **412** to prevent inadvertent movement of the pivot axis **412** during operation. A separate locking mechanism may be employed, if so desired.

[0031] It should be understood that moving the sledge rearward (i.e., toward the centerline of the bale) better accommodates smaller bale diameter and moving the sledge forward better matches a larger bale diameter. The position of the sledge is determined by the current bale size. As the bale diameter grows, the cylinder moves the pivot axis **412** of the sledge **400** along axis **410** from the starting point (see FIG. **4**) for a smaller diameter bale to a final pivot point position (see FIG. **5**) intended for a maximum bale diameter. The position of sledge **400** is driven as a function of the bale diameter, as monitored by sensor **45**.

[0032] It should be understood that as the bale diameter grows, the translational position (i.e., along axis **410**) of the sledge **400** shifts to accommodate the larger, growing bale. This constant pivot point adjustment allows the sledge roller arc to match the bale profile of the desired bale diameter and limits round bales from being formed in a non-circular bale chamber. Tying the sledge pivot point to the bale diameter allows the sledge arc formed by the rollers as well as the bale formation rollers position to match the bale profile based on the bale diameter.

[0033] As an alternative to the automated method for shifting the translational position of sledge **400**, the sledge **400** shift outwardly under the pressure of the growing bale, and return to its initial position by way of spring (at the same location as actuator **430**. Thus, item **430** could also represent a spring.

[0034] It is to be understood that the operational steps are performed by the controller **450** upon loading and executing software code or instructions which are tangibly stored on a tangible computer readable medium, such as on a magnetic medium, e.g., a computer hard drive, an optical medium, e.g., an optical disc, solid-state memory, e.g., flash memory, or other storage media known in the art. Thus, any of the functionality performed by the controller **450** described herein is implemented in software code or instructions which are tangibly stored on a tangible computer readable medium. Upon loading and executing such software code or instructions by the controller **450**, the controller **450** may perform any of the functionality of the controller **450** described herein, including any steps of the methods described herein.

[0035] The term “software code” or “code” used herein refers to any instructions or set of instructions that influence the operation of a computer or controller. They may exist in a computer-executable form, such as machine code, which is the set of instructions and data directly executed by a computer's central processing unit or by a controller, a human-understandable form, such as source code, which may be compiled in order to be executed by a computer's central processing unit or by a controller, or an intermediate form, such as object code, which is produced by a compiler. As used herein, the term “software code” or “code” also includes any human-understandable computer instructions or set of instructions, e.g., a script, that may be executed on the fly with the aid of an interpreter executed by a computer's central processing unit or by a controller.

[0036] While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

Claims

1. A rotary baler comprising: a frame defining an expandable bale-forming chamber; and a sledge assembly disposed on and defining a boundary of the expandable bale-forming chamber, wherein the sledge assembly comprises an arm and one or more rollers that are mounted to the arm, wherein the one or more rollers are configured to assist in forming a bale within the chamber, wherein the arm is pivotable relative to the frame about a pivot axis, and wherein the arm is also independently translatable relative to the frame for adjusting a position of the pivot axis.

2. The rotary baler of claim 1, wherein the sledge assembly comprising a plurality of rollers that are directly mounted to the arm.

3. The rotary baler of claim 1, wherein the sledge assembly is configured to translate relative to the frame without rotating about the pivot axis.

4. The rotary baler of claim 1, further comprising a sensor for sensing a diameter of the bale being formed within the chamber.

5. The rotary baler of claim 4, further comprising an actuator for translating the sledge assembly relative to the frame.

6. The rotary baler of claim 5, further comprising a controller that receives signals from the sensor and is also configured to control the actuator, wherein the controller is configured to actuate the actuator as a function of the signals received from the sensor.

7. The rotary baler of claim 6, wherein the controller is configured to actuate the actuator to translate the sledge assembly so that the bale-forming chamber expands when the sensor senses an increase in bale diameter.

8. The rotary baler of claim 5, wherein the actuator comprises a piston and cylinder arrangement.

9. The rotary baler of claim 1, wherein the rotary baler comprises stationary rollers that are not attached to the arm.
10. The rotary baler of claim 9, wherein the stationary rollers and the one or more rollers of the sledge assembly are arranged along an arc.
11. The rotary baler of claim 10, wherein the sledge assembly comprises a plurality of rollers, and the plurality of rollers along with the stationary rollers are positioned along the arc.
12. The rotary baler of claim 1, wherein one roller of said one or more rollers of the sledge assembly is rotatably mounted to a shaft, and the shaft also forms said pivot axis.
13. The rotary baler of claim 12, wherein said one roller is rotatable about the pivot axis, and an entirety of the sledge assembly is rotatable about said pivot axis independent of rotation of said one roller.
14. The rotary baler of claim 12, wherein the shaft is translatably positioned within an elongated slot that is formed in the frame.
15. The rotary baler of claim 14, wherein the shaft is mounted to a hub and the hub is translatably positioned within the elongated slot.