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(54) **SHOVEL LIFTING APPARATUS AND METHOD FOR LIFTING A SUPERSTRUCTURE OF A SHOVEL**

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E02F 9/00 (2006.01)
E02F 9/10 (2006.01)

(52) **U.S. Cl.**
CPC ***E02F 9/10*** (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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(57) **ABSTRACT**

There is provided a method of lifting a shovel comprising an undercarriage and a superstructure with a counterweight. The method comprises configuring the shovel and a front lifting assembly and a rear lifting assembly on a lifting site in a lifting configuration wherein the front lifting assembly matches corresponding force applying points on a front portion of an undersurface of the superstructure and the rear lifting assembly matches corresponding force applying points on an undersurface of the counterweight, wherein at least one of the front and the rear lifting assemblies includes a lifting beam including a set of spaced-apart lifting units and an elongated beam extending inbetween; contacting the front lifting assembly and the rear lifting assembly with the corresponding force applying points on the undersurface of the front portion of the superstructure and the undersurface

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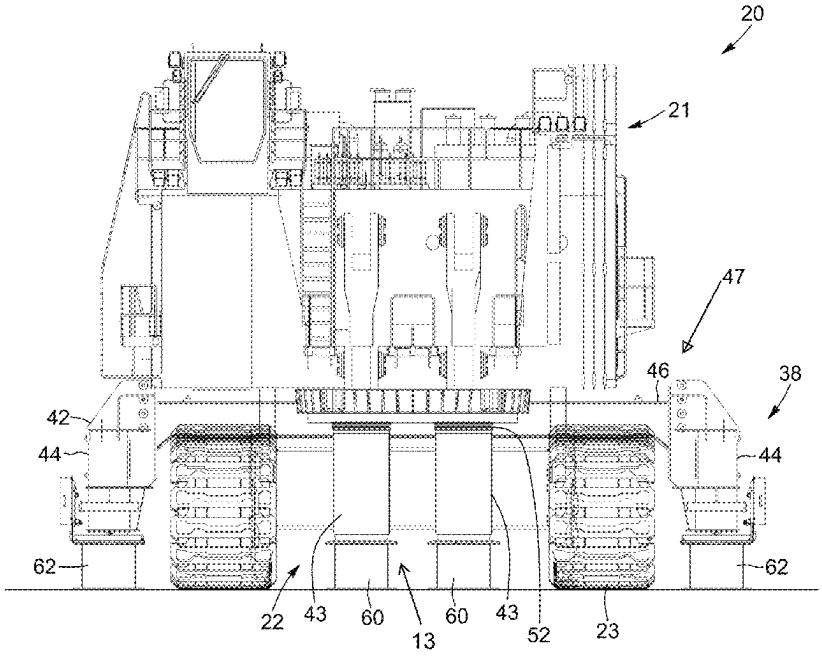

of the counterweight respectively; and starting a lifting operation to raise the superstructure to a desired height. There is also provided an apparatus for lifting the shovel from the ground surface.

20 Claims, 14 Drawing Sheets

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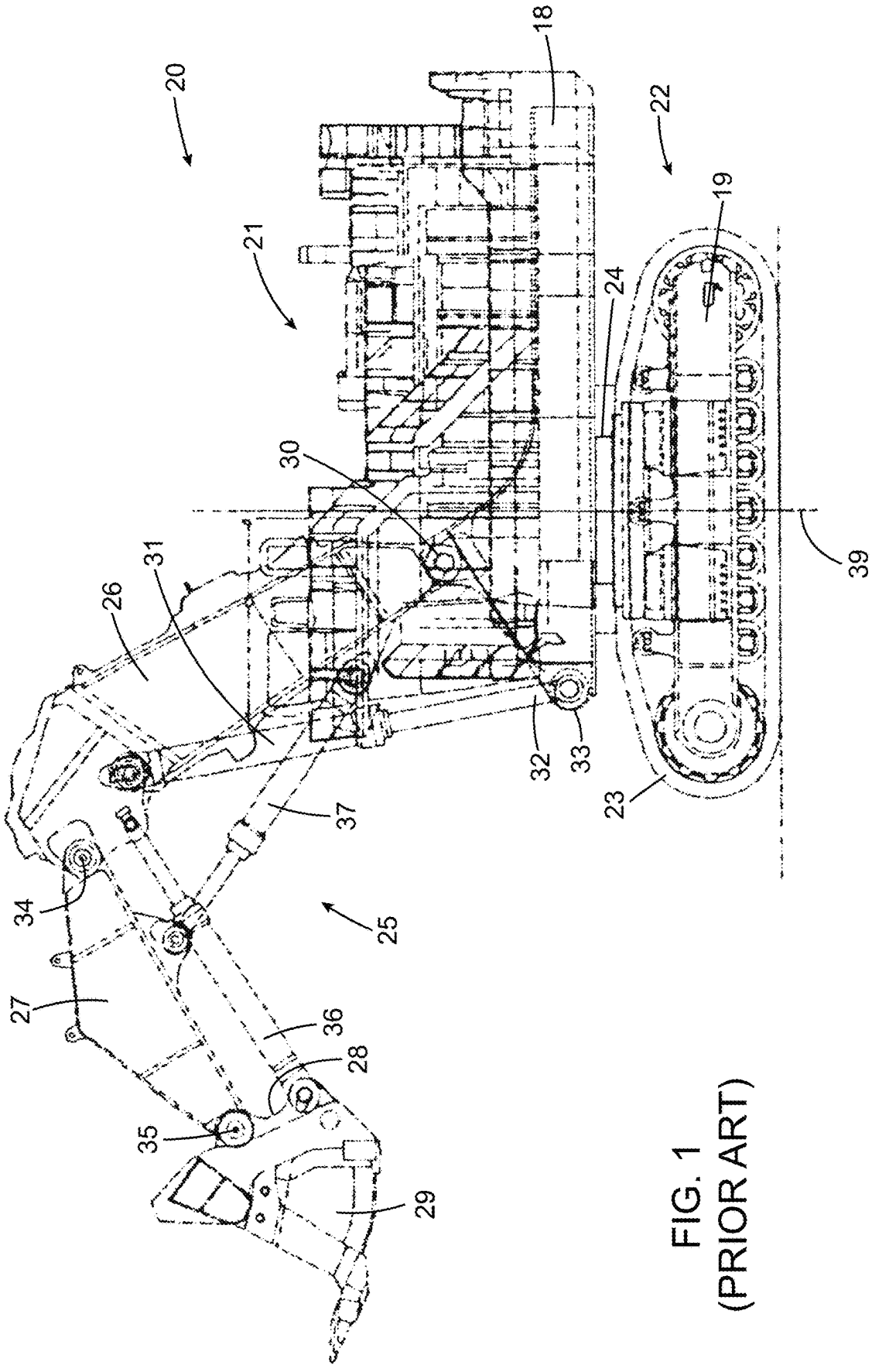

FIG. 1
(PRIOR ART)

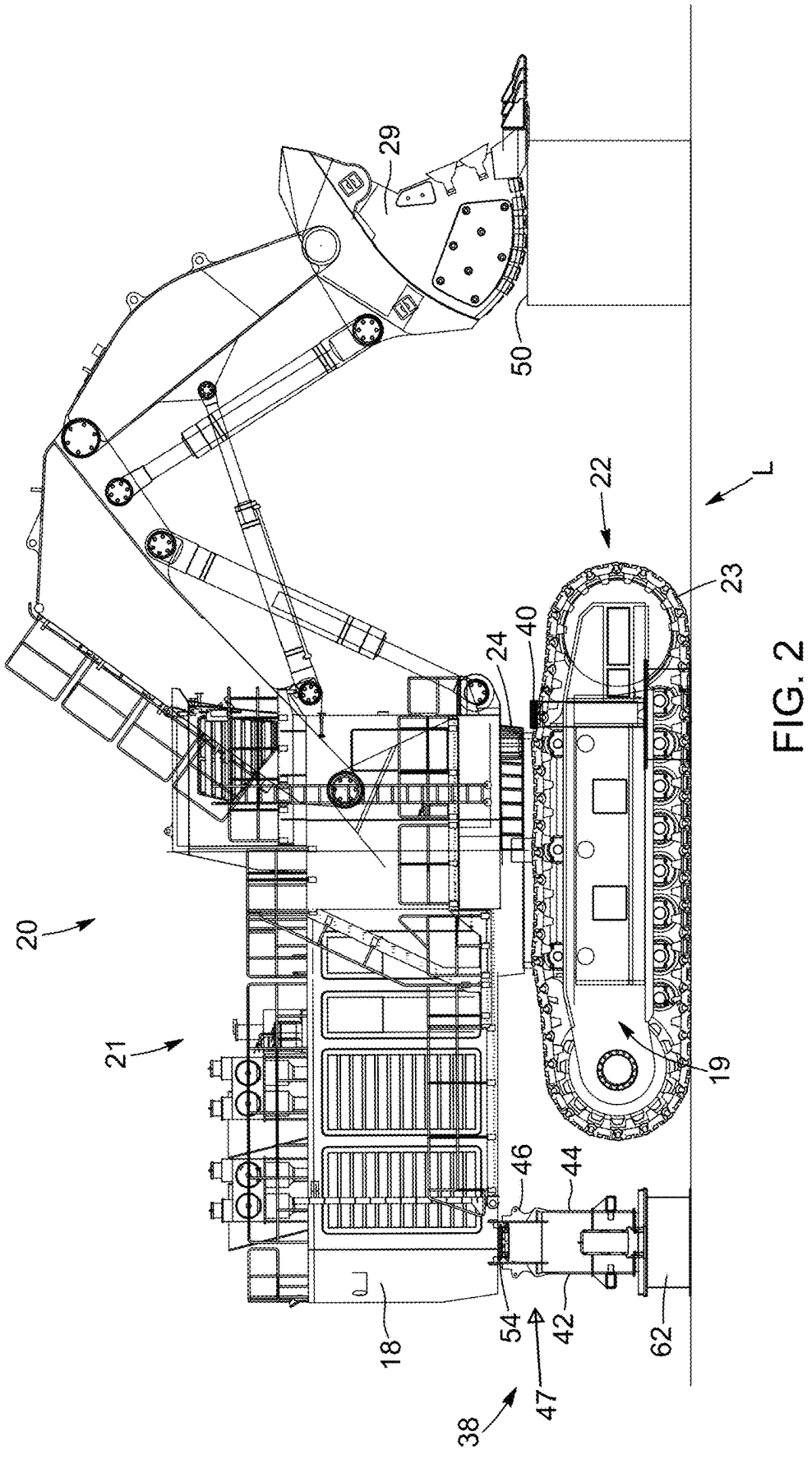

FIG. 2

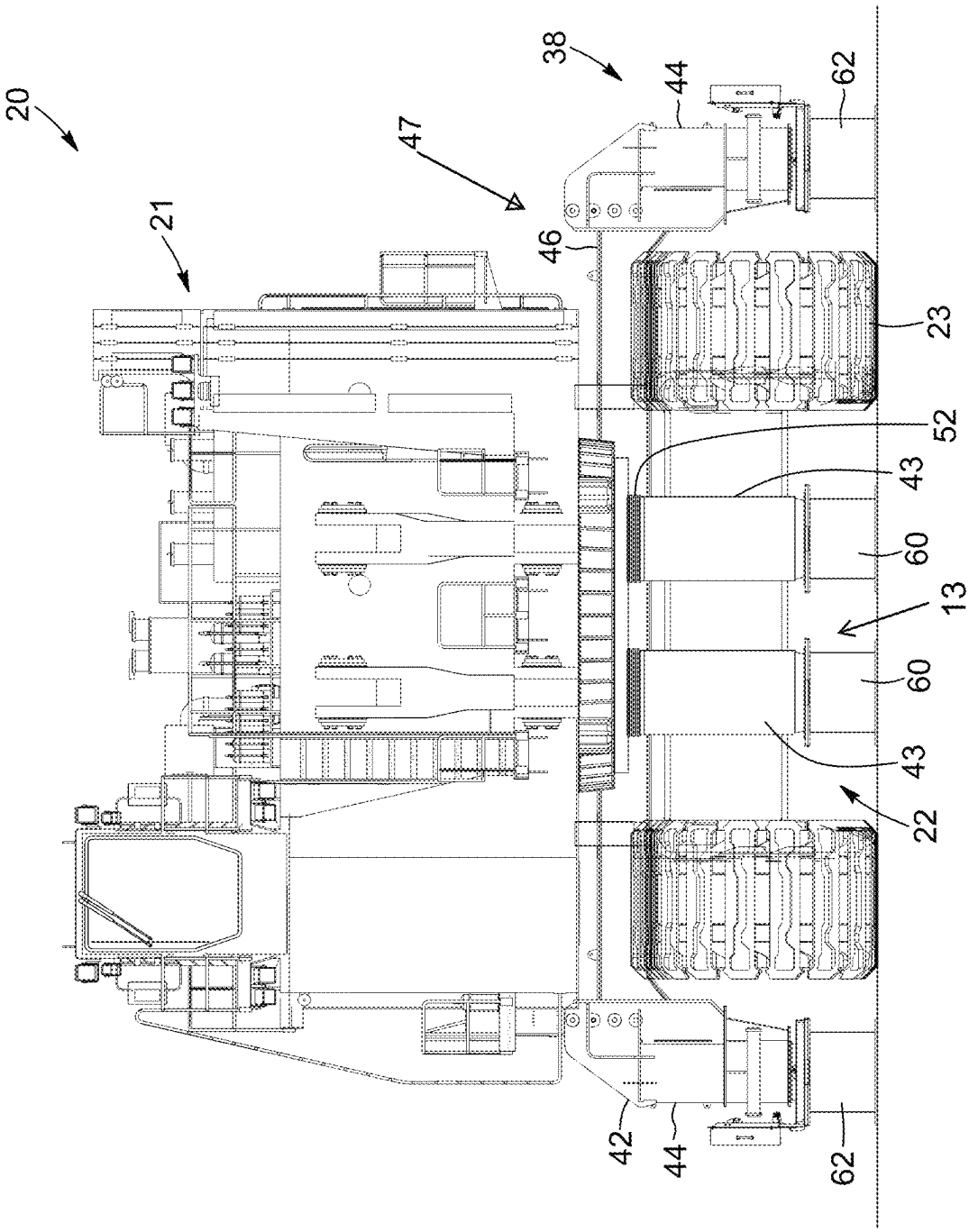

FIG. 3

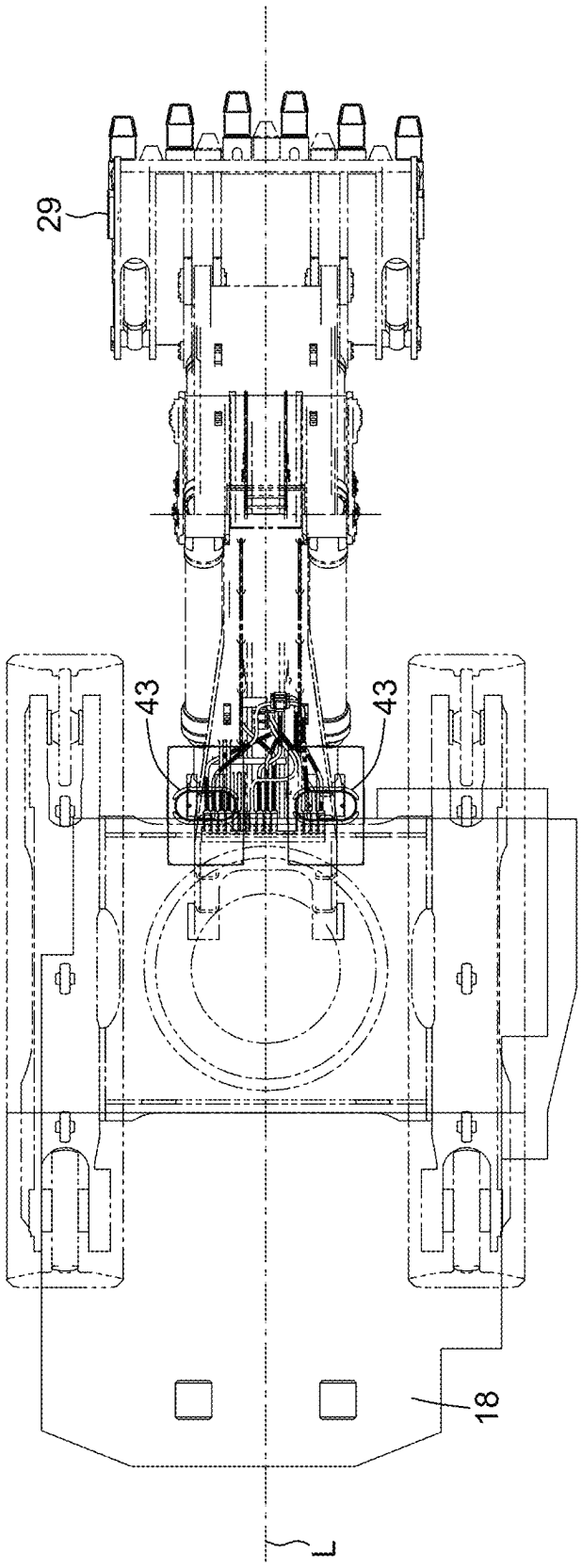

FIG. 4

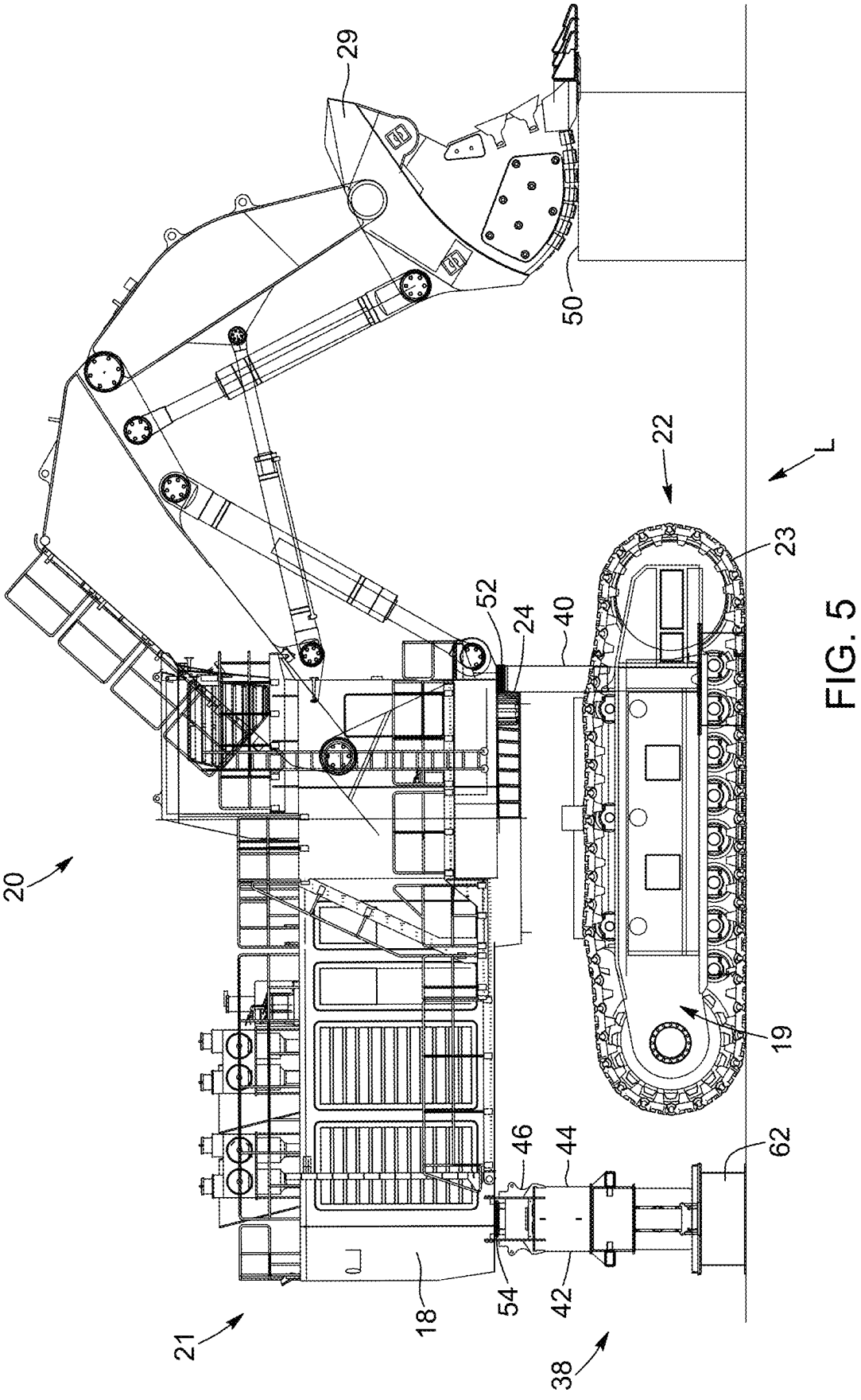

FIG. 5

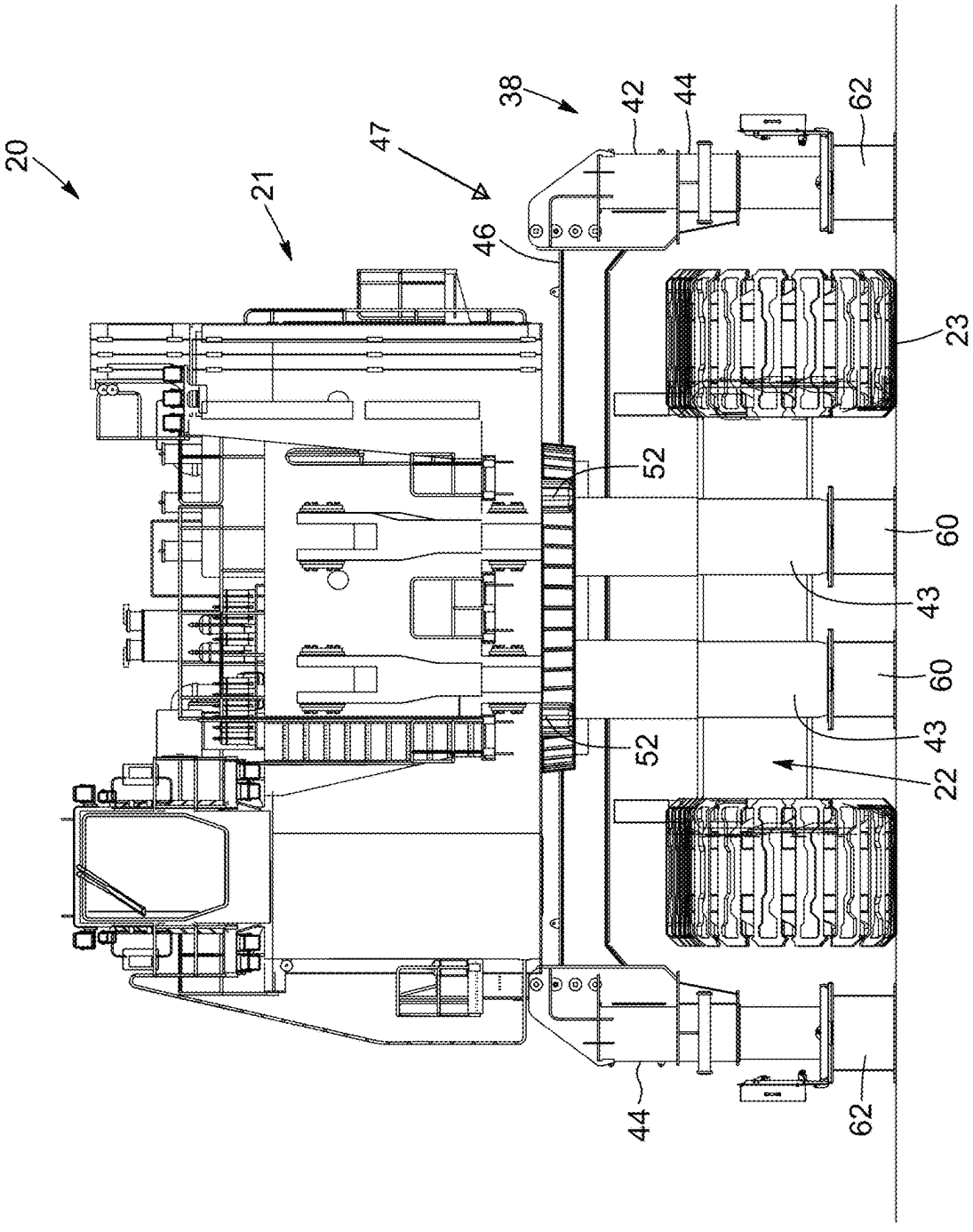

FIG. 6

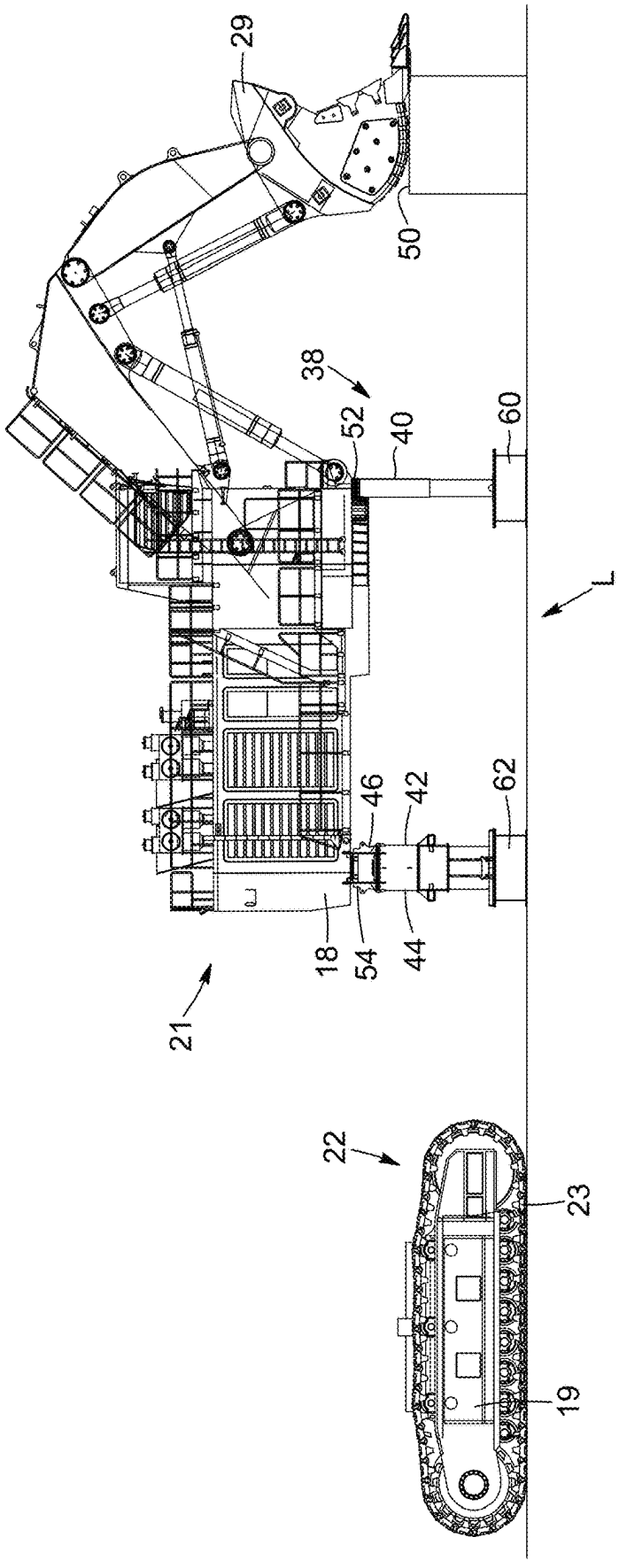

FIG. 7

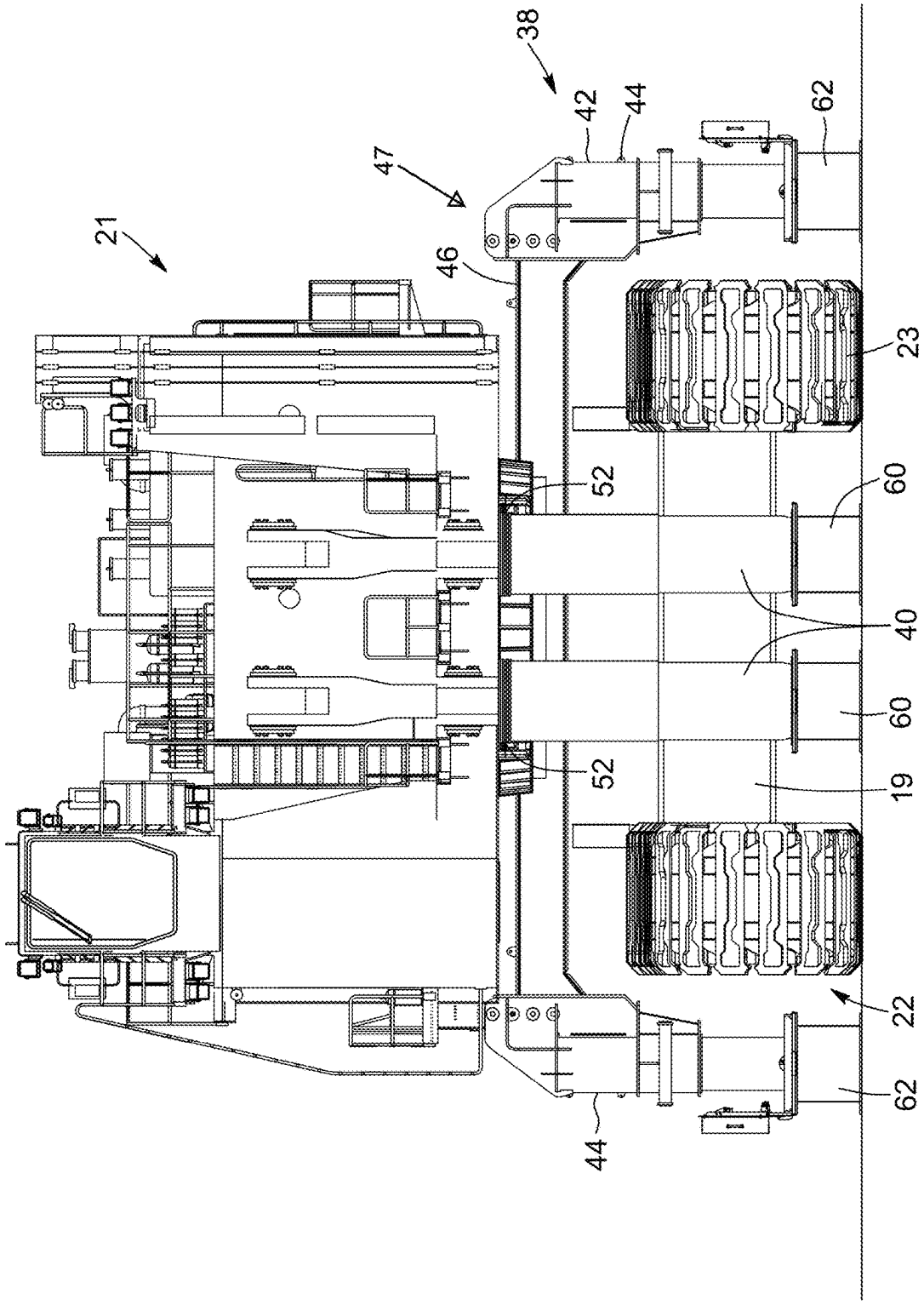

FIG. 8

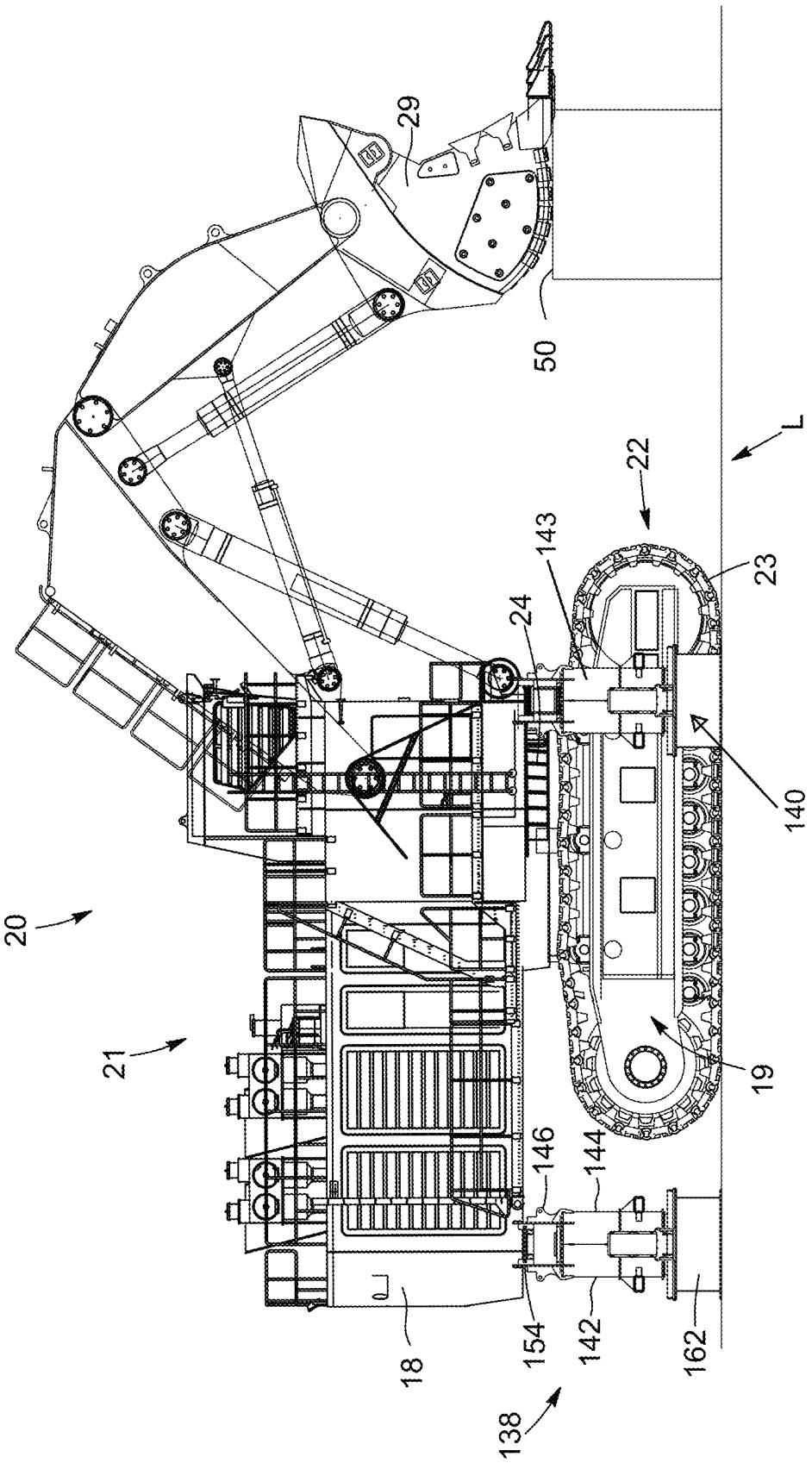

FIG. 9

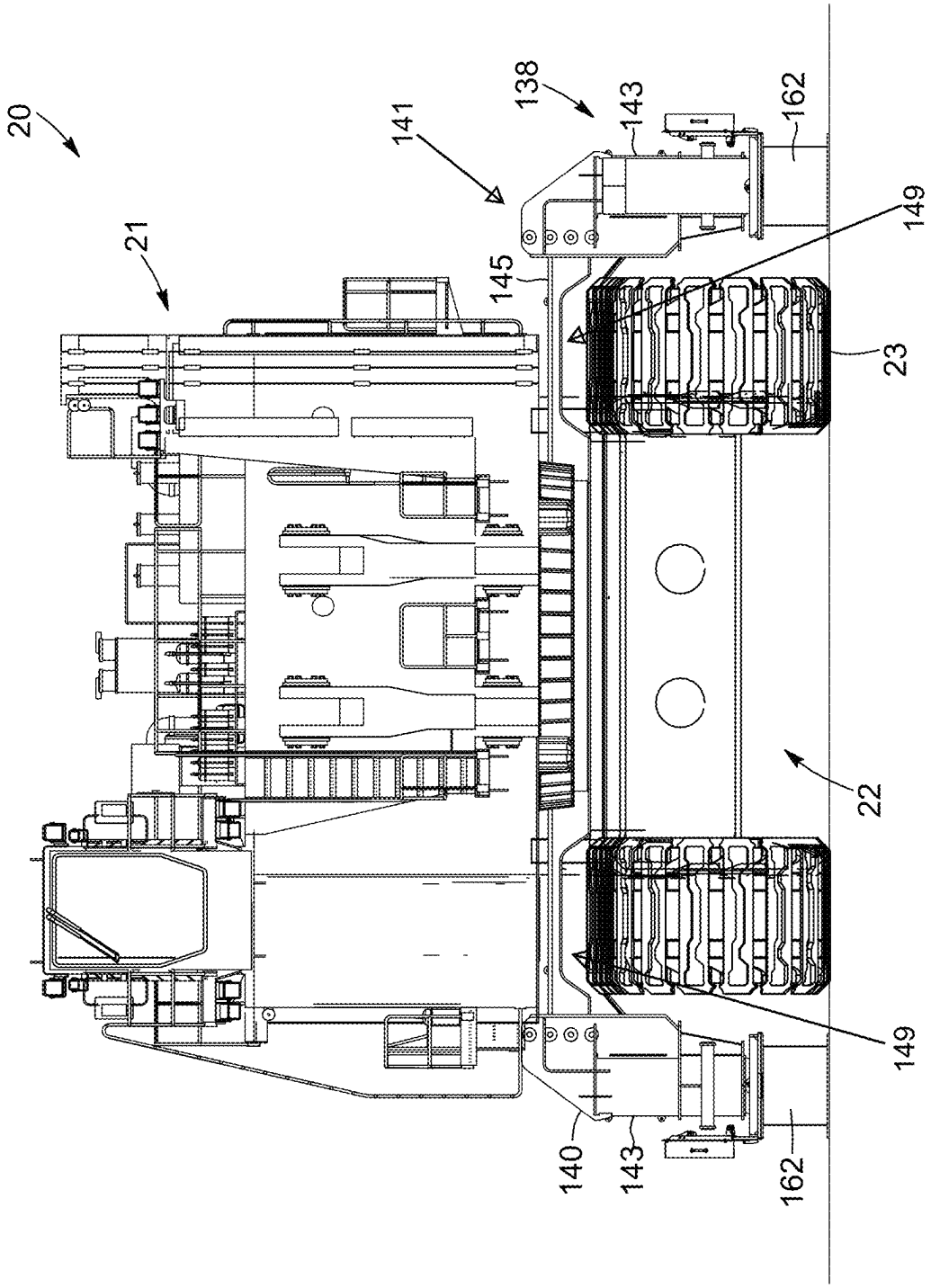

FIG. 10

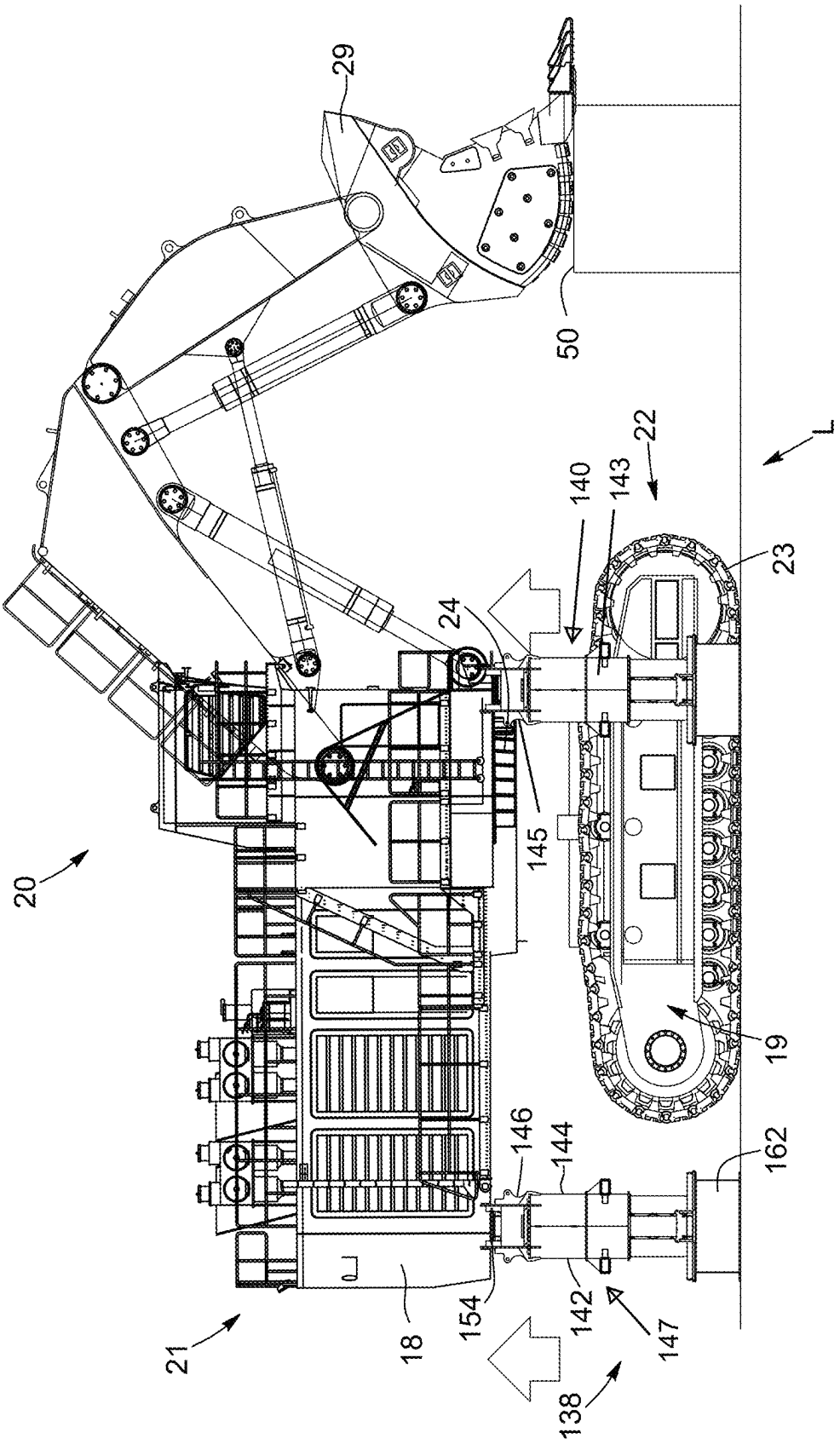

FIG. 11

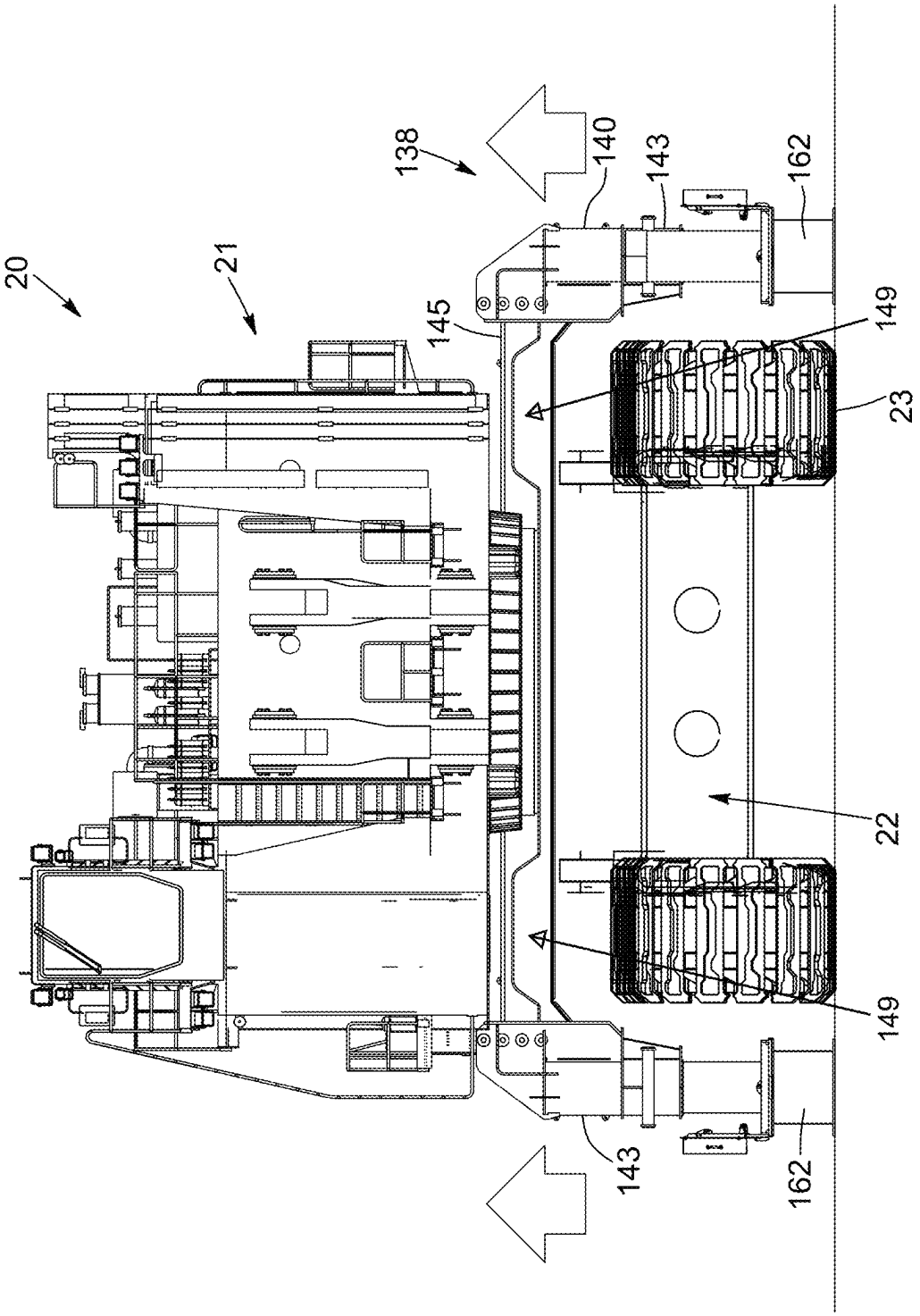

FIG. 12

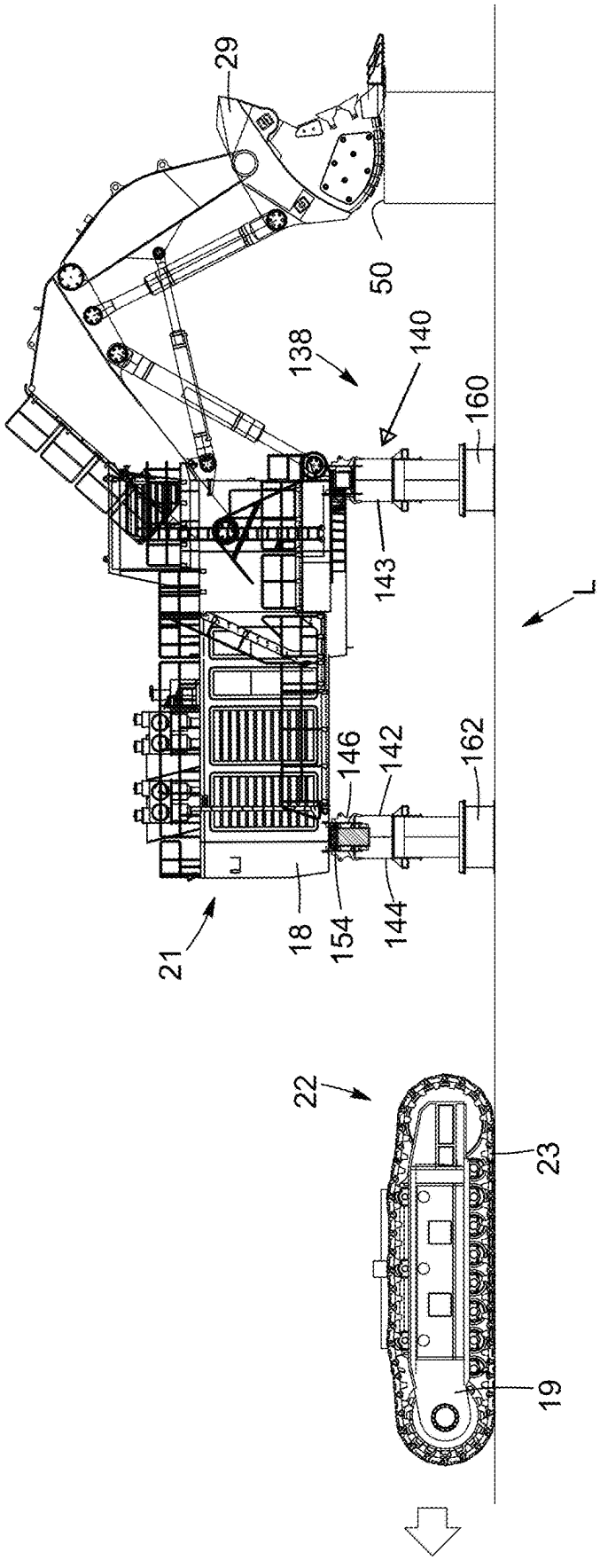

FIG. 13

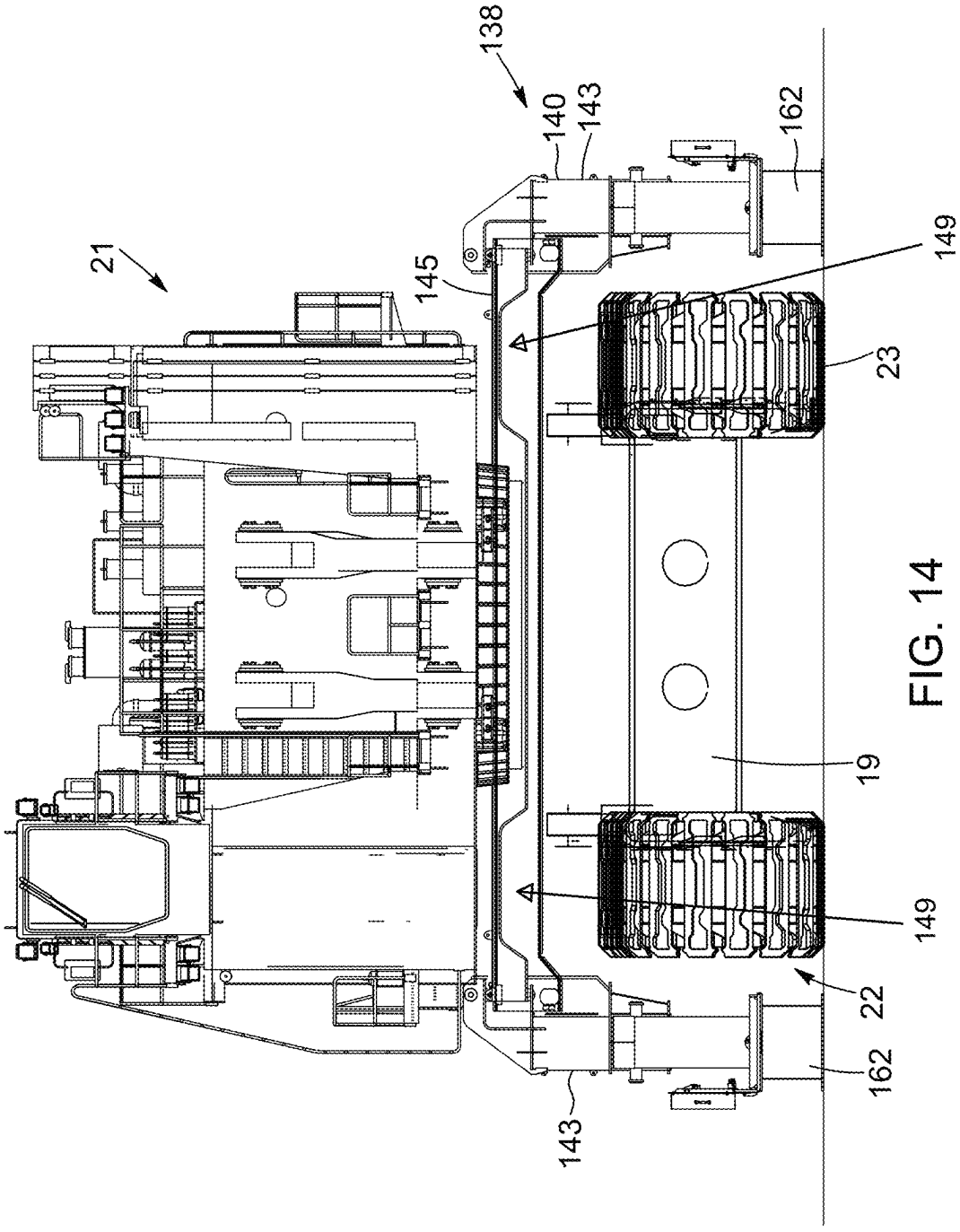

FIG. 14

SHOVEL LIFTING APPARATUS AND METHOD FOR LIFTING A SUPERSTRUCTURE OF A SHOVEL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35USC$119 (e) of U.S. provisional patent application 63/554,423, the specification of which is (are) hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

The technical field relates generally to raising heavy equipment and, more particularly, to a method and an apparatus allowing to safely raise a superstructure of a shovel.

BACKGROUND

From time to time, shovels (also referred to as excavators) need to be lifted for servicing purposes. For instance, the superstructure (upper part) of the shovel may need to be separated and lifted from the undercarriage (i.e. the lower part or the tractor) to access and, optionally, remove the undercarriage from underneath the superstructure, i.e. underdecking. For instance, the superstructure may be lifted from the undercarriage to provide access to the hydraulic shovel's rolling circle, which needs to be serviced at intervals. To do so, the superstructure (upper part) is separated from the undercarriage. This operation requires a lot of time and effort and in doing so; there is a great advantage to the owner if the lifting method utilized does not involve dismantling of the shovel's front attachments, including the shovel dipper (or bucket).

There is a need for shovel lifting method and apparatus that are at least one of quicker for performing a lifting operation, safer, and provide easy access to the shovel components for maintenance purposes.

BRIEF SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to address the above-mentioned issues.

According to a general aspect, there is provided a method of lifting a shovel comprising an undercarriage, a superstructure with a counterweight, and a bucket mounted to the superstructure. The method comprises: configuring the shovel and a lifting system including a set of front lifting units and a lifting beam including a set of spaced-apart rear lifting units on a lifting site in a lifting configuration wherein the set of front lifting units matches corresponding force applying points on a front portion of the superstructure and the lifting beam matches corresponding force applying points on the counterweight; contacting the set of front lifting units and the lifting beam with the corresponding force applying points on the front portion of the superstructure and the counterweight respectively; and starting a lifting operation to raise the superstructure to a desired height. In an embodiment, the bucket and the front attachments remains mounted to the superstructure for a duration of the lifting operation.

In an embodiment, contacting the set of front lifting units and the lifting beam with the corresponding force applying points on the front portion of the superstructure and the counterweight comprises extending the set of front lifting units and the set of rear lifting units of the lifting beam.

In an embodiment, contacting the set of front lifting units and the lifting beam with the corresponding force applying points on the front portion of the superstructure and the counterweight comprises adding front and rear shims to upper surfaces of the front lifting units and the lifting beam.

In an embodiment, configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises positioning the front lifting units at the lifting site and, then, driving the shovel at a lifting position at the lifting site, the front lifting units being located forwardly of a carbody of the undercarriage and inwardly of two endless tracks of the undercarriage. Configuring the shovel and the lifting system in the lifting configuration at the lifting site can comprise positioning the lifting beam with the rear lifting units of the lifting beam being positioned outwardly of the two endless tracks. Configuring the shovel and the lifting system in the lifting configuration at the lifting site can comprise positioning the rear lifting units at the lifting site and, then, driving the shovel at the lifting position at the lifting site and securing an elongated beam of the lifting beam to respective upper portions of the positioned rear lifting units.

In an alterative embodiment, configuring the shovel and the lifting system in the lifting configuration at the lifting site can comprise driving the shovel at the lifting position to the lifting site and, then, positioning the lifting beam at the lifting site rearwardly of the shovel, with an elongated beam of the lifting beam extending below the counterweight.

In an embodiment, the method further comprises, following positioning the shovel at a lifting position at the lifting site, detaching the superstructure from the undercarriage.

In an embodiment, the method further comprises, lowering the bucket mounted to the superstructure onto a supporting surface and maintaining the bucket on the supporting surface and mounted to the superstructure for a duration of the lifting operation.

According to another general aspect, there is provided an apparatus for lifting a shovel from a ground surface, the shovel comprising an undercarriage and a superstructure with a counterweight. The apparatus comprises: a set of front lifting units abuttable against an undersurface of a front portion of the superstructure; a lifting beam including a set of rear lifting units and an elongated beam extending between upper portions of the rear lifting units, a spacing between the rear lifting units being greater than a width of the undercarriage, the lifting beam being abuttable against an undersurface of the counterweight; and a control unit operatively connected to the set of front lifting units and the lifting beam.

In an embodiment, the shovel further comprises a bucket mounted to the superstructure, the bucket remaining mounted to the superstructure when lifting the shovel with the apparatus.

According to still another general aspect, there is provided a method of lifting a shovel comprising an undercarriage and a superstructure with a counterweight. The method comprises: configuring the shovel and a lifting system including a front lifting assembly and a rear lifting assembly on a lifting site in a lifting configuration wherein the front lifting assembly matches corresponding force applying points on a front portion of an undersurface of the superstructure and the rear lifting assembly matches corresponding force applying points on an undersurface of the counterweight, wherein at least one of the front and the rear lifting assemblies includes a lifting beam including a set of spaced-apart lifting units and an elongated beam extending inbetween; contacting the front lifting assembly and the rear

lifting assembly with the corresponding force applying points on the front portion of the undersurface of the superstructure and the undersurface of the counterweight respectively; and starting a lifting operation to raise the superstructure to a desired height.

In an embodiment, the shovel comprises a bucket mounted to the superstructure and the bucket remains mounted to the superstructure for the duration of the lifting operation.

In an embodiment, the front lifting assembly comprises a set of front lifting units and the rear lifting assembly comprises the lifting beam with the set of lifting units and the elongated beam, wherein contacting the front lifting assembly and the rear lifting assembly with the corresponding force applying points on the front portion of the superstructure and the counterweight comprises extending the set of front lifting units to contact the undersurface of the superstructure and the set of lifting units of the lifting beam to contact the undersurface of the counterweight. Contacting the set of front lifting units and the lifting beam with the corresponding force applying points on the front portion of the superstructure and the counterweight can comprise adding front and rear shims to upper surfaces of the front lifting units and the lifting beam.

In an embodiment, configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises positioning the front lifting assembly at the lifting site and, then, driving the shovel at a lifting position at the lifting site, the front lifting assembly being located f forwardly of a carbody of the undercarriage and inwardly of two endless tracks of the undercarriage. Configuring the shovel and the lifting system in the lifting configuration at the lifting site can comprise positioning the lifting beam with the lifting units of the lifting beam being positioned outwardly of the two endless tracks. It can also comprise positioning the lifting units of the lifting beam at the lifting site and, then, driving the shovel at the lifting position at the lifting site and securing the elongated beam of the lifting beam to respective upper portions of the positioned lifting units of the lifting beam, the lifting beam extending below the counterweight. Alternatively, it can also comprise driving the shovel at the lifting position to the lifting site and, then, positioning the lifting beam at the lifting site rearwardly of the shovel, with the elongated beam of the lifting beam extending below the counterweight.

In n an embodiment, the method further comprises, following positioning the shovel at a lifting position at the lifting site, detaching the superstructure from the undercarriage. The method can further comprise driving at least one of rearwardly, forwardly and laterally the undercarriage under the lifting beam and outside the lifting site once the superstructure is raised.

In an embodiment, the method further comprises lowering the bucket mounted to the superstructure onto a supporting surface and maintaining the bucket on the supporting surface and mounted to the superstructure for a duration of the lifting operation.

According to a further general aspect, there is provided an apparatus for lifting a shovel from a ground surface, the shovel comprising an undercarriage and a superstructure with a counterweight. The apparatus comprises: a set of front lifting units abuttable against an undersurface of a front portion of the superstructure; a lifting beam including a set of rear lifting units and an elongated beam extending between upper portions of the rear lifting units, a spacing between the rear lifting units being greater than a width of the undercarriage, the lifting beam being abuttable against an undersurface of the counterweight; and a control unit operatively connected to the set of front lifting units and the lifting beam.

In an embodiment, the elongated beam of the lifting beam is detachable from the rear lifting units.

According to still a further general aspect, there is provided an apparatus for lifting a shovel from a ground surface, the shovel comprising an undercarriage and a superstructure with a counterweight. The apparatus comprises: a front lifting beam including a set of front lifting units and an elongated beam mounted to an upper portion of the front lifting units, extending inbetween, and abuttable against an undersurface of a front portion of the superstructure, a spacing between the front lifting units being greater than a width of the undercarriage; a rear lifting assembly abuttable against an undersurface of the counterweight; and a control unit operatively connected to the set of front lifting units and the rear lifting assembly.

In an embodiment, the elongated beam of the lifting beam is detachable from the front lifting units.

In an embodiment, the rear lifting assembly comprises a set of rear lifting units and an elongated beam securable to upper ends of the rear lifting units and abuttable, a spacing between the rear lifting units being greater than a width of the undercarriage and the elongated beam being abuttable against the undersurface of the counterweight. The elongated beam of the lifting beam of the rear lifting assembly can be detachable from the rear lifting units. The elongated beam can comprise two recesses extending inwardly from a lower surface of the elongated beam and wherein a distance between the two recesses substantially corresponds to a distance between endless tracks of the undercarriage of the shovel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view of a hydraulic shovel of a type well known in the art;

FIG. **2** is a side elevation view of a hydraulic shovel with a shovel lifting apparatus in accordance with an embodiment prior to a lifting operation a lifting configuration at a lifting site;

FIG. **3** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **2**, wherein a bucket and front attachments of the shovel have been omitted;

FIG. **4** is a top plan view of the hydraulic shovel with the shovel lifting apparatus of FIG. **2**;

FIG. **5** is a side elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **2**, wherein a superstructure and an undercarriage of the shovel are detached and the superstructure is raised relative to the ground and the undercarriage;

FIG. **6** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **5**, wherein the bucket and front attachments have been omitted;

FIG. **7** is a side elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **2**, wherein the undercarriage is located behind the raised superstructure;

FIG. **8** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **7**, wherein the bucket and front attachments have been omitted;

FIG. **9** is a side elevation view of a hydraulic shovel with a shovel lifting apparatus in accordance with another embodiment prior to the lifting operation in the lifting configuration at the lifting site, wherein the shovel lifting apparatus includes a front lifting beam;

FIG. **10** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **9**, wherein a bucket and front attachments of the shovel have been omitted;

FIG. **11** is a side elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **9**, wherein a superstructure and an undercarriage of the shovel are detached and the superstructure is raised relative to the ground and the undercarriage;

FIG. **12** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **11**, wherein the bucket and front attachments have been omitted;

FIG. **13** is a side elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **9**, wherein the undercarriage is located behind the raised superstructure; and

FIG. **14** is a front elevation view of the hydraulic shovel with the shovel lifting apparatus of FIG. **13**, wherein the bucket and front attachments have been omitted.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION

Moreover, although the embodiments of the apparatus for lifting an upper part of a shovel and corresponding parts thereof consist of certain geometrical configurations as explained and illustrated herein, not all of these components and geometries are essential and thus should not be taken in their restrictive sense. It is to be understood, as also apparent to a person skilled in the art, that other suitable components and cooperation thereinbetween, as well as other suitable geometrical configurations, may be used for the shovel lifting apparatus, as will be briefly explained herein and as can be easily inferred herefrom by a person skilled in the art. Moreover, it will be appreciated that positional descriptions such as "above", "below", "left", "right" and the like should, unless otherwise indicated, be taken in the context of the figures and should not be considered limiting.

In the following description, the same numerical references refer to similar elements. Furthermore, for the sake of simplicity and clarity, namely so as to not unduly burden the figures with several references numbers, not all figures contain references to all the components and features, and references to some components and features may be found in only one figure, and components and features of the present disclosure which are illustrated in other figures can be easily inferred therefrom. The embodiments, geometrical configurations, materials mentioned and/or dimensions shown in the figures are optional, and are given for exemplification purposes only.

Moreover, it will be appreciated that positional descriptions such as "above", "below", "forward", "rearward" "left", "right" and the like should, unless otherwise indicated, be taken in the context of the figures and correspond to the position and orientation of the shovel lifting apparatus for lifting an upper part of a shovel, with the "front" corresponding to a position closer to a dipper (bucket) of the shovel and the "back"/"rear" corresponding to a position closer to a counterweight of the shovel. Positional descriptions should not be considered limiting.

Referring now to the drawings and more particularly to FIG. **1**, there is shown generally at **20** a hydraulic shovel of a type well known in the art. It comprises a superstructure **21** (i.e. the upper part of the shovel) secured to an undercarriage **22** (also often referred to as the lower part of the shovel, a truck or a tractor) having two spaced-apart endless tracks **23** to displace the shovel **20** on a ground surface and a carbody **19**. The superstructure **21** includes a counterweight **18** in a rear portion thereof and has front attachments **25** mounted to a front portion thereof. A rolling circle **24** is secured between the carbody **19** and the superstructure **21** to permit the superstructure **21** to revolve 360° around a central axis **39** of the shovel **20** in either direction left or right. The front attachments **25** include a boom **26**, an arm **27** and a connector flange **28**. The upper part further includes a bucket **29** (or a dipper), secured to the connector flange **28** of the front attachments **25**. The boom **26** is articulated on a pivot **30** by a boom cylinder **31**, which is herein shown fully extended and secured at a lower end **32** to a pivot attachment **33**. The arm **27** is pivotally connected at one end **34** to a top end of the boom **26** and at an opposed end **35** to an end of the connector flange **28**. A bucket control cylinder **36** is connected to the connector flange **28** to displace the bucket **29**. A hydraulic cylinder **37** displaces the arm **27**.

At regular intervals, such shovels need to be lifted for servicing purposes of components of their carbody **19**. For instance, the rollers of the carbody **19** need to be replaced at regular intervals. Similarly, the sideframes of the carbody **19** eventually also need repairs or replacement. This type of maintenance requires a lot of time and effort and in doing so; there is a great incentive to be able to lift the superstructure **21** as a whole in a safe and easy manner.

In FIG. **1**, the shovel **20** is a hydraulic shovel (or excavator) but it is appreciated that the shovel lifting apparatus can be used with a rope (or power or mining) shovel.

Referring now to FIGS. **2** to **8**, a method and a shovel lifting apparatus **38** to lift the superstructure **21**, detached the undercarriage **22**, and, optionally, withdraw the undercarriage **22** from under the superstructure **21** is shown (as shown in FIGS. **7** and **8**).

Turning now to FIGS. **2** to **4**, there is shown that the shovel lifting apparatus **38** includes a front lifting assembly **40** and a rear lifting assembly **42**. The shovel **20** and the shovel lifting apparatus **38** are configured in a lifting configuration at a lifting site L. In the lifting configuration, the shovel **20**, the front assembly **40** and the rear lifting assembly **42** are in a relative configuration at the lifting site L. In the embodiment shown, the front lifting assembly **40** is first positioned at a selected position on the ground (or on a base supported on the ground), at the lifting site L. In the non-limitative embodiment shown, the front lifting assembly **40** includes two lifting units (such as lifting jacks), transversally spaced-apart from another. Then, the shovel **20** is moved, i.e. driven forwards, towards the front lifting assembly **40** and configured at a suitable position with respect to the front lifting assembly **40** in a manner such that the front lifting assembly **40** is located at least partially below the superstructure **21** of the shovel **20**, forwardly of the carbody **19**. In the embodiment shown wherein the front lifting assembly **40** includes two lifting units **43**, the lifting units **43** are located inwardly of the two endless tracks **23**, each being located on a respective side of a central longitudinal axis X (FIG. **4**) of the shovel **20**. Each one of the lifting units is located under the superstructure **21** of the shovel **20** configured to abut an undersurface of the superstructure undersurface of the superstructure and, in a particular embodiment, directly abuts the undersurface of the superstructure and configured to apply a vertical trust thereon.

In some embodiments, each one of the front lifting assembly **40** and the rear lifting assembly **42** can include front and rear shims **52**, **54**, as will be described in more details. The front and rear shims **52**, **54** are insertable

between either the lifting units or an elongated beam of the lifting assembly and an undersurface of the superstructure **21** or the counterweight **18**.

It is appreciated that, in an alternative embodiment which will be described in more details below in reference to FIGS. **9** to **14**, the front lifting assembly **40** can include a lifting beam extending between the two spaced-apart front lifting units. In such embodiment, each one of the front lifting units can be positioned on a respective side of the superstructure **21** of the shovel **20**, outwardly of the two endless tracks **23**, with the beam extending inbetween and under the superstructure **21**, forwardly of the carbody **19**. In such embodiment, the front lifting beam and, more particularly an elongated beam thereof is configured to abut the undersurface of the superstructure and, in a particular embodiment, directly abuts the undersurface of the superstructure and is configured to apply a vertical trust thereon.

Then, still referring to the embodiment shown in FIGS. **2** to **4**, the rear lifting assembly **42** is positioned with respect to the shovel **20**. More particularly, the rear lifting assembly **42** is positioned substantially aligned with a rear end of the counterweight **18** along the longitudinal axis X of the shovel **20**. In the embodiment shown, the rear lifting assembly **42** includes a lifting beam **47**.

The rear lifting assembly **42** includes two lifting units **44** (hereinafter referred to as the rear lifting jacks or the lifting beam jacks) and an elongated beam **46** extending between upper ends of the two rear lifting units **44**.

In some implementations, for either the front lifting assembly **40** or the rear lifting assembly **42**, the elongated beam can be detachable from the lifting units. For instance, in the embodiment shown in FIGS. **2** to **4** wherein the rear lifting assembly **42** includes the lifting beam **47**, the rear lifting units **44** and the front lifting units **43** can be positioned simultaneously at the lifting site L and the elongated beam **46** can be secured to the rear lifting units **44** after positioning the shovel **20** between the four lifting units **40**, **44**. In the implementations wherein the elongated beam **46** is not detachable or easily detachable from the rear lifting units **44**, the lifting beam **47** can be positioned after positioning the shovel **20** at its lifting position at the lifting site L. In the embodiment shown, each one of the rear lifting units **44** is positioned outwardly (along a transversal axis extending perpendicular to the longitudinal axis X of the shovel **20**) of the two endless tracks **23** in a manner such that the undercarriage **22** including the endless tracks **23** can move between the rear lifting units **44**. As for the front lifting units **43** of the front lifting assembly **40**, the rear lifting units **44** are positioned on the ground (or on a base supported on the ground). For instance, if the elongated beam **46** is not secured to the rear lifting units **44** and the rear lifting units **44** are positioned at the lifting site L before the shovel **20**, the shovel **20** can access its lifting position between the four lifting units **40**, **44** via the space defined between the rear lifting units **44**. Furthermore, if the undercarriage **22** is removed from under the superstructure **21** once the latter is raised (i.e. underdecking), as described in more details below, the undercarriage **22** can be removed from the lifting site L, once again, via the space defined between the rear lifting units **44** (or laterally).

Thus, if the rear lifting units **44** are positioned simultaneously with the front lifting units **43** of the front lifting assembly **40** and before positioning the shovel **20** at the lifting site L, once the shovel **20** is positioned at the lifting site L, the elongated beam **46** is mounted to the rear lifting units **44**.

If the lifting beam **47** is provided as a single unit, the lifting beam **47** is positioned at the lifting site L once the shovel **20** is positioned at its lifting position.

In still an alternative embodiment, the shovel **20** can be first driven at its lifting position at the lifting site L. Then, the front lifting units **43** of the front lifting assembly **40** and the lifting beam **47** of the rear lifting assembly **42** can be positioned at their respective position at the lifting site L to configure the shovel, the front lifting assembly **40**, and the rear lifting assembly **42** in their relative lifting configuration at the lifting site L.

In an alternative embodiment wherein the front lifting assembly includes a lifting beam and the rear lifting assembly includes two spaced-apart and detached lifting units, the front and the rear lifting units can be positioned simultaneously at the lifting site L and the elongated beam can be secured to the front lifting units after positioning the shovel **20** between the four lifting units. In an embodiment wherein the elongated beam is not detachable from the front lifting units, the front lifting beam can be positioned after positioning the shovel **20** at its lifting position at the lifting site L.

In an alternative embodiment wherein each one of the front lifting and the rear lifting assemblies includes a lifting beam and the rear lifting assembly includes two spaced-apart and detached lifting units, such as the one shown in FIGS. **9** to **14**, if the elongated beams are detachable from the lifting units, the four lifting units can be first positioned at the lifting site L, the shovel **20** can be driven **20** at its lifting position at the lifting site L, and, then, the elongated beams can be secured to their respective lifting units. Alternatively, the shovel **20** can be driven at the lifting site L and, then, the lifting beams can be configured in the lifting configuration with respect to the shovel **20**.

The lifting operation can begin once the shovel **20**, the front lifting assembly **40** and the rear lifting assembly **42** are in the lifting configuration at the lifting site L. In the lifting configuration of the embodiment shown in FIGS. **2** to **4**, the front lifting units **43** of the front lifting assembly **40** are transversally spaced-apart from another, located under the superstructure **21** of the shovel **20**, vertically aligned therewith, forwardly of the carbody **19**, inwardly of the two endless tracks **23**, each being located on a respective side of a central longitudinal axis X (FIG. **4**) of the shovel **20**. In the lifting configuration, the lifting beam **47** of the rear lifting assembly **42** is positioned substantially aligned with a rear end of the counterweight **18** along the longitudinal axis X of the shovel **20**, with each one of the rear lifting units **44** being positioned outwardly (along the transversal axis) of the two endless tracks **23**. The elongated beam **46** extends under the counterweight **18**. In the lifting configuration, each one of the front lifting units **43** of the front lifting assembly **40** and the lifting beam **47** are aligned with corresponding predetermined force applying or lifting points on the front portion of the superstructure **21** and the rear portion of the counterweight **18** and are configured to apply a vertical trust thereon.

In the non-limitative embodiment shown, the front and rear lifting units of the front and rear liftin assemblies **40**, **44** are mounted front and rear bases **60**, **62**, which stabilize the lifting units during the lifting operation.

In some implementations, during the entire lifting and maintenance operations, the bucket **29** is kept on a supporting surface and mounted to the superstructure **21**. The supporting surface can be the ground or a raised supporting surface **50**, as shown in FIG. **2**.

Therefore, at anytime once the shovel **20** is positioned at its lifting position and before beginning the lifting operation, the bucket **29** can be lowered and positioned on the supporting surface **50**.

It is appreciated that, in other implementations, the bucket **29** can remain unsupported, above the ground, during the lifting and maintenance operations.

In further implementations, the bucket **29** or the front attachments **25** having the bucket **29** mounted thereto can be disconnected from the superstructure **21** during the lifting operation. Therefore, the superstructure **21** can lifted with the shovel lifting apparatus **38** without the bucket and, in some implementations, without the front attachments **25**.

Before beginning the lifting operation, the front lifting units **43** of the front lifting assembly **40** and the lifting beam **47** are abutted against a front section of the superstructure **21** and the counterweight **18** respectively. More particularly, the front lifting units **43** of the front lifting assembly **40** and the elongated beam **46** of the lifting beam **47** abut against the undersurface of the superstructure **21** the counterweight **18** respectively. Abutting the front lifting units **43** of the front lifting assembly **40** and the lifting beam **47** can be performed by slightly raising the front and rear lifting units and/or by adding front and rear shims **52**, **54** between an upper surface of the front lifting units **43** and the rear lifting beam **47** and the superstructure **21** and the counterweight **18** respectively to provide a contact therebetween, without raising the superstructure **21**.

If required, the superstructure **21** can be detached from the undercarriage **22** at any time once the shovel **20** is at its lifting position. Therefore, the superstructure **21** can be lifted by the front and rear lifting assemblies **40**, **42** while the undercarriage **22** remain stationary at the lifting position.

Still referring to FIGS. **2** and **3**, there is shown the shovel **20**, immobilized at its lifting position, in the lifting configuration with respect to the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** and in position to be lifted. More particularly, the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** precisely aligned with corresponding predetermined force applying or lifting points on the front portion of the superstructure **21** and the rear portion of the counterweight **18**, underneath thereof. The bucket **29** is lowered and rest on the raised supporting surface **50**. As mentioned above, in the non-limitative embodiment shown, the bucket **29** remains on the raised supporting surface **50** throughout the lifting operation. To do so, the pinion of the handle drive is put on neutral so that it will move freely inside the motorized handle connector frame during the lifting operation. The front lifting units **43** and the lifting beam **42** have been extended or front and rear shims **52**, **54** have been added to the upper surface of t lifting units **43** and the lifting beam **54**, respectively, to make contact with a bottom side of the superstructure **21** and the counterweight **18**.

In the embodiment, the bucket **29** or the front attachments **25** having the bucket **29** mounted thereto can be disconnected from the superstructure **21** before beginning the lifting operation. Therefore, the lifting operation can be performed on the shovel **20** free of front attachments **25** and/or bucket **29**.

The front and rear lifting units of the front and rear lifting assemblies **40**, **44** are extended substantially synchronously to maintain the superstructure **21** level and stable during the lifting operation.

As it is known in the art, level detectors (not shown) and, more particularly, front and rear level detectors, can be installed on the shovel **20**. The level detectors are used to monitor, continuously during the lifting operation, a distance to the ground and transferred the acquired height data to a control unit (not shown), such as a PLC, to which they are operatively connected. The control unit can also be operatively connected to stroke sensors (not shown) provided on each one of the front and rear lifting units of the front and rear lifting assemblies **40**, **44** for measuring their extension and thereby ensure that the superstructure **21** remains level and stable during the lifting operation.

The level detectors, the stroke sensors, and the control unit can be used modify the relative lifting speed of the lifting units of the front and rear lifting assemblies **40**, **44** to maintain the superstructure **21** level and stable.

FIGS. **5** and **6** show the shovel lifting apparatus **38** in a raised configuration, the superstructure **21** being detached from the undercarriage **22** and raised by the shovel lifting apparatus **38**, and the undercarriage **22** remaining on the ground underneath the raised superstructure **21**. In some implementations, the front and rear lifting assemblies **40**, **44** raise the superstructure **21** by about 40 to 80 inches and, in some embodiments, by about 50 to 70 inches. In some implementations, the front and rear lifting assemblies **40**, **44** raise the superstructure **21** by a distance to the ground sufficient to have a lower surface of the elongated beam **46** of the lifting beam **42** higher than an upper surface of the undercarriage **22**, such that the undercarriage **22** can be displaced under the raised lifting beam **42**.

Once the superstructure **21** is raised, maintenance operations can be performed. In some implementation, the undercarriage **22** can be driven backwards, between the rear lifting unit **44** and below the elongated beam **46** to be more accessible for the maintenance operations, as shown in FIGS. **7** and **8**. Once the maintenance operations are performed, the undercarriage **22** can be driven forwards until it reaches the lifting position, under the superstructure **21**. Then, the superstructure **21** can be lowered onto the undercarriage **22** by retracting the front and rear lifting assemblies **40**, **42** until it contacts the undercarriage **22** and the superstructure **21** and the undercarriage **22** can be secured together, as it is known in the art.

There is provided a method for lifting a shovel **20**, such as the one shown in FIGS. **1** to **8**, in accordance with an embodiment. The shovel **20** has an undercarriage **22**, a superstructure **21** detachably mounted to the undercarriage **22** and including a counterweight **18** at a rear end thereof, and a dipper (or bucket) **29** mounted to the superstructure **21** at a front end thereof.

The method includes configuring the shovel **20** and the lifting system **38** in a lifting configuration on a lifting site L. The lifting system **38** includes a front lifting assembly **40** and a rear lifting assembly **42**. In a particular embodiment, the front lifting assembly **40** includes a set of front lifting units **43** and the rear lifting assembly **42** includes a lifting beam. In the lifting configuration, the set of front lifting units **40** matches corresponding force applying points on a front portion of the superstructure **21** and the lifting beam **42** also corresponding force applying points on an undersurface of the counterweight **18**. The set of front lifting units **43** and the lifting beam **42** are operatively connected to a control unit.

The relative positioning of the shovel **20** and the lifting system **38** includes the configuration of the set of front lifting units **43** of the front lifting assembly **40** in a manner such that they abut against the undersurface of the superstructure, forwardly of a carbody **19** of the undercarriage **22**, inwardly of the two endless tracks **23** of the undercarriage **22**. Each one of the front lifting units **43** is located on a respective side of a central longitudinal axis X (FIG. **4**) of

the shovel **20**. In an embodiment, the relative positioning of the shovel **20** and the lifting system **38** includes first positioning the front lifting units **43** at the lifting site L and then, driving the shovel **20** at a lifting position at the lifting site L, i.e. driving the shovel **20** towards and rearwardly of the positioned front lifting units **43** of the front lifting assembly **40**.

The relative positioning of the shovel **20** and the lifting system **38** includes the configuration of the rear lifting assembly **42**, including the lifting beam **44**, in a manner such that it abuts against the undersurface of the counterweight **18**, adjacent to a rear end thereof. In a particular embodiment, each one of the rear lifting units **44** is positioned outwardly (along the transversal axis extending perpendicular to the longitudinal axis X of the shovel **20**) of the two endless tracks **23** in a manner such that a spacing between two rear lifting units **44** supporting an elongated beam **46** of the lifting beam **42** is greater than a width of the undercarriage **22**.

In an embodiment, the relative positioning of the shovel **20** and the lifting system **38** includes first positioning the rear lifting units **44** at the lifting site L and then, driving the shovel **20** at the lifting position at the lifting site L, i.e. driving the shovel **20** towards and forwardly of the positioned rear lifting units **44**. Then, securing the elongated beam **46** to respective upper portions of the positioned rear lifting units **44**.

In an alternative embodiment, the relative positioning of the shovel **20** and the lifting system **38** includes first driving the shovel **20** at the lifting position to the lifting site L. Then, positioning the rear lifting units **44** at the lifting site L rearwardly of the shovel, with the elongated beam **46** extending below the counterweight **18** and, the spacing between two rear lifting units **44** being greater than the width of the undercarriage **22**.

In still another the relative positioning of the shovel **20** and the lifting system **38** includes first driving the shovel **20** at the lifting position to the lifting site L. Then, positioning the front lifting assembly **40** and the rear lifting assembly **42** at the lifting site L. If the rear lifting assembly includes a lifting beam, the lifting beam is positioned rearwardly of the shovel, with the elongated beam **46** extending below the counterweight **18** and, the spacing between two rear lifting units **44** being greater than the width of the undercarriage **22**.

Then, the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** are contacted respectively with the undersurfaces of the superstructure **21** and the counterweight **18** at the corresponding force applying points. Contacting the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** with the undersurfaces of the superstructure **21** and the counterweight **18** can be carried out by adding front and rear shims to upper surfaces of the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** respectively. Alternatively or in addition, contacting the front lifting units of the front lifting assembly **40** and the lifting beam **42** with the undersurfaces of the superstructure **21** and the counterweight **18** can be carried out by extending the front lifting units **43** of the front lifting assembly **40** and the rear lifting units **44** of the lifting beam **42**.

Following driving the shovel to the lifting position at the lifting site L, either before or after contacting the front lifting units **43** of the front lifting assembly **40** and the lifting beam **42** with undersurfaces of the superstructure **21** and the counterweight **18**, in some implementations, the method includes lowering the bucket **29** mounted to the superstructure **21** onto the raised supporting surface **50**.

In other implementations, the method includes disconnecting the front attachments **25** having the bucket **29** mounted thereto or the bucket **29** from the superstructure **21**.

Then, a lifting operation is started to raise the superstructure **21** to a desired height. In an embodiment, the bucket **29** is mounted to the superstructure **21** and remains on the supporting surface **50** for a duration of the lifting operation.

In some implementations, the bucket **29** be unsupported, above the ground surface when the lifting operation is started and can remain in such a state during the entire lifting and maintenance operations.

In other implementations, the front attachments having the bucket **29** mounted thereto or solely the bucket **92** are detached from the superstructure **21** before carrying out the lifting operation and the lifting operation is carried out on the superstructure free of at least one of the front attachments **25** and the bucket **29**.

In an embodiment, the desired height is between about 40 to 80 inches and, in some embodiments, between about 50 to 70 inches. In an embodiment, the desired height is higher than a height of an upper surface of the undercarriage **22**.

In an embodiment, following driving the shovel **20** to the lifting position at the lifting site L, i.e. following following positioning the shovel **20** at the lifting position at the lifting site L, detaching the superstructure **21** from the undercarriage **20**.

In some implementations wherein the undercarriage **22** is detached from the superstructure **21**, the undercarriage **22** can be removed from under the superstructure **21** once the latter is raised. Removing the undercarriage **22** from underneath the raised superstructure **21** can be carried out by driving backwards the undercarriage **22**, via the space defined between the rear lifting units **44** and under the elongated beam **46** spacing the spaced between the rear lifting units **44**. It is appreciated that, in an alternative embodiment (not shown), the undercarriage **22** can be driven laterally, in a spacing between the front and the rear lifting assemblies **40**, **42**. In the embodiment wherein the front lifting assembly **40** includes a front lifting beam and the front attachments **25** having the bucket **29** mounted thereto are detached and removed for the lifting operation, the undercarriage **22** can be driven forwardly, in a spacing between the front lifting units and below the front elongated beam.

Referring now to FIGS. **9** to **14**, there is shown an alternative embodiment of the shovel lifting apparatus **38**, wherein the features are numbered with reference numerals in the **100** series which correspond to the reference numerals of the previous embodiment.

In the shovel lifting apparatus **138**, the front lifting assembly **140** includes a lifting beam **141** extending between the two spaced-apart front lifting units **143**. To perform a lifting operation, each one of the front lifting units **143** is positioned on a respective side of the superstructure **21** of the shovel **20**, outwardly of the two endless tracks **23**, with an elongated beam **145** extending inbetween and under the superstructure **21**, forwardly of the carbody **19**. In such embodiment, the front lifting beam **141** and, more particularly an upper surface of the elongated beam **145** thereof is configured to abut the undersurface of the superstructure **21** and, in a particular embodiment, directly abuts s the undersurface of the superstructure **21**.

As shown in FIGS. **10**, **12**, and **14**, to clear the endless tracks **23** when positioning/configuring the front lifting assembly **140** and the shovel **20** in the lifting configuration at the lifting site L wherein the front lifting assembly **140** matches corresponding force applying points on the front

portion of the undersurface of the superstructure **21**, the elongated beam **145** has a non-rectangular profile, with two recesses **149** extending inwardly from a lower surface of the elongated beam **145** and being aligned with a respective one of the endless tracks **23** in the lifting configuration. Therefore, a distance between the two recesses **149** substantially corresponds to a distance between endless tracks **23** of the undercarriage **22** of the shovel **20**. It is appreciated that, in an alternative embodiment (not shown), the elongated beam can be free of recesses (being sufficiently thin to be inserted between the tracks **23** and the superstructure **21**) or include a single continuous recess to clear the endless tracks **23**.

In the side elevation view of FIG. **9**, there is shown that the elongated beam **145** is aligned with the front portion of the superstructure **21**, abutting the undersurface thereof. Thus, the elongated beams **145**, **146** of the front and rear lifting assemblies **140**, **142** apply an upward and vertical trust directly to the undersurfaces of the superstructure **21** and the counterweight **18**, as represented by the arrows in FIGS. **11** and **12**. As for the above-described embodiment, once the superstructure **21** is raised, the undercarriage **22** can be removed from under the superstructure **21**. In the embodiment shown in FIGS. **13** and **14**, the undercarriage **22** is displaced rearwardly. However, it is appreciated that, in alternative embodiments, it can be displaced laterally or forwardly. In the embodiment shown in FIGS. **9** to **14**, the bucket **29** and the front attachments **25** remains mounted to the superstructure **21** for a duration of the lifting operation with the bucket **29** resting on the supporting surface **50** for a duration of the lifting operation. However, in an alternative embodiment (not shown), at least one of the bucket **29** and the front attachments **25** can be detached from the superstructure **21** for the lifting operation.

In the embodiment of FIGS. **9** to **14**, the rear lifting assembly **142** includes the rear lifting beam **147**. However, it is appreciated that, in an alternative embodiment (not shown), the rear lifting assembly **142** can include a set of spaced-apart rear lifting units, unconnected by an elongated beam, which can positioned be directly under the counterweight **18**.

In the embodiments of the shovel lifting apparatuses, **38**, **138**, the front and the rear lifting assemblies **40**, **140**, **42**, **142** are aligned with the superstructure **21** and the counterweight **18** in the lifting configuration. They are not located or forwardly extend or rearwardly of the superstructure **21** and the counterweight **18** respectively. Either the lifting units of the front and the rear lifting assemblies **40**, **140**, **42**, **142** apply a vertical trust directly to the superstructure **21** and the counterweight **18** respectively, by contacting their undersurface or the lifting units of the front and the rear lifting assemblies **40**, **140**, **42**, **142** apply the vertical trust via an elongated beam extending between the two transversally spaced-apart lifting units of a set.

The above-described lifting apparatuses and associated lifting method can allow removing the undercarriage **22** from underneath the raised superstructure **21** to ease the maintenance operation without the use of lifting jig or other similar devices which must be secured to the shovel **20** before carrying out the lifting operation. Lifting jigs are secured a to shovel to perform servicing operations. More particularly, the lifting jig provides a trust surface configured to receive a lifting force during a lifting operation and transfer the load to the superstructure of the shovel. By avoiding the attachment of a lifting jig to the shovel to perform a lifting operation, the above-described lifting apparatuses and associated lifting method can reduce downtime and provide cost-savings.

In the above description, an embodiment is an example or implementation of the inventions. The various appearances of "one embodiment," "an embodiment" or "some embodiments" do not necessarily all refer to the same embodiments.

Although various features of the invention may be described in the context of a single embodiment, the features any suitable may also be provided separately or in a combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single embodiment.

Reference in the specification to "some embodiments", "an embodiment", "one embodiment" or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments, of the inventions.

It is to be understood that the phraseology and terminology employed herein is not to be construed as limiting and are for descriptive purpose only.

The principles and uses of the teachings of the present invention may be better understood with reference to the accompanying description, figures and examples.

It is to be understood that the details set forth herein do not construe a limitation to an application of the invention.

Furthermore, it is to be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in embodiments other than the ones outlined in the description above.

It is to be understood that the terms "including", "comprising", "consisting" and grammatical variants thereof do not preclude the addition of one or more components, features, steps, or integers or groups thereof and that the terms are to be construed as specifying components, features, steps or integers.

If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

It is to be understood that where the claims or specification refer to "a" or "an" element, such reference is not be construed that there is only one of that element.

It is to be understood that where the specification states that a component, feature, structure, or characteristic "may", "might", "can" or "could" be included, that particular component, feature, structure, or characteristic is not required to be included.

It will be appreciated that the methods described herein may be performed in the described order, or in any suitable order.

Several alternative embodiments and examples have been described and illustrated herein. The embodiments of the invention described above are intended to be exemplary only. A person of ordinary skill in the art would appreciate the features of the individual embodiments, and the possible combinations and variations of the components. A person of ordinary skill in the art would further appreciate that any of the embodiments could be provided in any combination with the other embodiments disclosed herein. It is understood that the invention may be embodied in other specific forms without departing from the central characteristics thereof. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein. Accordingly, while the specific embodiments have been illustrated and described, numerous modifications

come to mind. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

The invention claimed is:

1. A method of lifting a shovel comprising an undercarriage and a superstructure with a counterweight, the method comprising:

configuring the shovel and a lifting system including a front lifting assembly and a rear lifting assembly on a lifting site in a lifting configuration wherein the front lifting assembly comprises a set of front lifting units located under a front portion of the superstructure and between two endless tracks of the undercarriage, and wherein each one of the front lifting units is vertically aligned with a corresponding force applying points on the front portion of an undersurface of the superstructure and the rear lifting assembly comprises a lifting beam including a set of spaced-apart lifting units positioned outwardly of the two endless tracks of the undercarriage and an elongated beam extending inbetween wherein the elongated beam matches corresponding force applying points on an undersurface of the counterweight, wherein a spacing between the lifting units of the rear lifting assembly is greater than a width of the undercarriage;

contacting the front lifting assembly and the rear lifting assembly with the corresponding force applying points on the front portion of the undersurface of the superstructure and the undersurface of the counterweight respectively; and

starting a lifting operation to raise the superstructure to a desired height.

2. The method of claim **1**, wherein the shovel comprises a bucket mounted to the superstructure and the bucket remains mounted to the superstructure for the duration of the lifting operation.

3. The method of claim **1**, wherein contacting the set of front lifting units and the elongated beam with the corresponding force applying points on the front portion of the superstructure and the counterweight comprises adding front and rear shims to upper surfaces of the front lifting units and the elongated beam.

4. The method of claim **1**, wherein configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises positioning the front lifting assembly at the lifting site and, then, driving the shovel at a lifting position at the lifting site, the front lifting assembly being located forwardly of a carbody of the undercarriage.

5. The method of claim **1**, wherein configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises positioning the lifting beam.

6. The method of claim **5**, wherein configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises positioning the lifting units of the lifting beam at the lifting site and, then, driving the shovel at the lifting position at the lifting site and securing the elongated beam of the lifting beam to respective upper portions of the positioned lifting units of the lifting beam, the lifting beam extending below the counterweight.

7. The method of claim **5**, wherein configuring the shovel and the lifting system in the lifting configuration at the lifting site comprises driving the shovel at the lifting position to the lifting site and, then, positioning the lifting beam at the lifting site rearwardly of the shovel, with the elongated beam of the lifting beam extending below the counterweight.

8. The method of claim **1**, further comprising, following positioning the shovel at a lifting position at the lifting site, detaching the superstructure from the undercarriage.

9. The method of claim **8**, further comprising driving at least one of rearwardly, forwardly and laterally the undercarriage under the lifting beam and outside the lifting site once the superstructure is raised.

10. The method of claim **2**, further comprising lowering the bucket mounted to the superstructure onto a supporting surface and maintaining the bucket on the supporting surface and mounted to the superstructure for a duration of the lifting operation.

11. The method of claim **1**, wherein the force applying points for the front lifting assembly are next to a rolling circle of the shovel.

12. The method of claim **1**, wherein the shovel is a hydraulic shovel.

13. The method of claim **1**, wherein the front lifting assembly is free of a mechanical connection extending between the front lifting units.

14. The method of claim **1**, wherein the superstructure is unsecured to the front lifting assembly during the lifting operation.

15. The method of claim **1**, further comprising withdrawing the undercarriage from the lifting site once the superstructure is raised to the desired height by displacing the undercarriage under the elongated beam and between the lifting units of the rear lifting assembly.

16. An apparatus for lifting a superstructure of a shovel, separated from an undercarriage, from a ground surface, the shovel comprising the undercarriage and the superstructure with a counterweight, the apparatus comprising:

a set of front lifting units abuttable against an undersurface of a front portion of the superstructure, located between two endless tracks of the undercarriage and next to a rolling circle of the shovel;

a lifting beam including a set of rear lifting units located outside of the endless tracks of the undercarriage and an elongated beam extending between upper portions of the rear lifting units, a spacing between the rear lifting units being greater than a width of the undercarriage allowing the undercarriage to circulate between the rear lifting units and the elongated beam, the lifting beam being abuttable against an undersurface of the counterweight; and

a control unit operatively connected to the set of front lifting units and the lifting beam.

17. The apparatus of claim **16**, wherein the elongated beam of the lifting beam is detachable from the rear lifting units.

18. The apparatus of claim **16**, wherein the shovel is a hydraulic shovel.

19. The apparatus of claim **16**, wherein the front lifting assembly is free of a mechanical connection extending between the front lifting units.

20. The apparatus of claim **16**, wherein the front lifting assembly is free of a mechanical connection extending between the front lifting units and the superstructure during a lifting operation.

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