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(54) Title of the Invention: **Integrated energy management, system recharge and grid stabilisation system for gravitational mechanical energy generators**

Abstract Title: **Gravitational mechanical energy generator**

(57) A gravitational mechanical energy generator comprises a dynamic load lifting system (DLLS) for periodic track arc rotations. The system comprises a motor 1 and a flywheel 2 so that energy can be supplied during a prolonged accumulation phase, and discharged to rotate the track periodically with high torque. A generator which is intended to supply energy to a grid is separate from the internal energy circuits, to de-couple the grid from load peaks when the track is moved. Various energy recovery sub-systems are also described.

(Figure 8a)

FIGURE 8 (a)

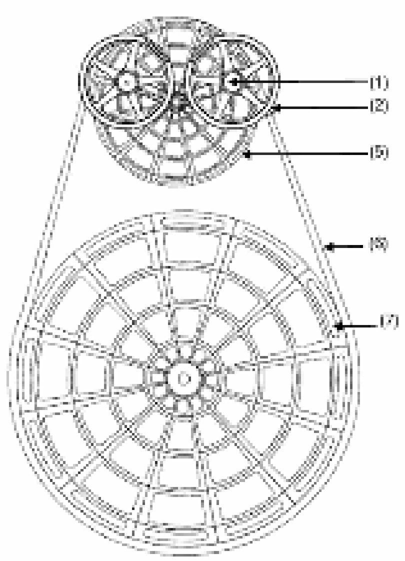


FIGURE 8 (a)

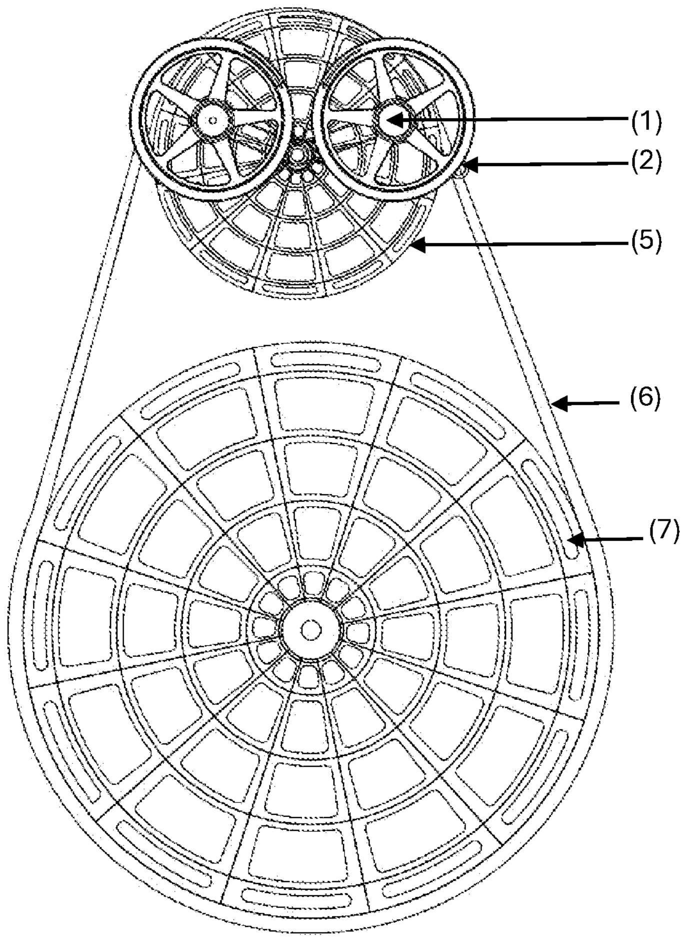


FIGURE 8 (b)

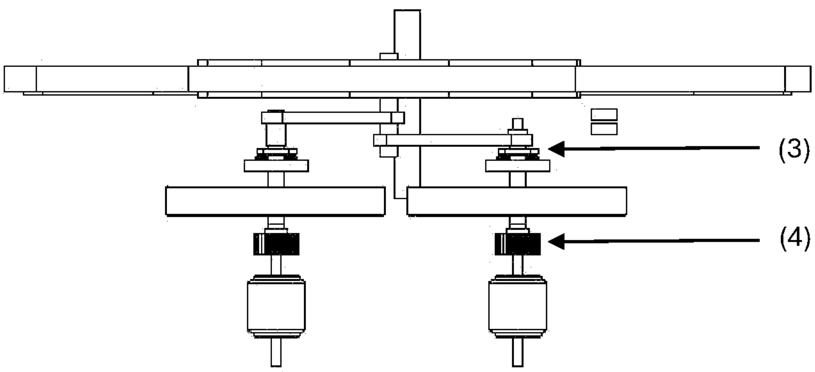


FIGURE 9 (a)

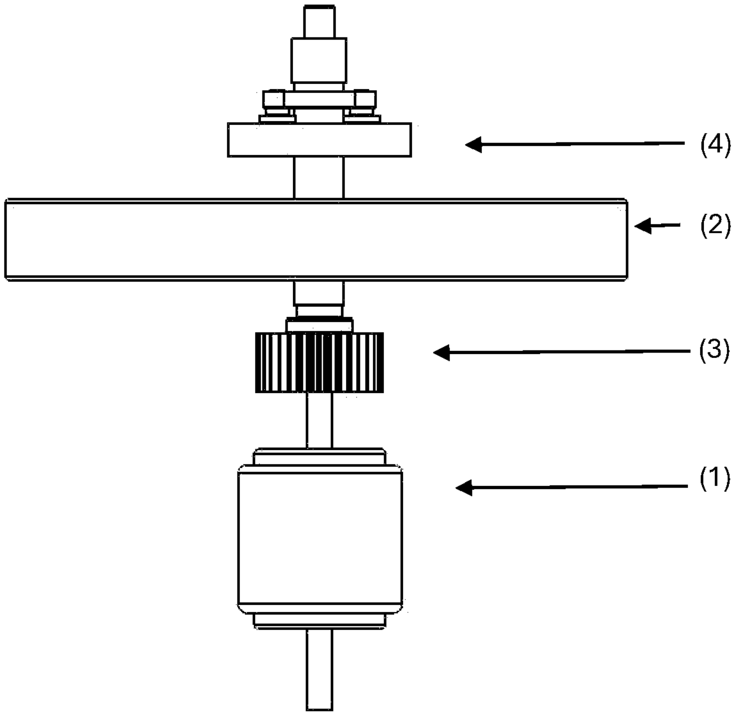


FIGURE 9 (b)

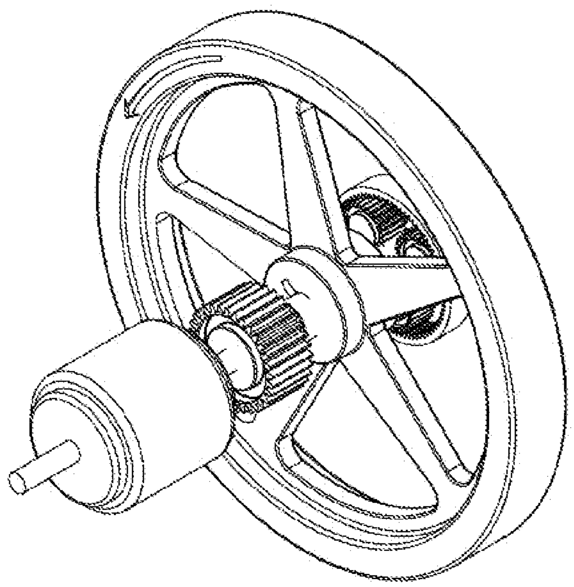


FIGURE 10

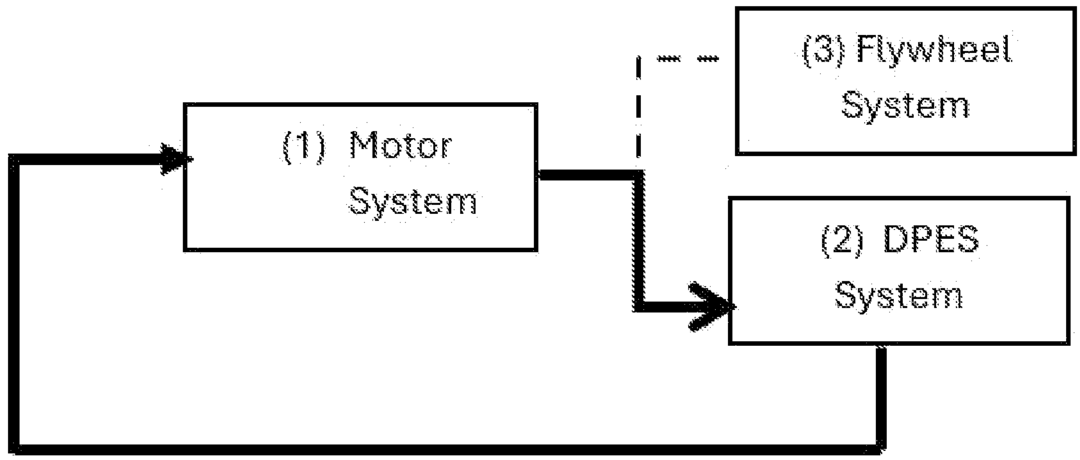


FIGURE 11

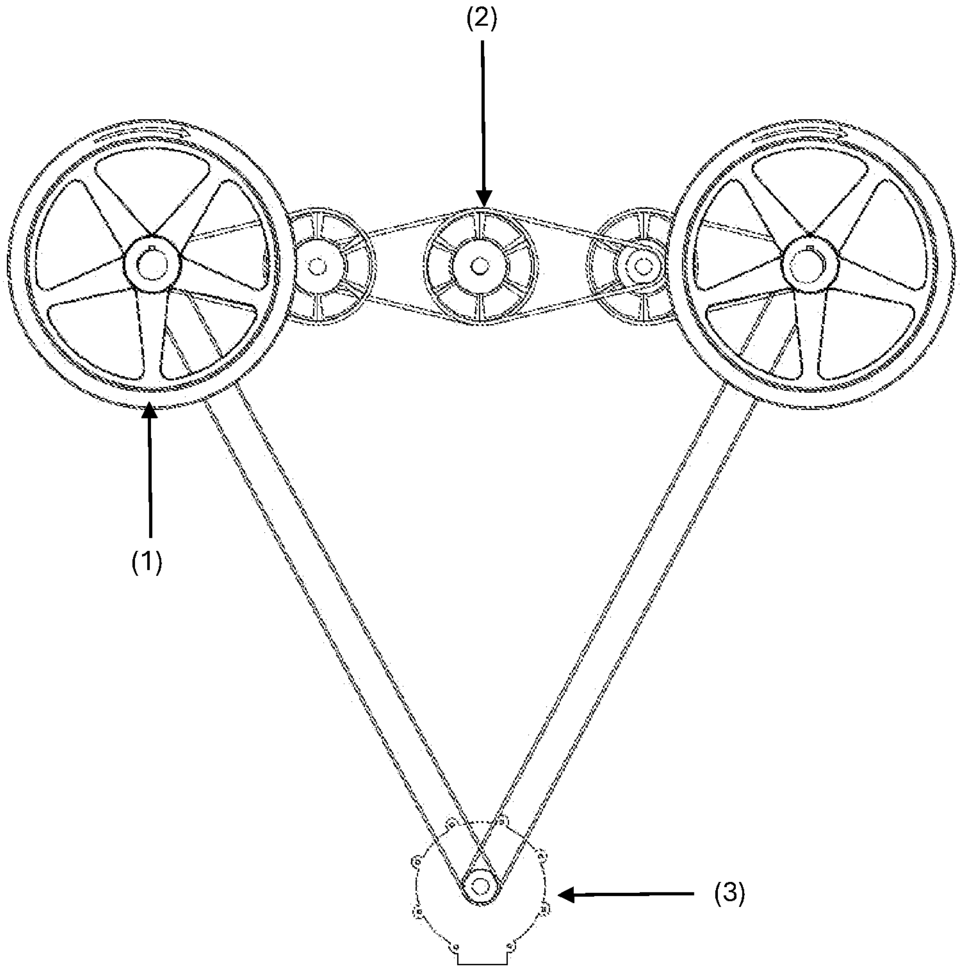


FIGURE 12

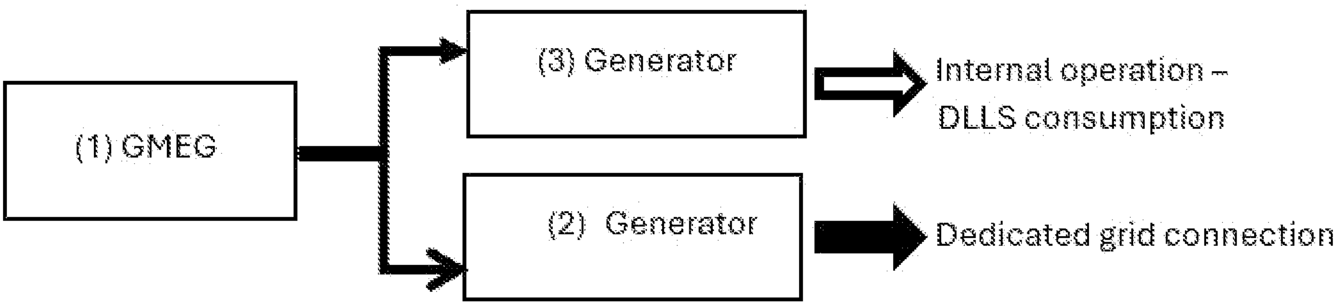
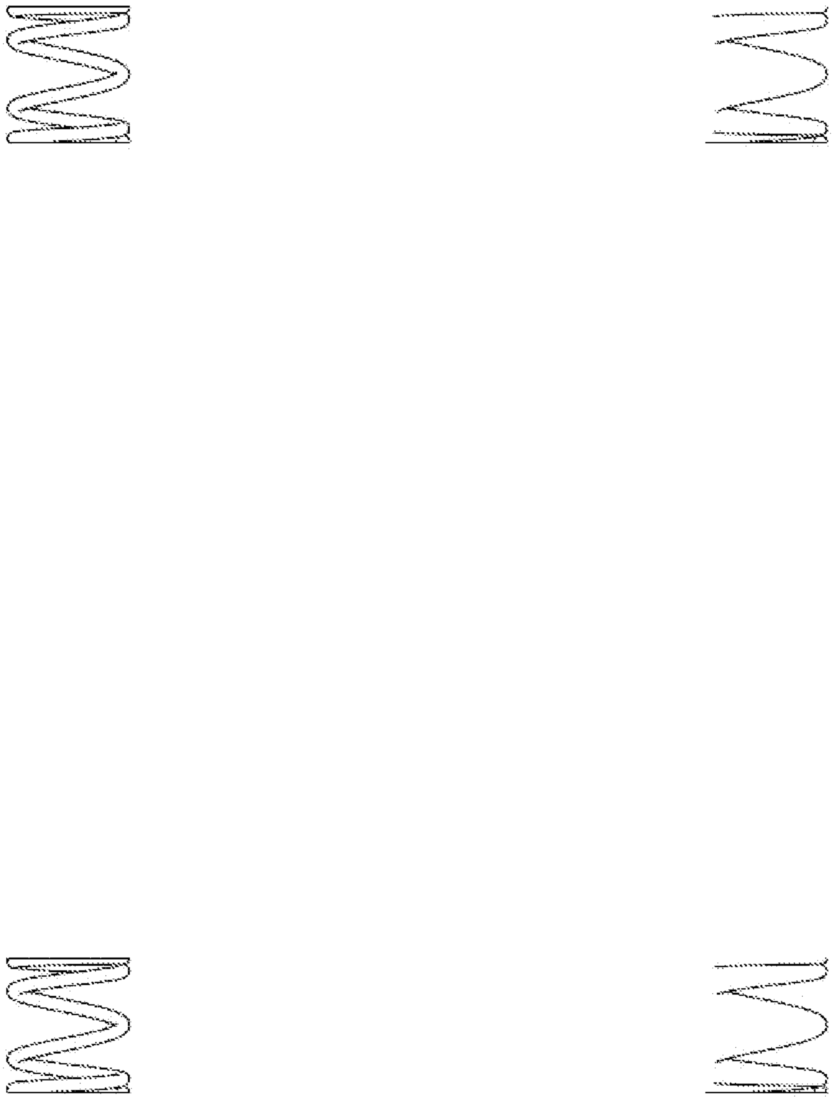

(1) GMEG
(3) Generator
(2) Generator
Internal operation –
DLLS consumption
Dedicated grid connection

FIGURE 13



TITLE

INTEGRATED ENERGY MANAGEMENT, SYSTEM RECHARGE AND GRID STABILISATION SYSTEM FOR GRAVITATIONAL MECHANICAL ENERGY GENERATORS

FIELD OF THE INVENTION

The present invention relates to an improvement in gravitational mechanical energy generators. Specifically, it provides a synchronised power management system for controlling the internal energy needs of the generator. The invention utilises an integrated Multi-Loop Recovery Architecture to maintain a consistent speed and system balance.

This is achieved using a Dynamic Load Lifting System (DLLS) designed to periodically rotate the track and reset the gravitational potential without interrupting the main power output. The system uses kinetic buffers, electrical scavenging, and inertial recovery to capture and reuse internal energy that would otherwise be lost.

The purpose of this design is to improve overall efficiency and provide a stabilised, reliable power supply to an external grid. This is done by separating the power needed for internal mechanical resets from the primary electrical generation circuit, which prevents voltage drops and keeps the frequency stable.

BACKGROUND

1. Managing Internal Power Loads

In large mechanical energy systems, especially those using gravity, a lot of the energy produced is used up by the machine’s own need to reset itself. In earlier designs, this internal load is taken directly from the main power output. This causes immediate power drops and frequency changes, which can make the local power grid unstable and reduce the overall effectiveness of the generator.

2. Energy Loss During Decoupling

Gravitational generators often need to disconnect drive parts to let gravity do its work. During these times, the leftover movement (inertia) in the parts and the remaining electricity in the motor windings (back-EMF) are usually wasted as heat or friction. There is a need for a Power Exchange System that can catch this lost energy and put it back to work to improve the machine’s efficiency.

3. Controlling Speed and Torque

If gravitational pull isn't regulated, it can lead to runaway speeds. This can damage the machine and create an inconsistent electrical frequency that is difficult to send to the grid. While traditional brakes just waste this extra energy as heat, a better solution is a mechanical governor (Kinetic Energy Transfer System or KETS). This turns extra torque into useful internal power without affecting the main energy flow.

4. Inertial Challenges in Track-Based Systems

The Dynamic Load Lifting System (DLLS) provides the necessary movement for the generator (as seen in PCT/GB2023/052482). However, managing the heavy weight and momentum of the track is a major technical challenge. Rotating a large track can cause sudden torque spikes. There is a need for a synchronised energy cycle that builds up energy over a longer period and then releases it in a high torque burst. This allows for Track Arc Rotations (TARs) while keeping the system moving, preventing it from stalling, and ensuring a steady supply of power.

BRIEF SUMMARY OF THE INVENTION

Integrated Energy Management, System Recharge and Multi-Loop Recovery

The present invention provides an energy management system for a Gravitational Mechanical Energy Generator (GMEG) using four integrated recovery loops: a Dynamic Load Lifting System (DLLS), a Dynamic Power Exchange System (DPES), a Kinetic Energy Transfer System (KETS), and an Inertial Energy Recovery System (IERS). The design uses a decoupled setup with at least one primary generator and at least one auxiliary generator. This allows the system to send a stabilised electrical output to the grid while handling internal power needs through a separate, isolated circuit.

To keep the system moving by resetting the gravitational potential energy periodically, the DLLS is used to perform alternating Track Arc Rotations (TARs) while the weights are in motion. The DLLS includes a drive unit with at least one motor and a flywheel (kinetic buffer) to provide the sudden torque needed to rotate the track. This prevents power drops on the main output by using stored mechanical energy to handle the heavy lift of the reset cycle.

An Inertial Energy Recovery System (IERS) is included to manage the stopping and starting of the heavy track assembly. The IERS recovers energy as the track slows down and then uses that stored energy to provide a kick-start impulse before the next rotation. This initiates the track's movement before the main DLLS motor engages, which reduces the strain on the drive system and helps overcome the initial resistance of the stationary track.

The invention also includes a Dynamic Power Exchange System (DPES) to catch leftover electricity from the drive motors when they are disconnected. This works alongside the Kinetic Energy Transfer System (KETS), which acts as a mechanical governor. The KETS turns extra gravitational torque into internal power to keep the main generator running at a steady speed.

A key feature of the invention is the separation of the primary and auxiliary circuits. The primary generator is dedicated to the grid, providing a clean signal. The auxiliary generator is dedicated to internal power and system stability. This ensures that internal mechanical resets are electrically invisible to the grid, allowing the generator to act as a reliable and steady grid-connected power source.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 8 (a) and (b) – Figure 8 (a) and (b) illustrates the Dynamic Load Lifting System (DLLS), detailing the drive parts (1,2,3,4) and how they connect (5,6) to the track rotation gear (7).

FIGURE 9 (a) and (b) – Figure 9 (a) and (b) details the parts of a drive unit within the DLLS. This illustrates the motor/generator system (1), the flywheel system (2), and the two gear assembly systems (3,4) used to manage torque.

FIGURE 10 – Figure 10 illustrates the Dynamic Power Exchange System (DPES). It shows the path of the electricity as it travels from the drive motors (1) to the capacitor storage (2) when the DLLS is disconnected (3).

FIGURE 11 – Figure 11 illustrates the Kinetic Energy Transfer System (KETS). It shows the mechanical governor (1) and the auxiliary generator (3) used to keep the internal power stable (2).

FIGURE 12 – Figure 12 illustrates the Decoupled Generation Architecture. It shows the separate electrical paths for the primary grid generator (2) and the auxiliary internal generator (3) to ensure they operate independently from the main supply (1).

FIGURE 13 – Figure 13 illustrates the Inertial Energy Recovery System (IERS), showing the connection between the track rotation gears and the regenerative braking/kick-start control interface.

DETAILED DESCRIPTION OF THE INVENTION

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the term “and / or” includes any and all combinations of one or more associated listed items. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well as the singular forms, unless the context clearly indicates otherwise. It will be further understood that that the terms “illustrates” and/or “details” when used in this specification, specify the presence of stated features, steps, operations, elements and / or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components and / or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one having ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

In describing the invention, it will be understood that a number of techniques and steps are disclosed. Each of these have individual benefit and each can also be used in conjunction with one or more, or in some cases all, of the other disclosed techniques. Accordingly, for the sake of clarity, the description will refrain from repeating every possible combination of the individual steps in an unnecessary fashion. Nevertheless, the specification and claims should be read with the understanding that such combinations are entirely within the scope of the invention and the claims.

In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one skilled in the art that the present invention may be practiced without these specific details.

The present disclosure is to be considered as an exemplification of the invention and is not intended to limit the invention to the specific embodiments illustrated by the figures or description below.

3. THE DYNAMIC LOAD LIFTING SYSTEM (DLLS)

The present invention details a mechanical assembly used to rotate the track at timed intervals, known as Track Arc Rotations (TARs). As illustrated in FIGURE 8 (a) and (b), the DLLS manages the heavy weight and movement (inertia) of the track to ensure the generator continues to deliver power without stopping.

3.1 Design and Components

The DLLS is made up of independent, symmetrical motorised units. These are designed to handle a system inertia that can exceed 1,000,000 $kg \cdot m^2$ for example. Each unit connects to a central drive gear, which links to a larger gear on the track.

The drive system uses at least one electric motor (1), which can be a single unit or a bank of multiple motors (for example, a bank of 10 motors) to share the load. These motors are sized to match the momentum of the track assembly. A flywheel (2) is built into the drive system to act as a kinetic buffer. This allows energy to be stored over a longer period at high speed (for example, up to 10,000 RPM) and then released in a high torque burst to rotate the track at a lower RPM.

The system uses an asymmetric gear setup to manage speed and torque. A first gear assembly (3) connects the motors to the flywheel, and a second high-torque gear assembly (4) connects the flywheel to the one of the track rotation gears. This uses a gear reduction (for example, 1:117 or similar) to increase the force needed during the rotation phase.

3.2 Operation and Trigger Logic

The DLLS is managed by a real-time control system that checks the status of the machine at a frequency determined by the track slant angle and the TAR operational time (for example, 80 Hz at a 40-degree slant or 60 Hz at a 30-degree slant). This controller monitors the "Centre Enabler Distance" (M) to track the exact position of the weights.

The track rotation is started based on a "Predictive Pivot Zone" calculation. The rotation is triggered at a specific start point (RotZone1_Start) determined by the track shape and the speed of the weights. For a track tilted at 32 degrees, the DLLS performs an arc rotation of 64 degrees with 61 segments. This is timed to ensure that the collective gravitational pull of the enabler train is maintained. By rotating the track at the precise moment the leading weights reach the calculated engagement point on the track, the system ensures the train maintains enough momentum to carry the trailing weights through the upward reset phase, preventing the device from reaching a standstill.

To help with this rotation, the system uses a Hybrid Inertial Management approach. Mechanical springs are set up to provide roughly 70% of the inertial energy stored from the previous TAR when bringing the system to s stop, and thereby reducing the work needed to move the track, enabling the flywheel to provide the rest. This allows the DLLS to complete a rotation quickly (for example, in 1.0 second) without causing a large power spike.

3.3 Energy Balancing and Startup

While storing energy, the motors draw a steady average power (for example, 361 kW) to charge the flywheels from the GMEG. Once the centre weight reaches the start of the rotation zone, the system performs the rotation, and the motors can be disconnected or switched to recover energy.

The device is not self-starting. It requires an initial external power source (such as a battery or grid connection) to start the first track movement and get the weights up to speed. Once the system reaches its operating speed, the DLLS becomes selfsustaining, powered by the internal auxiliary circuit. All speeds, trigger points, and gear ratios can be adjusted to suit the size and weight of the specific generator.

4. THE DYNAMIC POWER EXCHANGE SYSTEM (DPES)

The present invention details an electrical power management system designed to catch and reuse electricity during the working cycles of the DLLS. As illustrated in FIGURE 10, the DPES acts as a buffer between the heavy, short bursts of the track reset cycles and the need for a steady electrical output.

4.1 Design and Components

The DPES utilises the drive motors (1) of the DLLS to recover energy. When the motors are disconnected from the flywheels (3), the control system switches the motors into a regenerative state. This process converts the leftover movement and magnetic energy in the motor windings into useful electricity.

To manage these sudden, high-power spikes, the system uses a high-capacity electrical buffer (2), specifically a bank of supercapacitors. These units are chosen because they can handle rapid charging and discharging over 500,000 times without wearing out. Unlike standard batteries, this capacitor bank is designed to handle the sudden back-EMF (Electromotive Force) created when the DLLS motors slow down or disconnect.

A power management interface (PMI) controls the flow of this electricity. It uses an inverter or converter to ensure the recovered energy matches the voltage of the internal power circuit. A real-time controller, timed at as example 80 Hz or 60 Hz sampling rate, starts the energy recovery the moment the mechanical disconnect happens, so that energy is not wasted as heat.

4.2 Recovery and Smoothing Cycle

The DPES works in a charge-and-discharge sequence timed with the track rotations (TARs).

1. Recovery Phase: During a track rotation, as the motors finish their work and disconnect, the leftover energy is sent to the supercapacitor bank. This is a short, high-power burst (for example, approximately 675 kW of total energy).

2. Smoothing Phase: While the weights are moving steadily, the energy stored in the supercapacitors is released back into the internal power circuit in a steady stream (for example, a constant 161 kW output). This is timed to cover the power needed for the next cycle, which flattens the machine's internal power demand.

4.3 System Integration

The DPES works with the KETS, IERS, and GMEG to manage the machine's energy. By catching the energy not used during track arc rotations and putting it back into the system, the DPES reduces the risk of needing power from the grid for internal maintenance. This ensures the main grid generator can run at a steady rate regardless of the track resets, making the whole system more efficient.

5: THE KINETIC ENERGY TRANSFER SYSTEM (KETS)

The present invention includes a kinetic energy management system designed to keep the machine's speed steady and catch extra energy. As shown in FIGURE 11, the KETS acts as both a speed governor and a source of internal power. It is designed to manage extra gravitational torque using a set of flywheels, ensuring the main generator runs at a steady speed.

5.1 Design and Components

The system utilises at least one flywheel (1), which can be a single unit or a bank of flywheels. These act as a mechanical buffer, absorbing changes in speed to keep the system balanced. To make these flywheels as efficient as possible, a gearbox (2) is used to increase the rotational speed from the main output shaft to the flywheels. This allows more energy to be stored relative to the speed of the track.

The flow of power is managed by engagement parts that coordinate the flywheel cycles. This setup ensures that while extra torque is being gathered from the weights, stored energy is also available to support internal operations (3). A control system monitors the speed and power demand, managing the drive interface. This ensures the primary generator maintains a consistent and clean signal for the grid.

5.2 Speed Stabilisation and Governing

The KETS is specifically designed to act as a mechanical governor for the whole machine. By absorbing extra gravitational force that would otherwise cause the machine to speed up too much, the KETS ensures the device stays at a constant RPM. This happens regardless of the weight of the enablers or the angle of the track as example.

The energy caught during this process is sent to the internal circuit to help power the DLLS and other systems. This separates the energy needed for the internal reset from the main power being sent to the grid. This logic ensures that the mechanical work of maintaining the machine does not interfere with the quality or reliability of the power being exported.

6. DECOUPLED PRIMARY AND AUXILIARY GENERATION ARCHITECTURE

The present invention details a dual-path power system designed to provide a steady electrical feed to a utility grid while also handling the machine's internal power needs. As shown in FIGURE 12, the design physically and electrically separates the main power loop from the auxiliary recovery loop. This multi-generator setup isolates the high-quality export power from the changing power needs used for track resets and system stability.

6.1 Design and Components

The primary generation system uses at least one main generator (2), which can be a single unit or a bank of generators. This system is connected to the main output shaft of the GMEG (1) and is used only for sending a stable electrical feed to the grid. By keeping this shaft separate from the internal recovery parts, the main generator is protected from the mechanical noise and vibrations of the track reset cycle.

The system also uses at least one auxiliary generator (3) connected specifically to the internal energy recovery systems, including the GMEG, KETS, DPES and IERS. This auxiliary system is dedicated to powering the Dynamic Load Lifting System (DLLS) and the control electronics. An intelligent interface manages the power between these circuits. This ensures the main grid signal stays steady and is not affected by the sudden torque changes and high power demands needed for Track Arc Rotations (TARs).

6.2 Grid Stabilisation and Power Quality

By separating the main generation from the internal recovery loops, the device acts as a reliable and steady power source. The main generation system is set up to deliver a constant voltage and frequency that meets grid requirements. Because the high torque needed for the track reset comes from the internal flywheels (KETS) and the supercapacitors (DPES) through the auxiliary loop, the main grid feed does not suffer from the power drops or distortions common in other mechanical systems.

The auxiliary system ensures that the internal tax - the energy needed to move the track and reset the weights - is covered by the extra energy caught by the recovery loops. This means the main output stays clean regardless of the size of the machine. The system automatically adjusts to the weight of the enablers and the track shape, keeping the power quality high even during mechanical stress.

6.3 Adjustable Load Balancing

The balance between the main power output and the internal recovery capacity can be adjusted on-site. The system is modular, allowing the energy management to be tuned to prioritise either maximum grid export or maximum internal storage depending on what is needed. This flexibility allows the generator to be used for different commercial and industrial jobs while making sure the internal mechanical cycle has the smallest possible impact on the total power delivered.

7. CONTROL LOGIC AND PARAMETER OPTIMIZATION

The system uses a high-frequency control setup that can be driven by sensors to manage the machine in real-time. This controller allows for various settings to be adjusted on-site, so the machine design can adapt to different weights, track angles, and sizes.

7.1 High-Frequency Synchronisation

The controller monitors the speed and position of the gravity enablers using a closed-loop system. It checks the machine at a frequency determined by the number of track segments across the time period of a Track Arc Rotation (TAR). For example, the system may operate at 80 Hz for 81 segments (during a 40° to -40° slant) or 60 Hz for 61 segments (during a 30° to -30° slant). By tracking exactly where the weights are in relation to the track's rounded corners, the system calculates the best time to start the rotation.

Specifically, the controller uses the Centre Enabler Distance (M) and set Rotation Zones to trigger the movement. This timing ensures the track rotates at the exact moment when the weights are in the optimum position to benefit from the kinetic energy injection from the DLLS. This burst of energy helps the weights travel around or upwards through the rounded corners during the TAR. This keeps the momentum of the entire train going and prevents the system from reaching a standstill.

7.2 Gear Interfacing and Momentum Matching

The system is designed to manage different gear ratios across its transmissions. By monitoring the movement of the flywheels (KETS), the system selects gear ratios (for example, between 1:25 and 1:2000) that best match the weight and momentum of the track assembly. This ensures the machine stays in Energy Equilibrium - a state where the energy saved in the flywheels is always enough to help cover the work needed for the next track reset.

7.3 Load Balancing and Energy Management

The control logic maintains a physical separation between the main grid-export circuit and the internal auxiliary circuit. Instead of using a static power bank, the system combines the power from the second GMEG generator, the KETS, and the DPES into a single internal circuit. This circuit is used to power the DLLS motors, which constantly keep the flywheels (kinetic buffers) at the required speed.

By calculating the Torque Deficit in real-time, the controller ensures that the energy needed for the Track Arc Rotation (TAR) is already stored as kinetic energy in the flywheels. When the IERS kicks in to start the rotation, the system uses this built-up momentum to handle the reset. This ensures that the main grid generator never has to provide power for internal resets or suffer from power drops, as the energy required to keep the machine in motion is generated and managed entirely within the auxiliary loop. Because the system is operational and moving, it relies on this continuous kinetic energy rather than a stationary reserve to maintain a positive energy balance.

8. THE INERTIAL ENERGY RECOVERY SYSTEM (IERS)

The present invention includes an Inertial Energy Recovery System (IERS) designed to control the movement of the track at the start and end of a Track Arc Rotation (TAR). Because the track assembly has a massive total inertia (for example, exceeding 1,100,000 $kg \cdot m^2$), the energy created by stopping and starting the track must be managed to prevent damage and save power.

8.1 Mechanical Energy Capture

Instead of using standard friction brakes, the IERS uses a system of heavy-duty springs located at the terminal points of the track rotation. In a preferred design, four springs are used, arranged in a square pattern at each corner of the rotation path. As the track reaches the end of its 60-degree or 80-degree arc, it comes into contact with these springs. The momentum of the track compresses the springs, which slows the track down naturally while capturing its kinetic energy. Once the track reaches its final position, it is locked in place with the springs fully compressed.

8.2 Kinetic Kick-Starting

The IERS uses the stored energy in the compressed springs to provide a Kick-Start function for the next rotation. When the controller triggers the next TAR, the locks are released, and the springs push the track in the required direction. This provides an initial burst of movement both up and down across the corners of the track. This happens slightly before the main DLLS motors and flywheels engage. By using the springs to move the track from a standstill, the system significantly reduces the breakaway torque and the initial strain on the gears and chains. This protects the mechanical parts and ensures the rotation starts smoothly.

TECHNICAL ANNEX: SYSTEM PARAMETERS

The following table while indicative but not limited to details the operational parameters of the system as determined by the Operational Performance Simulator (OPS). These values represent a sample embodiment of the invention:

Parameter	Value	Purpose
Control Sampling Frequency	60 Hz	Real-time torque-matching and TAR timing.
Total System Inertia	> 1,100,000 kg·m²	Defines the load managed by the KETS and DLLS.
Operating Track Angle	32° (Nominal)	Balance of gravitational pull vs. friction.
TAR Execution Time	1.0 Seconds	Ensures continuous movement of the weights.
Mechanical Efficiency	88.84%	Total efficiency after friction and gear losses.
DPES Smoothing Ratio	~4.2:1	Converts 675 kW surge to 161 kW steady output.
IERS Recovery Efficiency	70% - 85%	Capture of energy during track stopping.

CLAIMS

I hereby claim:

1. A gravitational energy management system comprising:

- a track assembly supporting a plurality of movable masses;
- a Dynamic Load Lifting System (DLLS) comprising at least one electric motor and at least one kinetic buffer;
- characterised in that the DLLS is configured to perform a two-phase energy cycle consisting of a prolonged accumulation phase and a high-torque discharge phase to periodically rotate the track assembly; and
- wherein a control unit triggers said discharge phase based on a predictive spatial trigger zone calculated as a function of the speed of the movable masses and the track geometry.

2. The system of claim 1, further comprising a decoupled power generation architecture wherein:

- at least one primary generator is coupled to a primary output shaft and dedicated to an external grid-connected circuit;
- at least one auxiliary generator is dedicated to an internal power circuit;
- said internal power circuit is powered by the combined harvested energy from a Gravitational Mechanical Energy Generator (GMEG), a Kinetic Energy Transfer System (KETS), a Dynamic Power Exchange System (DPES), and an Inertial Energy Recovery System (IERS) to satisfy internal loads and the operational demands of the DLLS, so that the primary output shaft is electrically and mechanically isolated from the torque fluctuations of the track rotation cycle.

3. The system of claim 2, wherein the primary generation circuit is configured to deliver a stabilised electrical signal to an external power grid, providing frequency regulation by isolating the primary output from the pulses and torque spikes associated with the gravitational recharge cycles.

4. The system of claim 1, further comprising a Kinetic Energy Transfer System (KETS) utilising a bank of flywheels, configured to act as a mechanical speed governor by absorbing extra gravitational torque through a multi-stage transmission, maintaining the system at a steady speed regardless of gravitational load changes.

5. The system of claim 1, further comprising a Dynamic Power Exchange System (DPES) utilising at least one supercapacitor, configured to recover back-EMF and electrical energy from the DLLS motors during a regenerative state timed with the mechanical disconnection of the drive system.

6. The system of claim 1, wherein the DLLS utilises a multi-stage transmission providing an asymmetric gear ratio between the energy accumulation phase and the energy discharge phase, matched to the momentum (inertia) of the track assembly.

7. A method for delivering stabilised power using the system of claim 1, characterised in that:

- the operational state is monitored by a control unit at a sampling frequency determined by the track slant angle and rotation time (for example, between 60 Hz and 80 Hz);
- the system dynamically adjusts settings—including timing intervals, rotational speeds, and gear ratios—to maintain a positive net kinetic energy balance across all parts of the operational cycle; and
- wherein the track arc rotation is performed using a spring-support system calibrated to provide a portion of the work required to move the track mass.

8. The system of claim 1, further comprising an Inertial Energy Recovery System (IERS) utilising a mechanical spring bank at the terminal points of the track rotation, characterised in that:

- During deceleration: the IERS captures the kinetic energy of the track assembly through the compression of the spring bank as the track reaches the end of the rotation zone; and
- During initiation: the IERS releases the stored mechanical energy to provide an initial "kick-start" push to the track assembly before the primary DLLS

motors engage, reducing the initial breakaway torque and the energy demand on the flywheel.

Amendments to the claims have been filed as follows:

CLAIMS

I hereby claim:

1. A gravitational energy management system comprising:

- a track assembly supporting a plurality of movable masses;
- a Dynamic Load Lifting System (DLLS) comprising at least one electric motor and at least one kinetic buffer;
- characterised in that the DLLS is configured to perform a two-phase energy cycle consisting of a prolonged accumulation phase and a high-torque discharge phase to periodically rotate the track assembly; and
- wherein a control unit triggers said discharge phase based on a predictive spatial trigger zone calculated as a function of the speed of the movable masses and the track geometry.

2. The system of claim 1, further comprising a decoupled power generation architecture wherein:

- at least one primary generator is coupled to a primary output shaft and dedicated to an external grid-connected circuit;
- at least one auxiliary generator is dedicated to an internal power circuit;
- said internal power circuit is powered by the combined harvested energy from a Gravitational Mechanical Energy Generator (GMEG), a Kinetic Energy Transfer System (KETS), a Dynamic Power Exchange System (DPES), and an Inertial Energy Recovery System (IERS) to satisfy internal loads and the operational demands of the DLLS, so that the primary output shaft is electrically and mechanically isolated from the torque fluctuations of the track rotation cycle.

3. The system of claim 2, wherein the primary generation circuit is configured to deliver a stabilised electrical signal to an external power grid, providing frequency regulation by isolating the primary output from the pulses and torque spikes associated with the gravitational recharge cycles.

4. The system of claim 1, further comprising a Kinetic Energy Transfer System (KETS) utilising a bank of flywheels, configured to act as a mechanical speed governor by absorbing extra gravitational torque through a multi-stage transmission, maintaining the system at a steady speed regardless of gravitational load changes.

5. The system of claim 1, further comprising a Dynamic Power Exchange System (DPES) utilising at least one supercapacitor, configured to recover back-EMF and electrical energy from the DLLS motors during a regenerative state timed with the mechanical disconnection of the drive system.

6. The system of claim 1, wherein the DLLS utilises a multi-stage transmission providing an asymmetric gear ratio between the energy accumulation phase and the energy discharge phase, matched to the momentum (inertia) of the track assembly.

7. A method for delivering stabilised power using the system of claim 1, characterised in that:

- the operational state is monitored by a control unit at a sampling frequency determined by the track slant angle and rotation time,
- the system dynamically adjusts settings – including but not limited to timing intervals, rotational speeds, and gear ratios- to maintain a positive net kinetic energy balance across all parts of the operational cycle; and
- wherein the track arc rotation is performed using a spring-support system calibrated to provide a portion of the work required to move the track mass.

8. The system of claim 1, further comprising an Inertial Energy Recovery System (IERS) utilising a mechanical spring bank at the terminal points of the track rotation, characterised in that:

- During deceleration: the IERS captures the kinetic energy of the track assembly through the compression of the spring bank as the track reaches the end of the rotation zone; and
- During initiation: the IERS releases the stored mechanical energy to provide an initial "kick-start" push to the track assembly before the primary DLLS motors engage, reducing the initial breakaway torque and the energy demand on the flywheel.

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Field of search

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Databases used in the preparation of this search report:
SEARCH-PATENT

Documents considered to be relevant

Patent literature

Category	Relevant to claims	Document of relevance
X	1-8	US 2019/0154009 A1 (LO et al.) – see whole document and note paragraph 43
X	1-8	JP 2011127583 A (KOIZUMI YUZURU) – see whole document and note paragraph 10
X	1-8	US 2013/0241331 A1 (TSUGANE) – see whole document and note paragraph 24

Non-patent literature

[None]

Categories

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Letter or symbol	Description
X	Document indicating lack of novelty or inventive step.
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A	Document indicating technological background.
P	Document published on or after the priority date but before the filing date of the present application.
E	Earlier application published on or after the filing date of the present application.