

(21) Application No: 1400450.1

(22) Date of Filing: 11.01.2014

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(51) INT CL:
F03B 17/02 (2006.01)

(56) Documents Cited:
GB 2484324 A **US 4599857 A**

(58) Field of Search:
 INT CL **F03B, F03C, F03G**
 Other: **WPI, EPODOC, TXTE**

(54) Title of the Invention: **Rigid body dynamics-based hydropower technology**
 Abstract Title: **Hydropower generator with power take off using rigid body collision**

(57) A hydropower generator raises a ball 6, or other weight which can roll using wheels, and allows it to roll down a track 2.1, 300 to convert its potential energy into kinetic energy. The strike ball 6 collides with a similar sphere 7, thereby transferring its kinetic energy to the targeted sphere 7. The balls 6, 7 are rigid, so the collisions are elastic with complete energy transfer. In figure 2, the strike ball 6 is raised by track 2.1, which is alternately raised by water from a stream. In figure 14, a breastshot water wheel is used to raise a series of balls 6 (see figure 8) which are allowed to roll down a track 300. The strike balls 6 collide with a targeted ball 7, which transfers its energy to a linear motion mechanism 8 driving connecting rod 10, crankshaft 19, flywheel 13, and electric generator 15.

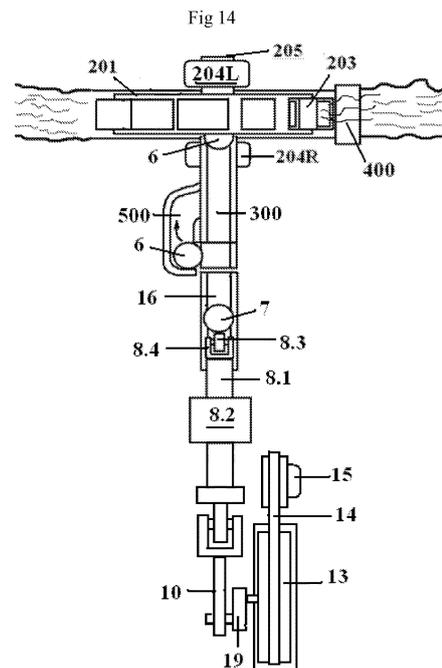
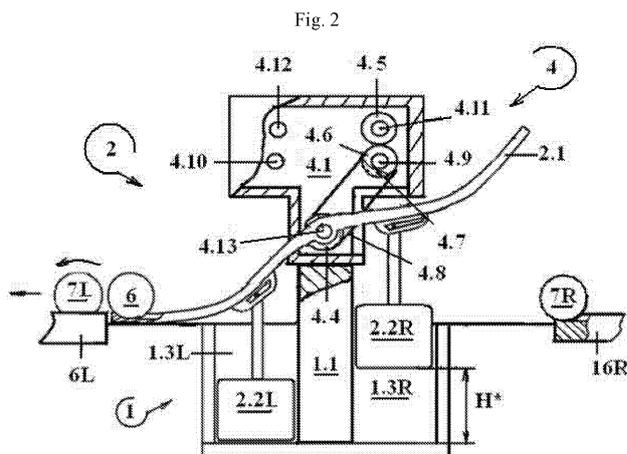


Fig.3

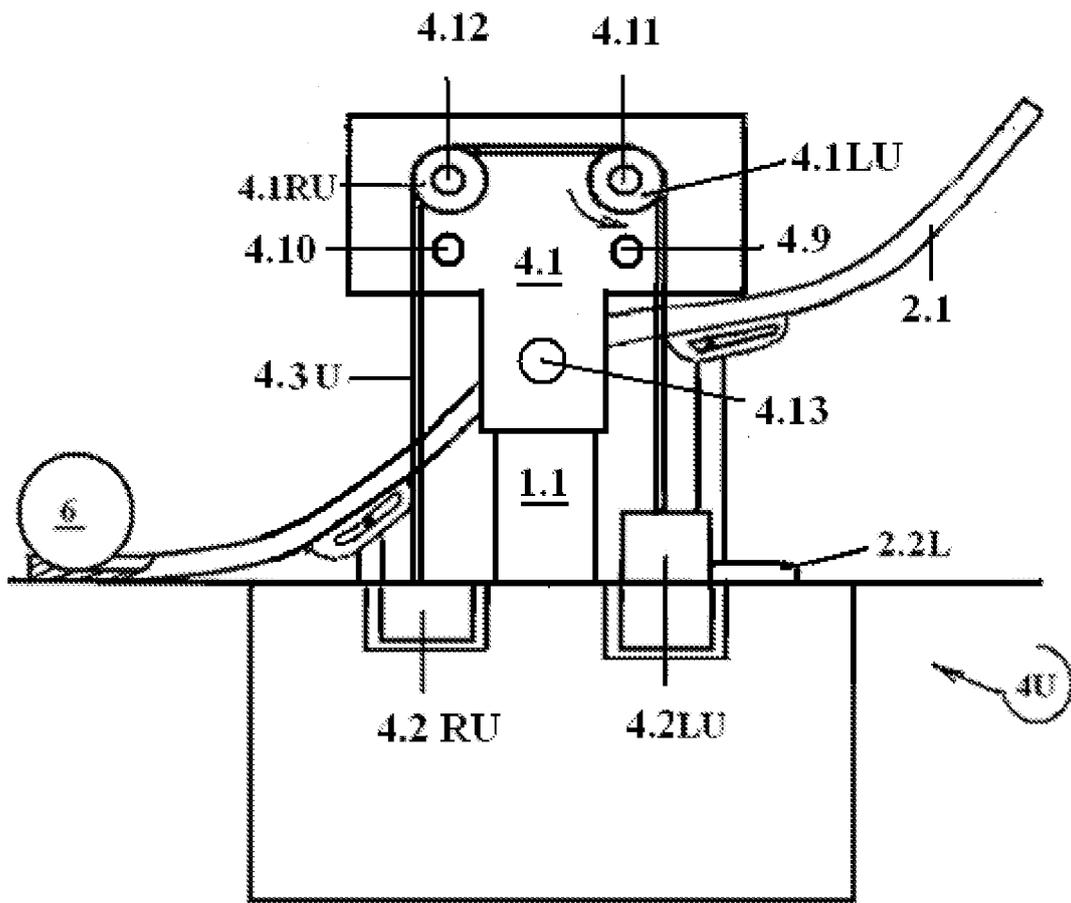


Fig. 4

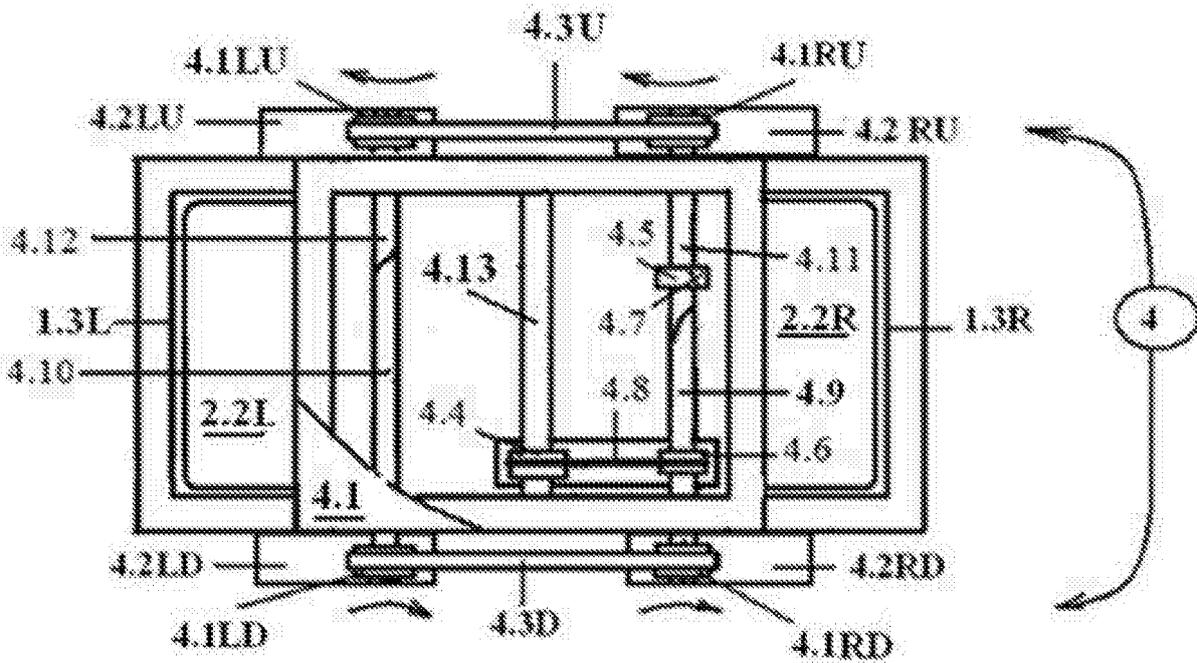


Fig 5

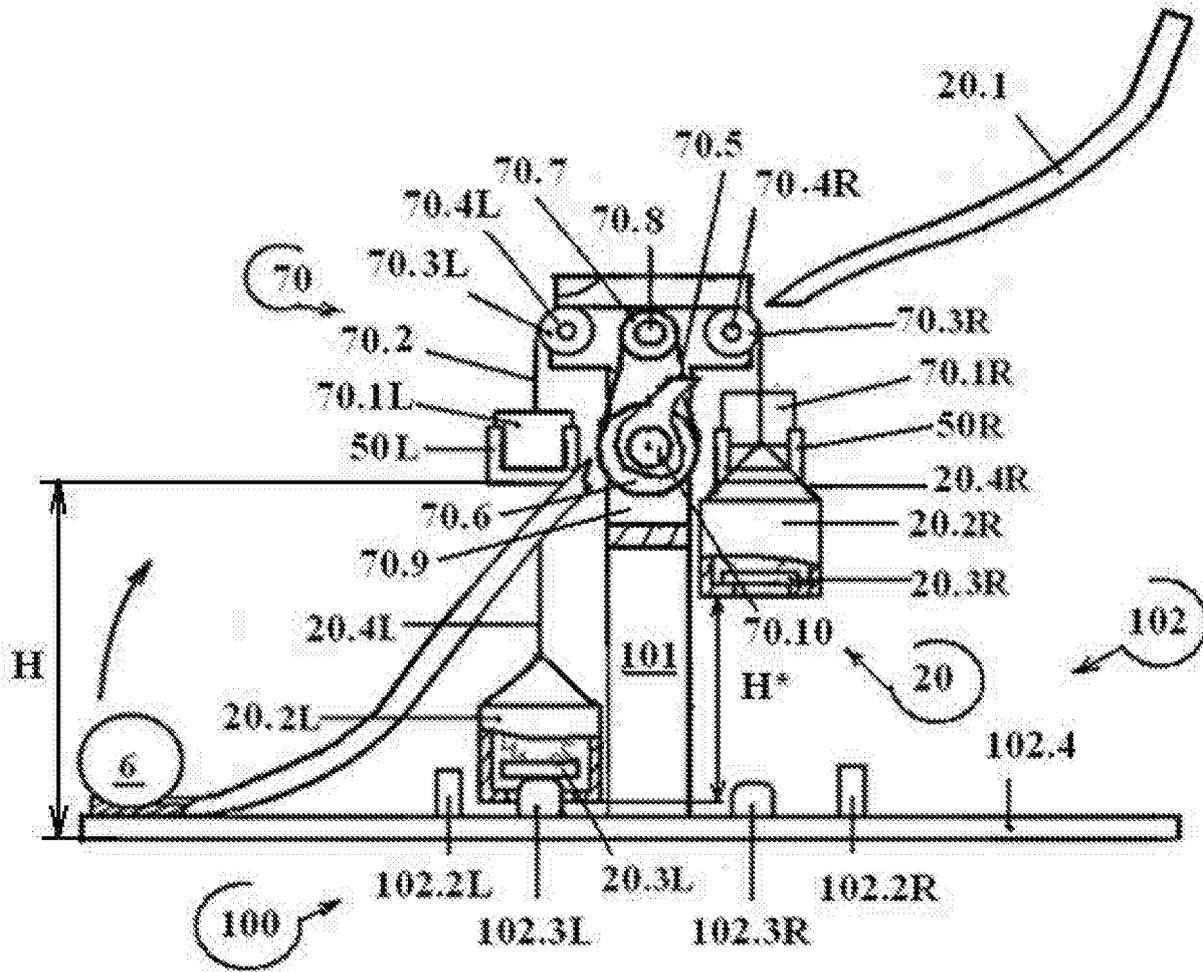


Fig. 6

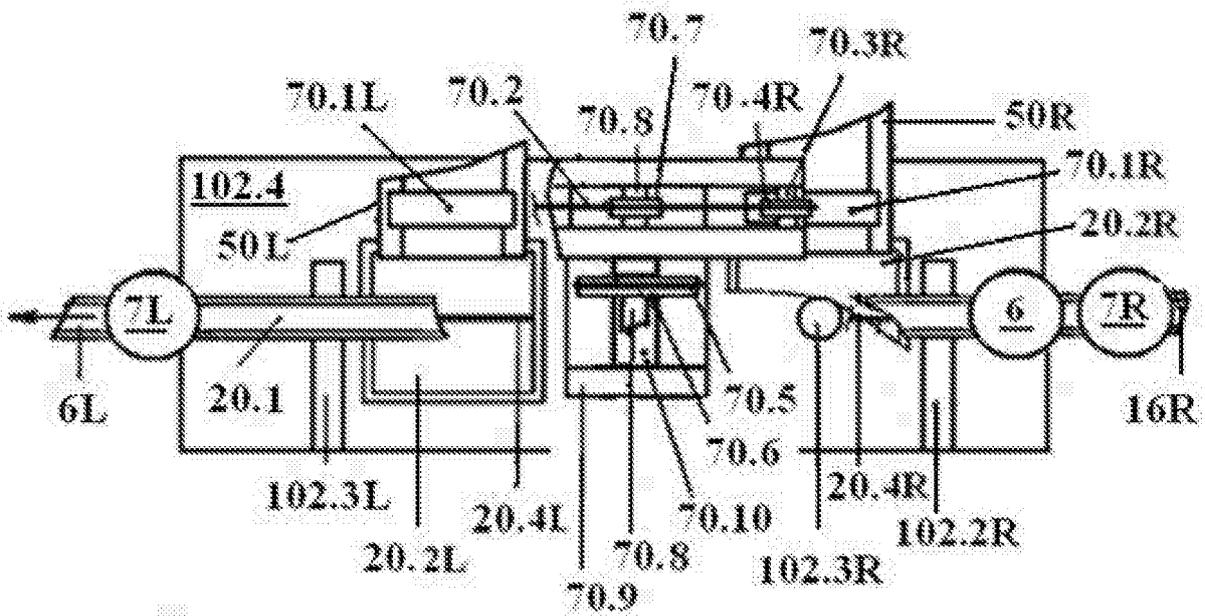


Fig. 7

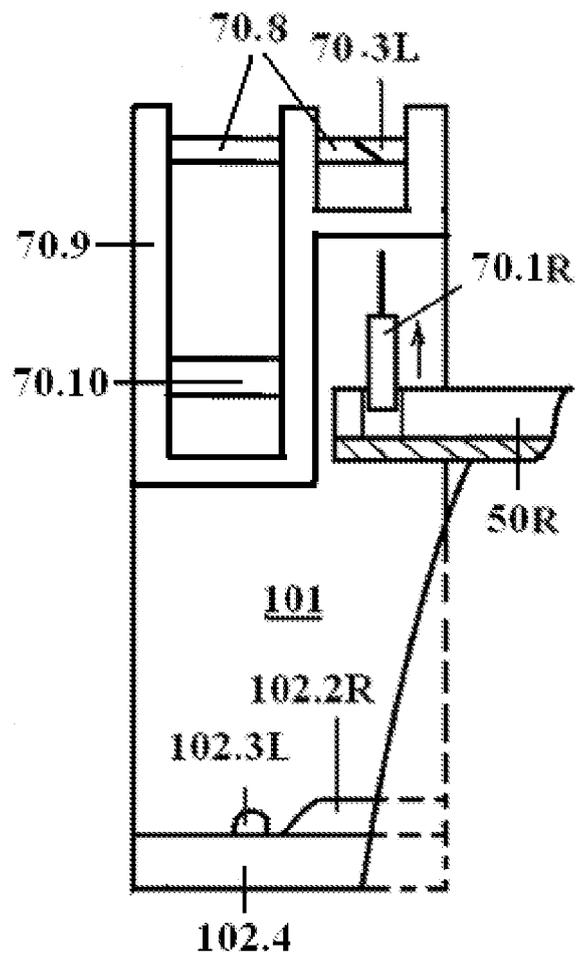


Fig 19

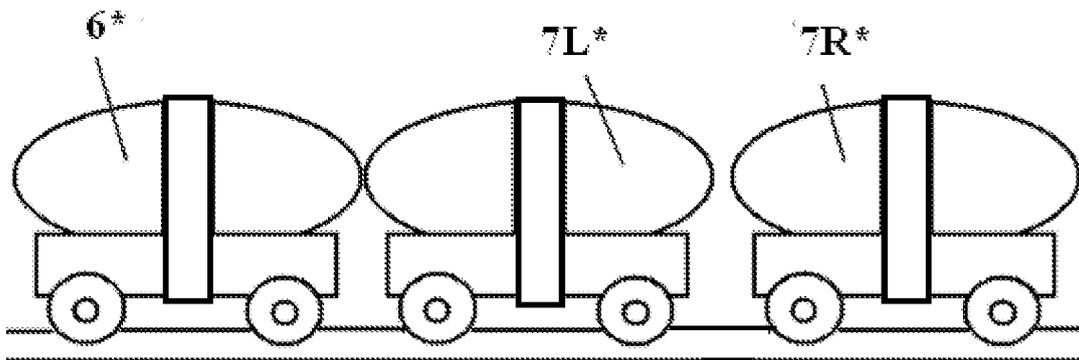


Fig. 8

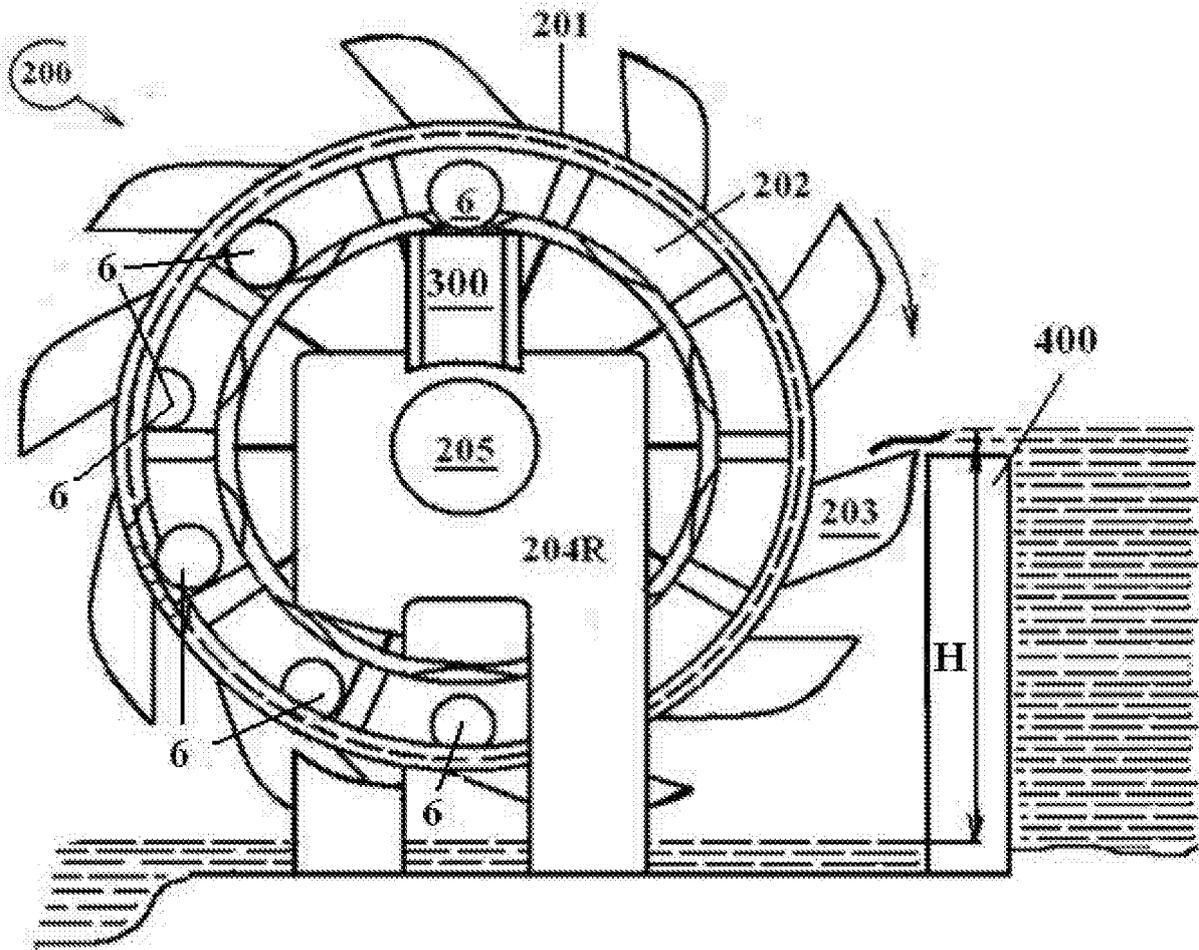


Fig 18

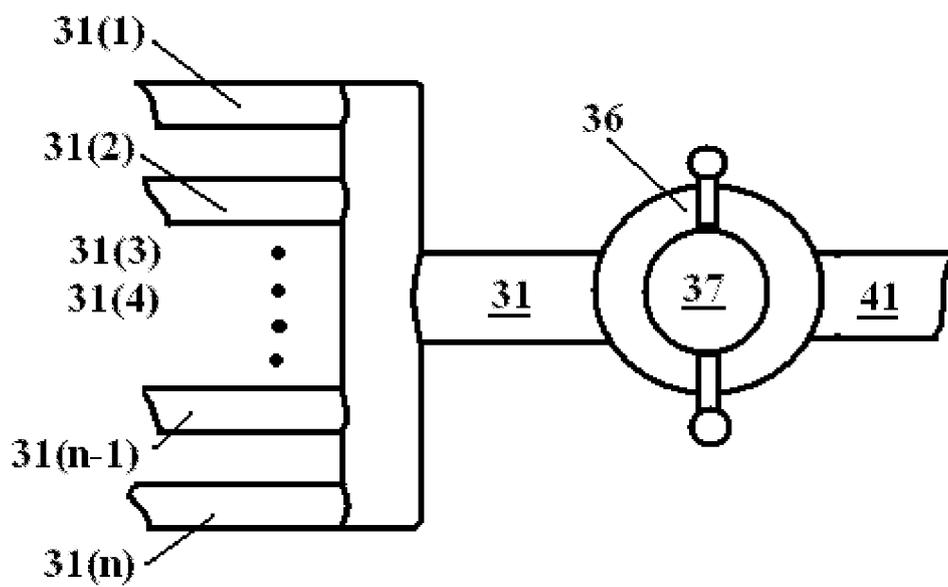


Fig. 9

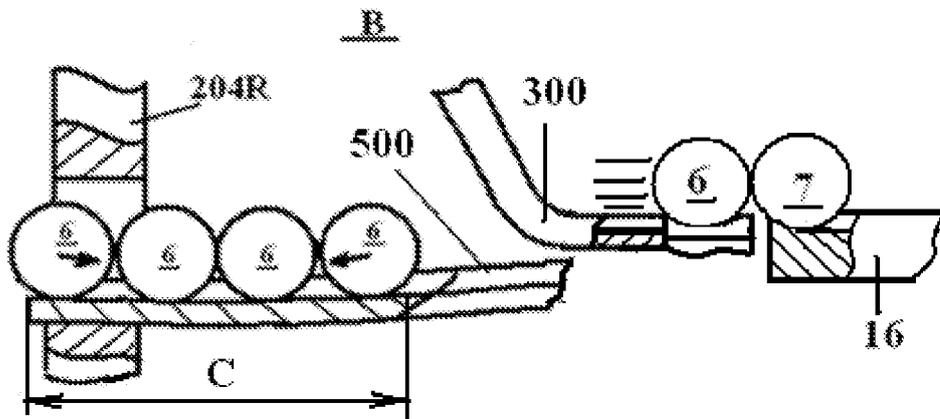
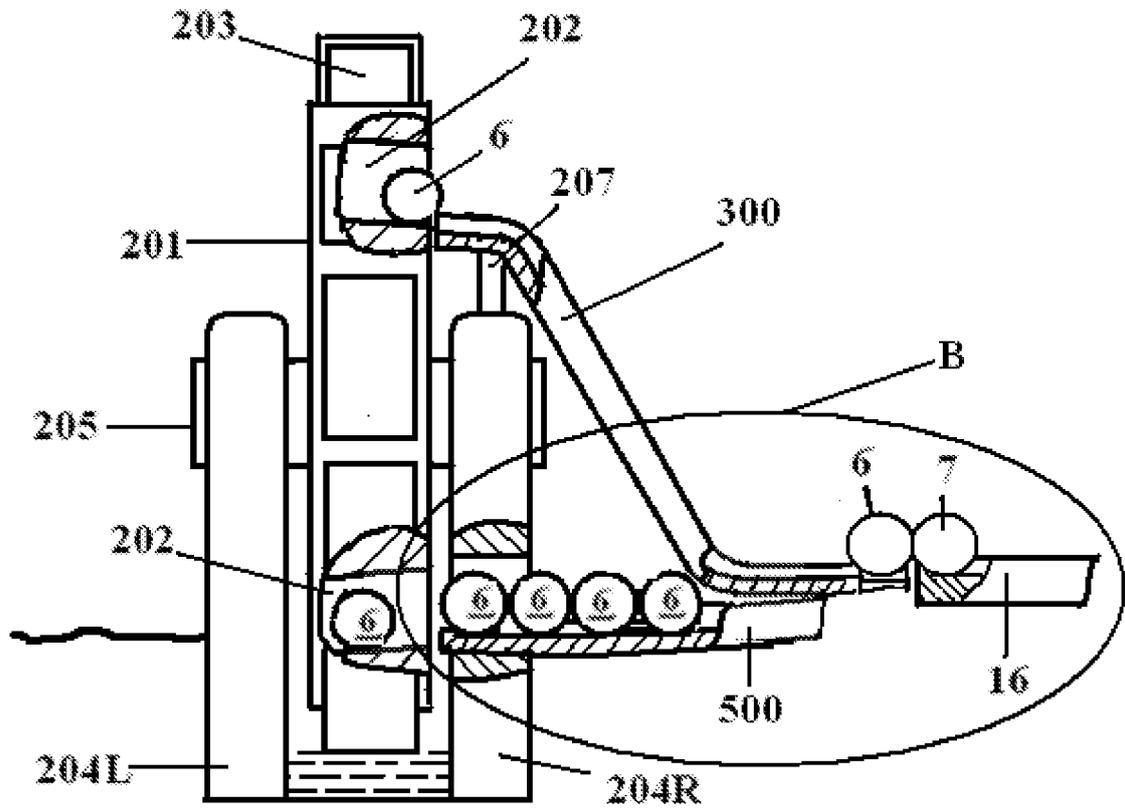


Fig. 12

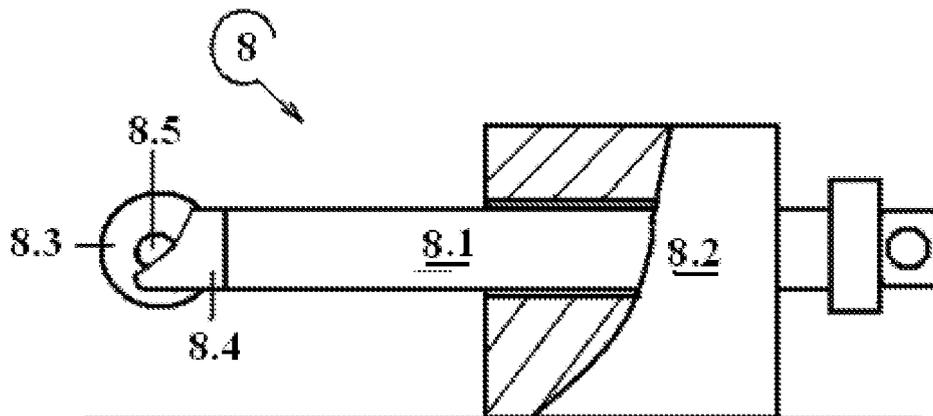


Fig. 10

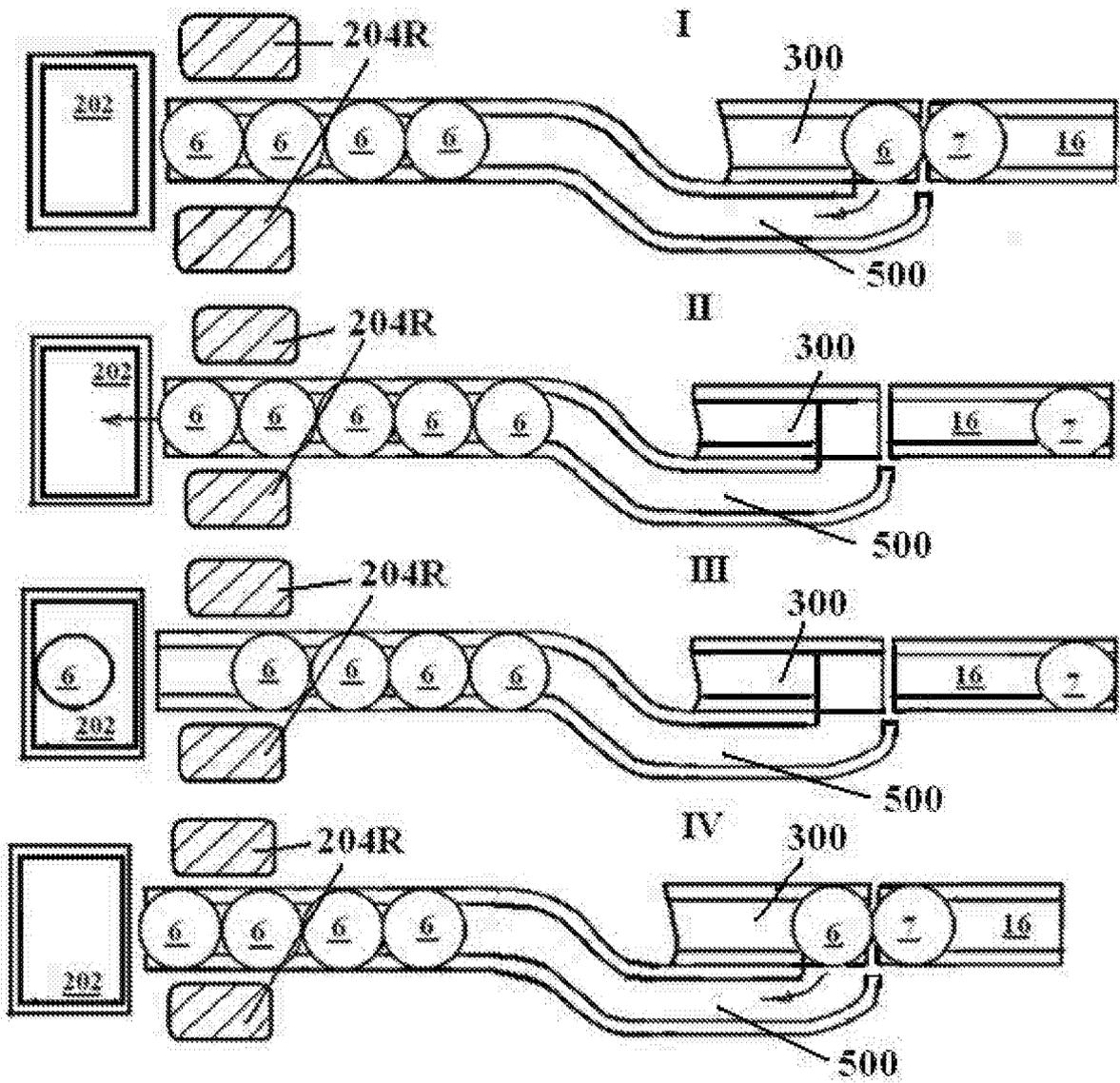


Fig. 15

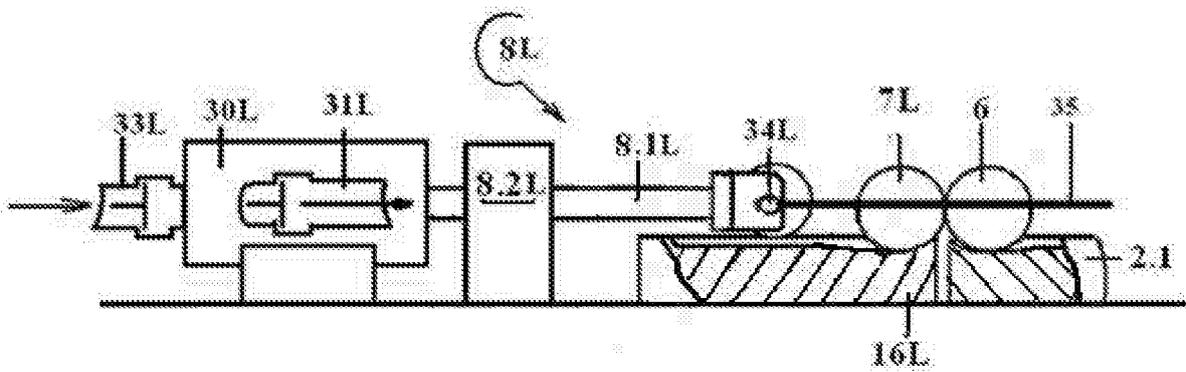


Fig. 11

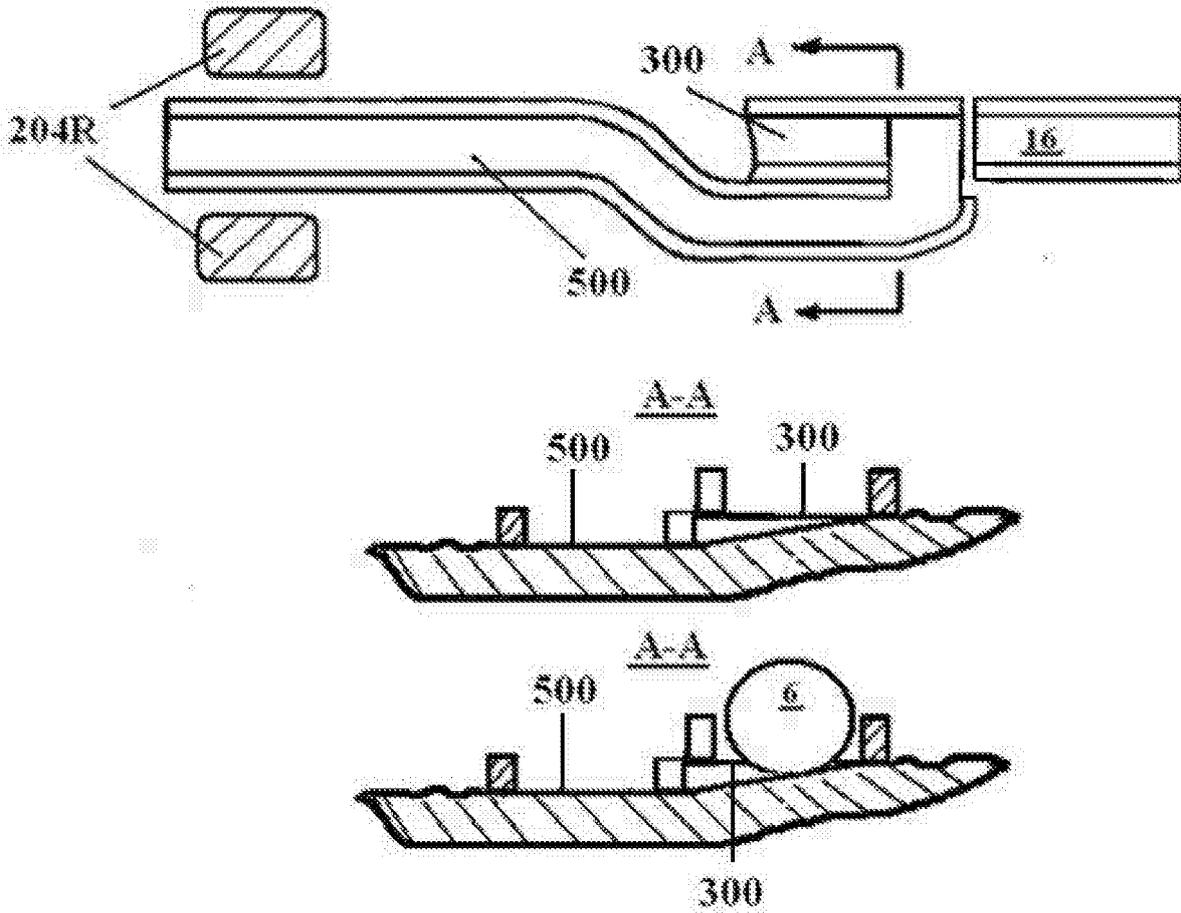


Fig 17

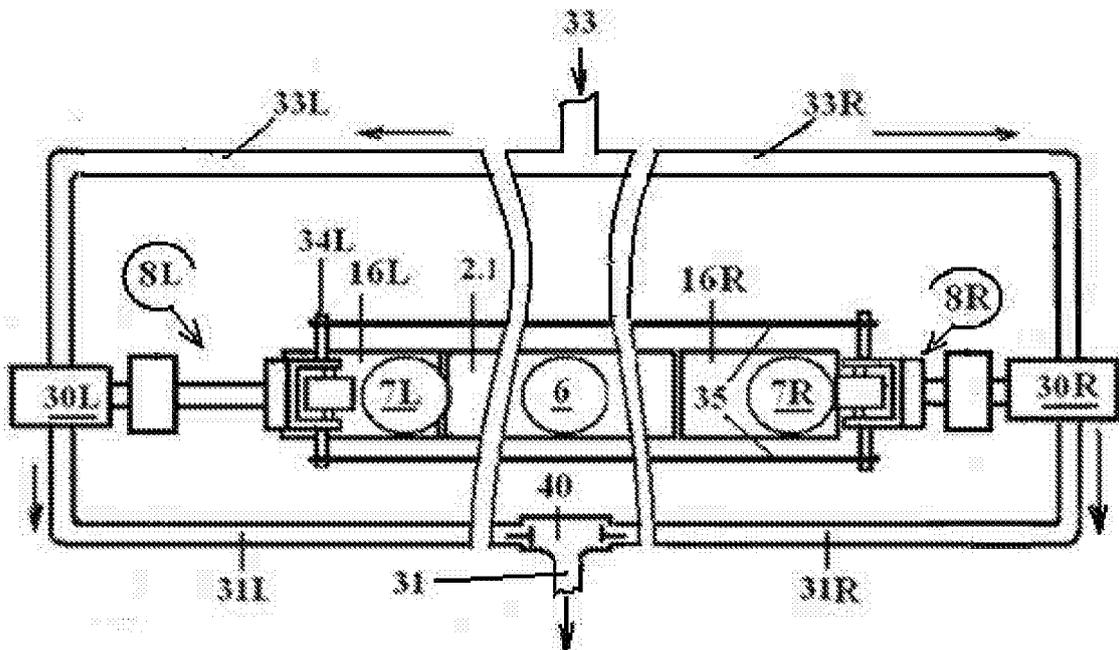


Fig. 13

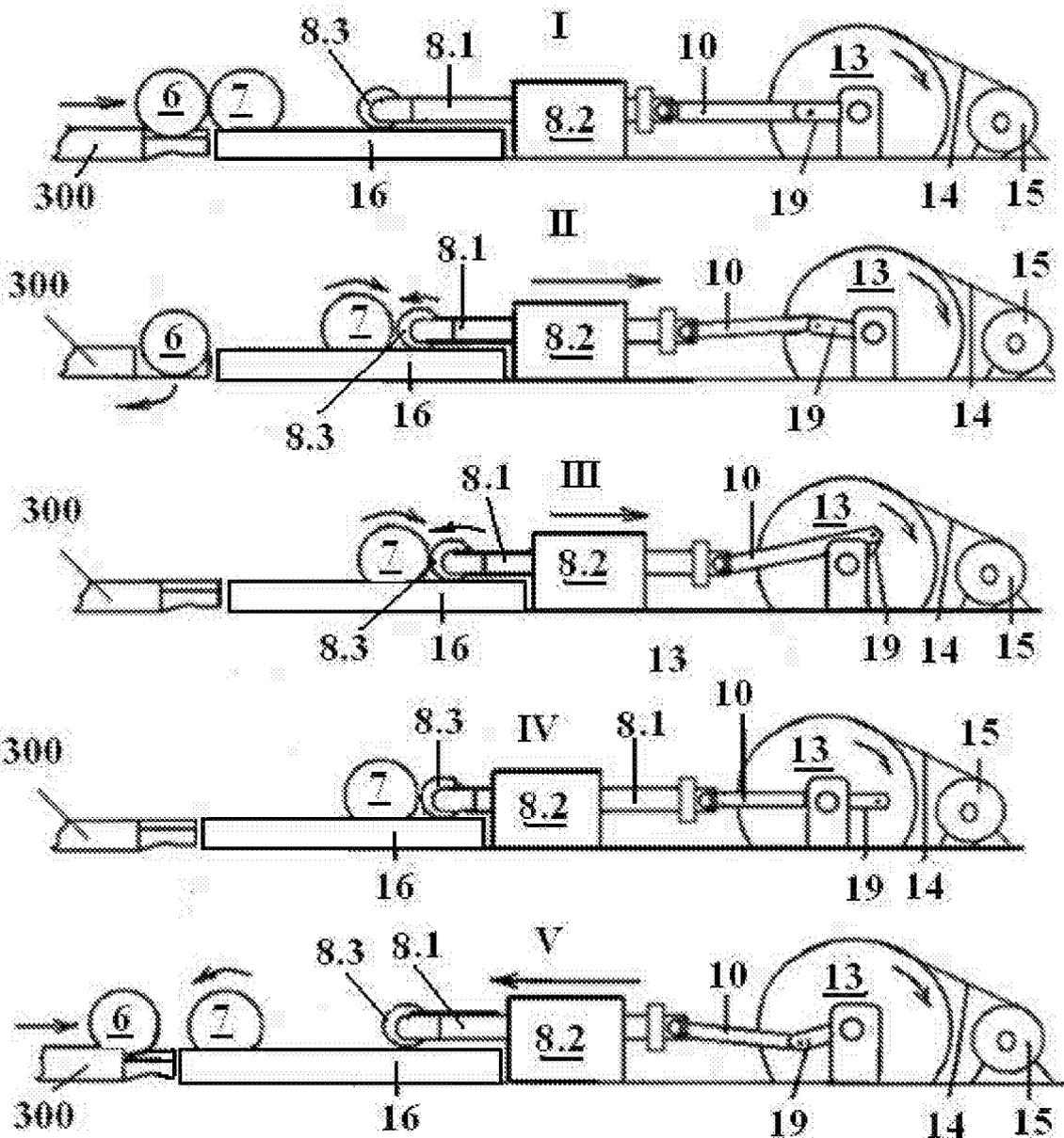


Fig 16

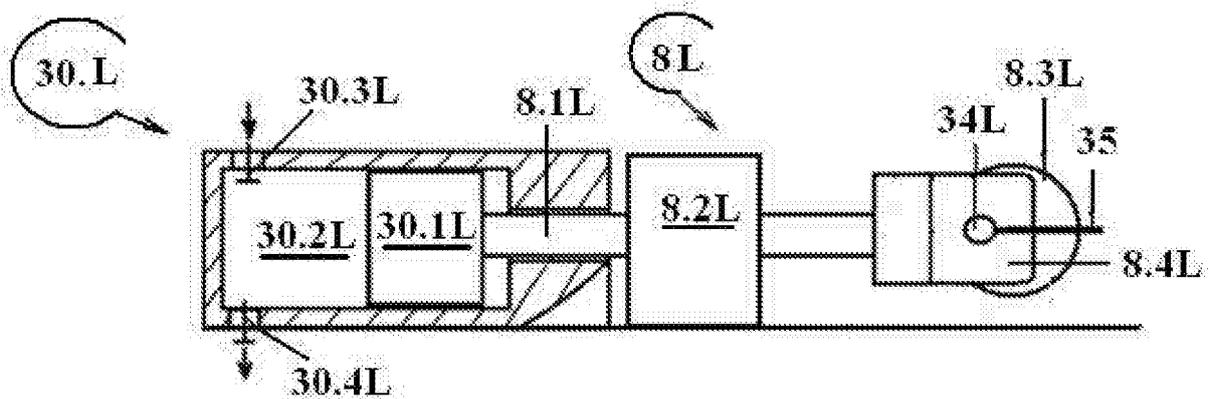


Fig 14

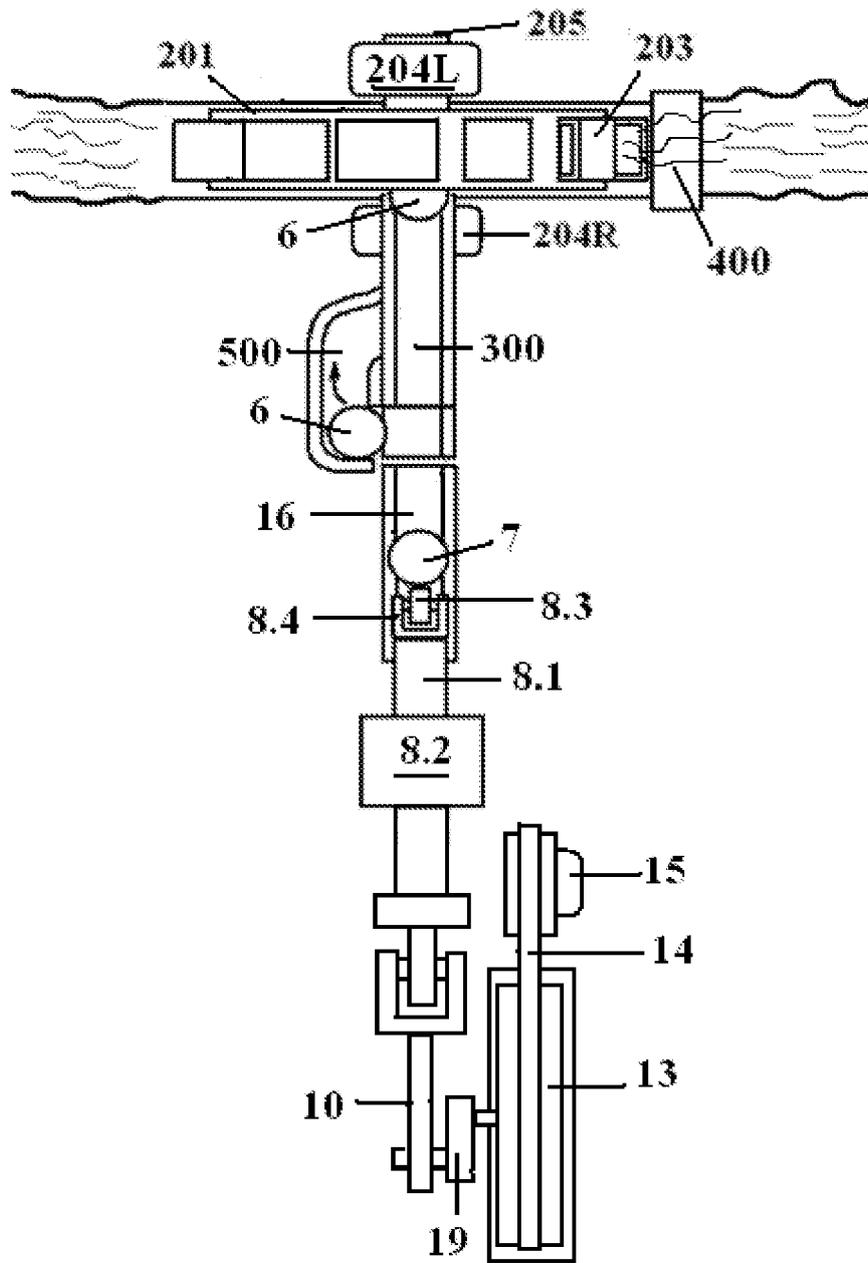
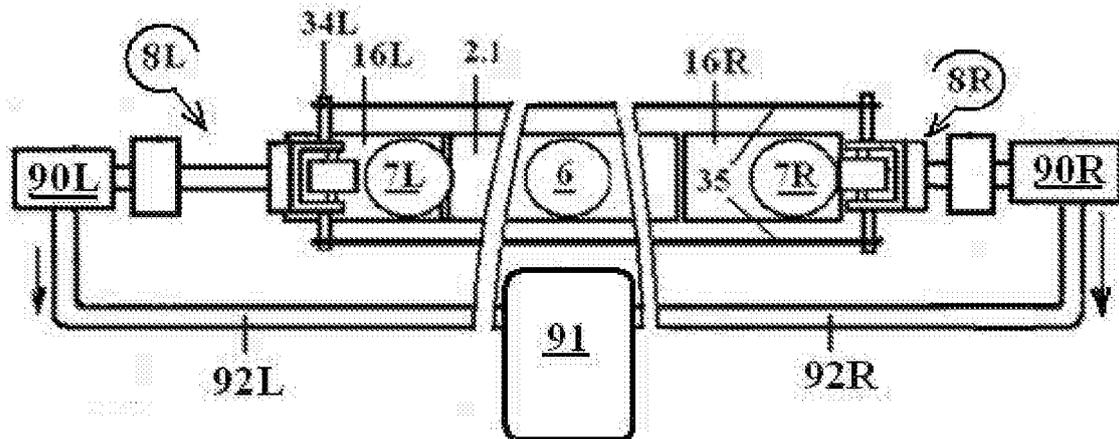


Fig. 20



Rigid Body Dynamics-Based Hydropower Technology

This invention relates to a rigid body dynamics-based hydropower technology. This is a technology for generating useful mechanical or/and electrical energy from gravitational potential energy contained in renewable water resources regardless the height of hydraulic head on the basis of rigid spheres capable of performing elastic collision.

A number of hydropower technologies are known from the state of the art. These technologies are based on rotary mechanical devices, such as water turbines, waterwheels, hydro-electric barrels, Archimedes screws and the like. All conventional hydropower technologies follow the principles of conservation of energy to extract power from a body of water. The potential energy of flowing water is converted into kinetic energy through a drop in height and used for turning the relevant rotary mechanical device and generator to produce electricity.

The conventional hydropower technologies have two main deficiencies. The first is the dependency of their technical efficiency and economic viability on the hydraulic head. The dependency on large hydraulic heads is the cause for neglecting renewable water resources with large rate of water flows and low hydraulic heads. The existence of a huge number of untapped slow-moving water resources around the world, such as small and large rivers, streams and irrigation canals is a stunning testament to the shortcomings of traditional hydropower technologies.

At present the total output of hydropower stations accounts only about 16 percent of global electricity generation. "World Watch Institute (January 2012)". The greatest amount of electrical energy comes from steam turbines coupled to electric generators. These turbines are driven by steam produced in either a fossil-fuel-fired or a nuclear-powered generator.

The second deficiency is the eco damage resulting from their application. Hydropower plants with large hydraulic heads require large reservoirs for their operation. Despite their technological efficiency which provides for reducing the basic production cost of electricity, they cause a verity of ecological and economic damages, such as submersion of extensive areas upstream of the dams and destruction of biologically rich and productive lowland usually comprising valley forests, marshland and grasslands.

There is an urgent need for a novel alternative technology which enables harnessing useful mechanical and electrical energy from all available renewable water resources. This kind of technology is what this invention aims to provide. A hydropower plant based on this technology must be above all capable of producing electricity from any net head greater than zero. It must also be eco friendly, efficient and capable of minimizing unit cost of generated useful mechanical or electrical energy.

The invention solves the set task on the basis of two principles:

- The first is harnessing a renewable water resource on the basis of containing the flowing water by means of containers to be filled at the level of the source and to be emptied out after performing a work at the level of outlet.
- The second principle is using the performed work by a water container for lifting a rigid sphere which is capable of performing elastic collision to a higher level.

A filled container with water contains an amount of gravitational potential energy at the level of water intake proportional to the net head H^* .

H^* = the head (H) – the height of the water container with an intake from the top and outlet from the bottom.

H is the difference in height between the source and the water's outflow of the plant.

Using the contained gravitational potential energy in the contained water for lifting the rigid sphere to a certain height means its transformation to the rigid sphere. The contained gravitational energy in the sphere at this raised level can now be converted into kinetic energy, for instance, by letting the rigid sphere to roll over a slide towards the level from which it was lifted. At the bottom of the slide the stored potential energy in the rigid sphere would be converted into kinetic energy.

Transferring the contained potential energy in the contained water to the rigid sphere and its conversion into kinetic energy comprises the first production phase. The stored kinetic energy in the rigid sphere would be captured and converted into useful mechanical or electrical energy in the second phase of production.

With the help of rigid spheres we can generate useful mechanical and/or electrical energy from renewable water resources having any net head H^* greater than zero. This is possible to realize because the used rigid spheres act in accordance with the laws of rigid-body dynamics. In this way harnessing renewable water resources could

be freed from the use of traditional hydropower technologies along with their precondition of having a sufficient hydraulic head.

The application of the invented technology is presented below on the basis of three different ways for lifting rigid spheres. The first is based on direct lifting by means of a lever, the second is based on elevating on the basis of Archimedes principle and the third is based on lifting by means of a revolving device.

The invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 shows a schematic back view of the first phase of production based on Archimedes' elevating principle,

Figure 2 shows a schematic back view of the first phase of production based on Archimedes' elevating principle, where the energy generating mechanism and the mechanism for regulating water intake and outflow are revealed,

Figure 3 shows a schematic front view of the first phase of production based on Archimedes' elevating principle,

Figure 4 shows a schematic top view of the first phase of production based on Archimedes' elevating principle,

Figure 5 shows a schematic front view of the first phase of production based on direct lifting principle,

Figure 6 shows a schematic top view of the first phase of production based on direct lifting principle,

Figure 7 shows a schematic side view of the first phase of production based on direct lifting principle. For a better view the moving parts are not shown,

Fig. 8 shows a schematic side view of the first phase of production based on revolving lifting principle,

Figure 9 shows a schematic back view of the first phase of production based on revolving lifting principle and an enlarged fragmentary view of the connected track to the slide,

Figure 10 shows a schematic top view of the segment of the connected track to the slide according to the revolving principle showing the locations of the strike spheres after their collision with the targeted sphere,

Figure 11 shows a schematic top view of the tracks and slide based on revolving lifting principle in addition to an enlarged cross-section on the line A-A,

Figure 12 shows a schematic side view of a linear motion mechanism,

Figure 13 shows a schematic side view of the second phase of production,
Figure 14 shows a schematic top view of an integrated plant based on revolving principle according to the invention,
Figure 15 shows a schematic side view of the second phase of production of a plant functioning as water pumping station,
Figure 16 shows a schematic side view of the piston pump used in the water pumping station,
Figure 17 shows a schematic top view of an integrated plant functioning as water pumping station,
Figure 18 shows a schematic top view of a turbine and generator powered by means of (n) blocks comprising a unified plant,
Figure 19 shows a schematic side view of the rigid bodies for substituting the rigid spheres,
Figure 20 shows a schematic top view of an integrated plant functioning as an air-compressing and -storage station.

Figs. 5, 6 and 7 show the first phase of production in the case of using direct lifting principle. According to Figs. 5 water is supplied to the plant from a slow-moving renewable water resource by means of two water channels 5L and 5R. The water is contained in the containers 20.2L and 20.2R.

The plant comprises a number of rigid spheres. We shall refer to the one specified for lifting as the strike sphere 6. The contained gravitational potential energy in the water contained in the container 20.2L or 20.2R depends on the volume of the container and the net head H^* .

The appropriate design for the first phase of production must first of all enable using the contained water for efficient lifting of the rigid sphere 6. All kinds of levers could be adapted for this purpose. The simplest lever in this context is a scale.

The energy generating mechanism 20 constitutes a scale comprising the beam 20.1 which is mounted on the shaft 70.10 and the two water containers 20.2L and 20.2R, which are hanging on the beam 20.1 by means of the relevant hanging elements 20.4L and 20.4R. The beam 20.1 swings about the shaft 70.10 and functions thereby as a lever for the strike sphere 6. The beam's back 21 functions as a track for rolling of the strike sphere 6 from the lifted side to the lowered side.

The energy generating mechanism 20 is supported by means of the structure 100 and the water supply from the channels 5L and 5R to the containers 20.2L and 20.2R is regulated by means of the mechanism for regulating water intake 70.

The structure 100 consists of a tower 101, and a basement for controlling water outflow 102. The basement comprises a platform 102.4, two water barriers 102.2L and 102.2R and two rigid objects 102.3L and 102.3R.

The mechanism for regulating water intake 70 consists of the water gates 70.1L and 70.1R and the gear box 70.9. The latter comprises the chain 70.5, the gear wheel 70.6 which is fixed on the shaft 70.10, the belt 70.2, the drive pulley 70.7 which is fixed on the shaft 70.8, the driven pulley 70.4L which is mounted on the rotating shaft 70.3L, the driven pulley 70.4R which is mounted on the rotating shaft 70.3R.

Each water container 20.2L and 20.2R is equipped with a relevant mechanical valve for emptying the water 20.3L and 20.3R respectively. Each valve comprises a lid to plug the opening at the bottom of the container and pressure springs for adding pressure on the lid.

Only one water gate 70.1L or 70.1R is opened in the state of misbalances of the beam 2.1. In this state only one valve 20.3L or 20.3R is opened. Once the water container 20.2L, for instance, reaches the bottom the lid 20.2L collides with the rigid object 102.1L causing the outflow of its water content. At the same time the water gate 70.1L closes the channel 50L and the water gate 70.1R opens the channel 50R. Let us assume that the strike sphere 6 rests first on the left side of the beam 20.1, then the anti clockwise movement of the beam 20.1 which brought it into this position has caused water gate 70.1L to close and both water gate 70.1R and valve 20.3L to open. This caused in turn lifting the water container 20.2R to the upper position.

Because of the counterweight of the strike sphere 6 the water container 20.2R would remain in this position so long it is not filled with water. In this position the valve 20.3R remains locked.

Once the water container 20.2R was filled with water the left side would be lifted above the right side. In this position the gravitational potential energy of water has already transferred to the strike sphere 6 which starts to roll immediately along the track on the back of the beam 2.1 towards the right edge. While doing so the strike sphere 6 starts converting its stored potential energy into kinetic energy. When it reaches the edge of the right side, the whole contained potential energy is already converted into kinetic energy.

As indicated earlier in the second phase of production of the plant the stored kinetic energy in the strike sphere 6 would be captured and converted into useful mechanical or electrical energy. In order to enable capturing the stored kinetic energy in the strike sphere 6 in the second phase of production the targeted spheres 7L and 7R and the tracks 16L and 16R were provided. (See Fig. 6)

The targeted sphere 7L is exactly similar to the strike sphere 6 in terms of dimension and weight. The same applies to the targeted sphere 7R. All three spheres are made from materials which guarantee perfectly elastic collisions. As is known a perfectly elastic collision is one in which the kinetic energy of the system is conserved before and after collision.

At the moment when the strike sphere 6 reaches the right edge of the beam 2.1 it hits the targeted sphere 7R right in the centre. Since the collision is perfectly elastic and occurs in an isolated system, then both momentum and kinetic energy are conserved. Both spheres 6 and 7R transfer their momentum to the other and bounce off with the exact momentum as the other body prior to the collision. In this case the targeted sphere 7R receives the momentum of the strike sphere 6 and starts to roll rightwards along the track 16R. In this way the contained kinetic energy in the sphere 6 could be captured.

The strike sphere 6 would remain at rest at the right edge of the beam 20.1 until enough water has flown into the water container 2.2L. In this way the strike sphere 6 performs a *reciprocal* (back-and-forth) motion along the two edges of the beam 20.1. The production cycle could simply be repeated by discharging the contained water in the container 20.2L or 20.2R after performing a work when reaching the bottom and the refilling after being elevated to the top.

The rigid spheres 6, 7L and 7R could be substituted by means of rigid bodies capable of performing elastic collision. According to Fig. 19 the rigid bodies 6*, 7L* and 7R* could be loaded on carriages rolling on rails. The relevant slides, tracks and the backs of the beams must be equipped with rails.

The sphere 6 on one side of the scale could be lifted directly by means of filling a water container placed on the other side or by means of filling a chamber beneath the sphere's side of the beam having a floating body for lifting the sphere, which functions on the basis of Archimedes lifting.

According to Figs 1, 2, 3, 4 the first production phase of the plant which is based on Archimedes' elevating principle consists of a structure 1, energy generating mechanism 2, a strike sphere 6 and a mechanism for regulating water intake and outflow 4.

The structure 1 comprises two chambers 1.3L and 1.3R and a supporting wall 1.1. The structure 1 could be built in such away as to impounds the water of a tiny slow-moving river or a flow derivative. The water could also be brought to structure 1 by means of two pipes or channels.

The energy generating mechanism 2 comprises a beam 2.1 and two floating bodies 2.2L and 2.2R. The beam 2.1 is mounted on the shaft 4.13 and rests on the floating bodies 2.2L and 2.2R. The floating body 2.2L is located in chamber 1.3L and the floating body 2.2R in chamber 1.3R.

The mechanism for regulating water intake and outflow 4 regulates water movement into and out of the chambers 1.3L and 1.3R. It consists of the water gates 4.2LU, 4.2RU, 4.2LD and 4.2RD, the drive pulleys 4.1RD and 4.1RU, the driven pulleys 4.1LU, 4.1LD, and the belts 4.3U and 4.3U and the gear box 4.1. The latter comprises the gears 4.4, 4.5, 4.6 and 4.7, the chain 4.8, the shafts 4.9, 4.10, 4.11, 4.12 and 4.13.

The water gates 4.2LU and 4.2RU regulate water intake into the relevant chambers 1.3L and 1.3 R, and the water gates 4.2LD and 4.2RD regulate water discharge of the said chambers. When water flows into one chamber, for instance 1.3L it flows at the same time out of the second chamber 1.3R, so as to make the floating bodies 2.2L and 2.2R float respectively.

The floating body 2.2L or 2.2R starts exerting buoyant force on the side of the beam 2.1 where the sphere 6 is resting in accordance with Archimedes' principle. The floating body 2.2L for instance starts exerting a buoyant force on the left side of the beam 2.1 when the water starts flowing into chamber 1.3L and out of chamber 1.3R.

When the floating body 2.2L or 2.2R is released under water the gravitational force would act on it and push it upwards towards the surface of water, causing, thereby lifting the left or the right side of the beam 2.1. The extra force that pushes it upwards comes from Archimedes force. According to Archimedes' principle the upward buoyant force that is exerts on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces.

The amount of contained potential energy in the contained water in the chamber 1.3 which could be transferred to the strike sphere 6 depends on the mass of the displaced water by the floating body 2.2 and the net head H^* . The immersed volume of the floating body 2.2 must displace a mass of water greater than the weight of the sphere 6 so as to enable pushing it upwards.

The energy generating mechanism 2 enables transferring the stored potential energy in contained water to the strike sphere 6 and the conversion of the transferred potential energy into kinematic energy.

Let us assume that the strike sphere 6 rests first on the left side of the beam 2.1, then the anti clockwise movement of the beam 2.1 which brought it into this position causes water gate 4.2LD to close and water gate 4.2LU to open. As a result the water starts to flow into chamber 1.3L and out of chamber 1.3R.

Because of the counterweight of the strike sphere 6, the floating body 2.2L would remain at the bottom until enough water has flown into the chamber 1.3L so as to enable it to immerse in water and release, thereby, the required buoyant force for lifting the left side of the beam 2.1 together with the strike sphere 6.

Once the left side is lifted above the right side the gravitational potential energy of water has already transferred to the strike sphere 6 which starts to roll immediately along the track on the back of the beam 2.1 towards the right edge. While doing so the strike sphere 6 starts converting its stored potential energy into kinetic energy and after colliding with the targeted sphere 7R it loses its energy and remained at rest on the right edge of the beam 2.1.

In the second phase of production the contained kinetic energy in the spheres 7L and 7R must be converted into useful mechanical or electrical energy. There are varieties of options for the fulfillment of this task. In the following we shall first demonstrate how the captured kinetic energy contained in the targeted spheres 7L and 7R could be converted into useful electrical energy by means of a water turbine and a generator.

One should note that although the generation of electrical energy is the main goal, the useful mechanical energy could also be put into more direct use. A plants based on the invented technology could be used for operating a hummer, cutting wood, pumping water and grinding grains.

According to Fig. 17 the first phase of production according to the plants based on direct lifting and on Archimedes' elevating principle must be complemented by adding

two similar units of the second phase one unit on the left side and one on the right side. In both units the kinetic energy stored in the sphere 6 would be captured and converted it into useful mechanical or electrical energy.

Let assume that the plant which is based on direct lifting is required either for water pumping or electricity generating, while the plant which is based on Archimedes' elevating principle is required for air compressing.

The second phase of production of a plant for water pumping comprises the targeted spheres 7L and 7R, the tracks 16L and 16R, the linear motion mechanisms 8L and 8R, the piston pumps 30L and 30R, the suction pipes 33, 33L and 33R, the penstock pipes 31L, 31R and 31, the Junction 40 and the two wire ropes 35.

According to Fig. 16 the piston pump 30L is made up of a piston 30.1L, a body with a chamber 30.2L, a suction valve 30.3L and a discharge valve 30.4L. The piston 30.1L is fixed directly on the linear motion shaft 8.1L. The piston pump 30R comprises similar components and its piston 30.1R is also fixed directly on the linear motion shaft 8.1R.

According to Fig. 17 both pumps utilize suction to draw in water for compression from the water supplying source by means of the pipe 33 then by means of the relevant pipe 33L or 33R.

After the collision with the strike sphere 6 the targeted sphere 7L or 7R rolls and collides with the linear motion shaft 8.1L or 8.1R which is situated very close as shown in fig. 15. The piston 30.1L or 30.1R compresses the water in the chamber 30.2L or 30.2R and sent the compressed water through the open discharge valve 30.4L or 30.4R.

According to Fig. 17 the discharged water by the piston pump 30L or 30R flows by means of the penstock pipe 31L or 31R. The two pipes are joined together at the Junction 40. The latter ensures that the pressurized water flow further through the penstock pipe 31 to the end user.

In order to enable drawing back the pistons 30.1L and 30.1R both linear motion shafts 8.1L and 8.1R are connected together by means of two wire ropes 35. As shown in Figs. 15 and 16 the wire ropes 35 are connected to the relevant holders 34L and 34R. When the piston 30.1L or 30.1R draws back it opens the suction valve 30.3L or 30.3R and closes the discharge valve 30.4L or 30.4R, thereby utilizing suction to draw in additional water for compression.

When the piston 30.1L or 30.1R draws back it pushes the targeted sphere 7L or 7R towards the beginning of the track 16L or 16R so as to enable the next encounter with the sphere 6. As shown in Fig. 15 a slight slope is arranged at the beginning of the tracks 16L and 16R so that the spheres 7L or 7R rest at the edge of the relevant track before the collision with the sphere 6 takes place.

The flowing pressurized water through the penstock pipe 31 could be used for generating electricity for one single block or for n blocks. According to Fig. 18 the flowing pressurized water through the penstock pipes 31(1) – 31(n) of n blocks of the plant flow further jointly through the penstock 31* creating a jet of moving water to rotate the water turbine 37. The water is discharged through the draft pipe 41. The turbine 37 in turn rotates the shaft of the generator 36 which is attached to its centre. The generator coil rotates and produces electricity.

It is worthwhile mentioning the fact that the decision on the capacity and specification of the water turbine 37 are not dictated by the required head but on the bases of the capacity of generating pressurized water.

The air-compressing and -storage station share a number of components with the pumping station. Let us assume for the sake of simplicity that piston air pumps are used with a relevant piston fixed directly on the linear motion shaft 8.1L or 8.1L.

According to Fig. 20 a plant functioning as an air-pumping and -storage station have the following specific components: two air pumps 90L and 90R, two pipes 92L and 92R and a pressurized air tank 91.

As indicated earlier a revolving lifting principle could be adopted so as to provide for the continuity of production. A wheel with slots for accommodating the spheres and water containers could be used for a continuous lifting of the spheres. We will refer to such a wheel as spheres' lifting wheel.

According to Figs. 8 and 9 the first phase of production of the plant based on revolving equipment consists of a spheres' lifting wheel complex 200, a slide 300, a track 500, n spheres 6 and a weir 400.

The spheres' lifting wheel complex 200 consists of the wheel 201, two load-bearing structures 204L and 204R and a slide supporting structure 207. The wheel 201 is mounted on the shaft 205 and comprises the water containers 203 and the slots 204. The water containers 203 are designed in such a way as to ensure containing the

required amount of water for clockwise turning of the wheel 201 together with the accommodated spheres 6 on the opposite side.

The weir 400 is built across a slow-moving water source in order to create the necessary hydraulic head H . The water flows over the weir directly into the water containers 203. The water containers 203 discharge their contain water completely while reaching the bottom.

Each sphere 6 moves continuously during the first phase of production from the slide 300 to the track 500, then enters one of the slots 204 of the wheel 201 to be lifted to the level of the slide 300 where it starts rolling down again.

When the strike sphere 6 reaches the top of the slide 300 it has already acquired a potential energy. At the bottom of the slide 300, where it strikes the targeted sphere 7 rights in the center the whole acquired potential energy is already converted into kinetic energy and transmitted to the targeted sphere 7.

According to Figs 9 and 11 the slide 300 is connected at the end to the track 500. This connection comprises a slight slope. According to fig. 10 (I) after the encounter with the targeted sphere 7 the strike sphere 6 cannot remain at rest at the edge of the slide 300 because of the slight slope which descends towards the track 500. That is why the strike sphere 6 rolls into the track 500 and keeps rolling towards the area C.

According to Fig. 9 the track 500 within the area C descends first from the right then rises slightly towards the end. In this way it enables 4 strike spheres 6 to remain at rest within this area.

According to Fig. 10 (II) the strike sphere 6 strikes the first strike sphere 6 in the series resting within the area C and comes to nearly a dead stop. According to Fig. 10 (III), the strike sphere 6 on the opposite side acquires most of the energy and momentum that was in the rolling strike sphere 6 causing it to be pushed into the slot 204.

As shown in Fig. 10 (IV) under the effect of the force of gravity the four remaining strike spheres 6 would roll towards the wheel 201 and rest within the area C.

The whole complex wheel 200 could be designed in such a way as to ensure a perfect timing for the turning of the wheel 201 and entering the strike spheres 6 into the slots 204.

The slots 204 are closed from one side and provide access for the spheres 6 from the open side. The wheel 201 is designed in such a way as to keep the sphere 6 on

the closed side of the accommodating slot 204 as long as it is at the bottom. When it reaches the top it causes the sphere 6 to roll towards the open side of the slot 204 and continues rolling over the slide 300.

As indicated earlier the generated kinetic energy in the first phase of production has to be captured and converted into useful mechanical or electrical energy in the second phase. In order to enable capturing this kinetic energy the sphere 7 and the track 16 were provided in the second phase of production. In the following we shall first demonstrate how the captured kinetic energy contained in the targeted sphere 7 could be converted into useful electrical energy by means of mechanical equipment.

According to Fig. 13 the required mechanical equipment for the second phase of production for converting the captured kinetic energy contained in the spheres 6 comprise a linear motion mechanism 8, a connecting rod 10, a crankshaft 19, a flywheel 13, a belt 14 and an electric generator 15.

According to Fig. 12 the linear motion mechanism 8 comprises a linear motion shaft 8.1 and a guiding cylinder 8.2. In order to enable a smooth encounter between the rolling targeted sphere 7 and the linear motion shaft 8.1 a ball bearing 8.3 was used. The latter is mounted on the shaft 8.5 which is fixed on the supporting element 8.4. The latter is fixed on the linear motion shaft 8.1.

In order to enable converting the kinetic energy into useful mechanical or electrical energy the encounter of the rolling targeted sphere 7 with the linear motion shaft 8.1 must take place while the latter is in the position of pushing the flywheel 13. In this position the targeted sphere 7 could push the flywheel 13 by means of the linear motion shaft 8.1. That is why the encounter between the spheres 6 and 7 must take place when the linear motion shaft 8.1 reaches the end of its motion from right to left as is shown in Fig. 11(I).

According to Fig. 11(II) the sphere 7 catches up the linear motion shaft 8.1 while the crankshaft 10 is in the position of pushing the flywheel 13. The targeted sphere 7 starts pushing the crankshaft 10 and continues to do so until the linear motion shaft 8.1 reaches the end of its own rightwards motion as shown in Fig. 11(III). While the targeted sphere 7 pushes the crankshaft 10 by means the linear motion shaft 8.1 the flywheel 13 would be turned.

According to Fig. 11(IV) the sphere 7 comes to a still stand when the linear motion shaft 8.1 reaches the end of the rightwards movement. Once it starts moving leftwards under the impact of the released stored energy by the flywheel 13 it starts

pushing the targeted sphere 7 toward the beginning of the track 16 as shown in Fig. 11(V). The sphere 7 reaches the beginning of the track 16 before the next strike sphere 6 reaches the bottom of the slide 300 and collides with it. In this way the continuity of the generation of useful mechanical or electrical energy could be guaranteed.

The role of the targeted sphere 7 resembles that of high steam pressure in the steam engine heated by combustion in an external source. The steam escapes the boiler then enters the engine at high pressure and expands through pistons performing thereby a mechanical work.

The flywheel 13 releases stored energy by applying torque to the electric generator 15 by means of the belt 14. The generator 15 converts supplied mechanical energy into electrical energy.

Fig. 14 shows a schematic top view of the integrated plant based on revolving principle according to the invention. The two phases of production are interlinked by means of the encounter of the strike sphere 6 with the targeted sphere 7.

The output capacity of a plant based on rigid body dynamics-based hydropower technology is decided by means of the weight of the strike sphere (s) 6. The output capacity of a plant performing reciprocal motion, for instance, is decided by means of the weight of the strike sphere 6. The output capacity could be doubled by means of doubling the weight of the sphere 6 while keeping a constant net head H^* . Doubling the weight of the sphere 6 requires however doubling the volume of the contained water per cycle and hence doubling the volume of water intake in general. The same applies to the weight of the spheres and volume of contained water in the case of the plant based on revolving equipment.

The maximum capacity of the plant depends only on the rate of outflow of the renewable water source. In order to avoid exceeding physical limits of the structure, the plant could be divided into smaller blocks. For instance instead of lifting one single sphere of 30 tons so as to enable matching a contained water of 30 cubic meters per cycle, three neighboring production blocks could be constructed each capable of lifting a sphere of 10 tons per cycle.

A plant on the basis of rigid body dynamics-based hydropower technology is the ideal alternative to conventional hydropower plants with large hydraulic heads as well. A conventional hydropower station, for instance, with 50 meters head could be

substituted by means of a plant on the basis of rigid body dynamics-based hydropower technology consisting of 12 rows of neighboring blocks each having a head of 4 meters. Such a plant is capable of producing the same amount of electricity as a conventional hydropower station without causing any ecological damage.

This invented novel technology works automatically and requires extremely low investment. This could be seen from the simple component of the first phase, such as a beam, a sphere and the like. The use of turbine in the second phase of production is quite simple and does not require huge reservoirs to be created by means of high dams.

There are a large number of existing dams worldwide which were built for other purposes than hydropower stations. These dams whatever their hydraulic heights might be, they could be used for building plants based on the invented technology because of their capability of generating useful mechanical or electrical energy regardless the heights of the hydraulic heads.

Plants based on the invented technology may be connected to conventional electrical distribution networks as a source of low-cost renewable energy. Because of their independence upon any kind of industrial supply and existing infrastructure they may be built in isolated areas to develop new economic centers. An interesting example in this respect is the rain forest. Building this kind of plants in rain forests might provide for much more rewarding economic opportunities than those resulting from their destruction.

The construction of plants based on the invented technology should substantially increase the share of global electricity generated on the basis of renewable resources and strongly reduce pollutants which contribute to both air pollution and global climate change.

Claims

- 1- Rigid body dynamics-based hydropower technology applied in a plant, having a weir 400, a spheres' lifting wheel complex 200 comprising: a wheel 201, two Load-bearing structures 204L and 204R and a supporter 207; a slide 300, a track 500, n strike spheres 6, one targeted sphere 7, a track 16, a linear motion mechanism 8, a connecting rod 10, a crankshaft 19, a flywheel 13, a belt 14 and an electric generator 15, *wherein* the wheel 201 is mounted on the shaft 205 and comprises the slots 202 and the water containers 203, the slide 300 is supported by means of the supporter 207 and connected to a track 500, the linear motion mechanism 8 comprises a linear motion shaft 8.1, a guiding cylinder 8.2, a ball bearing 8.3 and joined from the linear motion shaft 8.1 to the connecting rod 10,
- 2- Rigid body dynamics-based hydropower technology according to claim 1 applied in a plant (pumping station) having two water channels 5L and 5R, a structure 100 consisting of a tower 101, and a basement for controlling water outflow 102 comprising a platform 102.4, two water barriers 102.2L and 102.2R and two rigid objects 102.3L and 102.3R, an energy generating mechanism 20 comprising a beam 20.1 and two water containers 20.2L and 20.2R, which are hanging on the beam 20.1 by means of the relevant hanging elements 20.4L and 20.4R, a mechanism for regulating water intake 70 and a sphere 6 or a rigid body 6*, two targeted spheres 7L and 7R or two targeted rigid bodies 7R* and 7R*, two tracks 16L and 16R, two linear motion mechanisms 8L and 8R, two piston pumps 30L and 30R, suction pipes 33, 33L and 33R, penstock pipes 31L, 31R and 31, a Junction 40 and two wire ropes 35, *wherein* the piston 30L is fixed directly on the linear motion shaft 8.1L and 30R and the two wire ropes 35 connecting the linear motion shafts 8.1L and 8.1R.
- 3- Rigid body dynamics-based hydropower technology according to claims 1 and 2 applied in a plant generating electrical energy having hydro generating equipment comprising one penstock pipe 31 or n penstock pipes 31(1) – 31(n), the draft pipe 41, the water turbine 37 and the generator 36.
- 4- Rigid body dynamics-based hydropower technology according to claims 1 and 2, applied in a plant (for supplying high-pressure clean air) having a structure 1 comprising two chambers 1.3L and 1.3R and a supporting wall 1.1, an energy

generating mechanism 2 comprising a beam 2.1 and two floating bodies 2.2L and 2.2R, a mechanism for regulating water intake and outflow 4, two air pumps 90L and 90R, two pipes 92L and 92R and a pressurized air tank 91.



Application No: GB1400450.1

Examiner: Mr Peter Middleton

Claims searched: 1-4

Date of search: 9 May 2014

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	1-4	GB2484324 A (MANSOOR) see abstract and figures: example of energy generation using impact of balls
A	1-4	US4599857 A (KIM) see abstract and figures: example of water powered rocking beam

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

F03B; F03C; F03G

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTE

International Classification:

Subclass	Subgroup	Valid From
F03B	0017/02	01/01/2006