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(54) Title: BUMPER CRANE SUBSTRUCTURE UNIT

(57) Abstract: A bumper crane substructure unit comprising a crane buffer mounted on the rail axis and interconnected with a moveable crane construction and a kinetic energy absorption rotor arrangement fixed to a building wall on the line of the travel of the crane buffer, in which kinetic energy of progressive movement is transformed into kinetic energy of rotational movement, wherein the arrangement comprises a moveable beater element cooperating with racks interengaged with toothed wheels driving the kinetic energy rotor accumulators of a given moment of inertia, characterized in that at least two racks (2) of the kinetic energy absorption rotor arrangement (1) cooperating with the beater element (10) interengages with toothed wheels (3, 3a, 3b, 3c) of the kinetic energy rotor accumulators (4, 5, 6) of differentiated capabilities of energy accumulation, wherein between the beater element (10) and racks (2) interengaged with toothed wheels (3, 3a, 3b, 3c) of kinetic energy rotor accumulators (4, 5, 6) differentiated gaps (7, 8, 9) are defined providing differentiated idle stroke of the beater element (10) relative to the racks.



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BUMPER CRANE SUBSTRUCTURE UNIT

The present invention relates to a bumper crane substructure unit decreasing impact loads of crane elements and building walls.

The bumper unit known from patent application KR100784618 comprises elements absorbing impact energy that operate in case of reaching movement limit by the crane. The basic stoppage devices in this known solution are bumpers made out of energy absorbing materials that are located in the upper part and buffer elements attached to the rails in the vicinity of its ends.

Each of the buffer elements comprises a stabilizing-attaching arrangement and an impact energy absorbing arrangement featuring adjustable friction force.

- 10 From international patent application W02004028864 a device is known for absorbing energy, in which kinetic energy is converted into kinetic energy of rotating masses. In this known solution an element absorbing energy is connected with two toothed bars which by medium of toothed wheels drive kinetic energy rotor accumulators in forms of rods with moveable weights slidably mounted on the rods.
- 15 An appropriate progressiveness of energy absorption is obtained in this known solution by employment of the moveable weights located as close to the rotation axis of the rotor with the rods as possible in order that a moment of inertia of the rotor in the initial phase of energy absorption be as small as possible. In further movement phase while the rotor starts to rotate, the weights start to translocate under influence
- 20 of centrifugal force and move away from the rotation axis along the rod axis, until they reach the rod end limiters and in such weight positions the biggest moment of inertia of rotor is achieved that enables for absorption of increased kinetic energy.

- International application WO2005121593 discloses a device for absorbing energy comprising a beater element cooperating with an energy dissipation arrangement comprising a toothed bar inducing rotation of rotating masses, thus causing a
- 25 conversion of progressive movement kinetic energy resulted from an impact into kinetic energy of a rotational movement. In one of disclosed embodiments of this known solution, the toothed bar drives a rotor by means of a toothed wheel, wherein the rotor cooperates with a moveable weights. In order to provide a progressive
- 30 change of a moment of inertia of the rotor during a process of energy absorption, the

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moveable weights are maintained in appropriate distance from a rotation axis by means of springs.

German patent application DE3141024 discloses a device for generation of energy by using vibrations of other devices. In this known solution vibrations are converted
5 into kinetic energy of a rotational movement. Torque generated in this manner is transferred by medium of toothed gear, with employment of fly-wheels, and also by hydraulic arrangements in order to be used for driving other electrical or mechanical devices.

Such known solutions do not provide an efficient absorption of energy at different,
10 difficult to predict velocities of a collision of a crane into a wall. Therefore the object of the present invention is to provide higher efficiency of absorption and dissipation of different random amount of energy of a crane collision.

A bumper crane substructure unit according to the present invention comprises a crane buffer mounted on the rail axis and interconnected with a moveable crane
15 construction and a kinetic energy absorption rotor arrangement fixed to a building wall on the line of the travel of the crane buffer, in which kinetic energy of progressive movement is transformed into kinetic energy of rotational movement. The kinetic energy absorption arrangement comprises a moveable beater element cooperating with racks interengaged with toothed wheels driving the kinetic energy
20 rotor accumulators of a given moment of inertia. The solution according to the present invention is characterized in that at least two racks of the kinetic energy absorption rotor arrangement cooperating with the beater element interengages with toothed wheels of the kinetic energy rotor accumulators of differentiated capabilities of energy accumulation, wherein between the beater element and racks
25 interengaged with toothed wheels of kinetic energy rotor accumulators differentiated gaps are defined providing differentiated idle stroke of the beater element relative to the racks.

The kinetic energy rotor accumulators are preferably rotatively mounted on the independent body plates fastened to the building wall.

30 The kinetic energy rotor accumulators preferably have differentiated moments of inertia.

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The kinetic energy rotor accumulators are preferably driven by means of toothed gears of differentiated transmission ratios that increase rotational velocities.

The idle stroke of the rack driving the toothed wheel of the kinetic energy rotor accumulator having a capability of accumulation of higher energy is greater than the
5 idle stroke of the rack driving the toothed wheel of the kinetic energy rotor accumulator having a capability of accumulation of lower energy.

Furthermore the body plates preferably have through openings.

In the bumper crane substructure unit according to the present invention an increased efficiency of absorbing and dissipating energy of crane collision at different
10 random collision velocities is achieved by providing possibility of inducing rotational movement of consecutive kinetic energy rotor accumulators. Particularly significant abrupt stepped increase of a capability of absorbing kinetic energy during a crane collision is obtained by inducing rotational movement of consecutive kinetic energy
15 rotor accumulators of increasing moments of inertia or by inducing rotational movement of consecutive kinetic energy rotor accumulators which are gained with increasing rotational velocities by employment of gears of increasing transmission ratios that increase rotational velocities.

The rotor arrangement according to the present invention provides high efficiency of kinetic energy absorption during collisions of low kinetic energy as well as during
20 collisions of higher kinetic energy. In the first instance the rotor arrangement according to the present invention provides efficient and very smooth shock absorption, as an absorption of kinetic energy of progressive movement takes place with using kinetic energy rotor accumulators of the smallest moment of inertia. In the second instance, the rotor arrangement according to the present invention also
25 provides appropriately efficient and smooth shock absorption, as kinetic energy absorption takes place with using several rotor accumulators of increasing energy absorption capabilities.

In case of collisions of greater energy an additional effect occurs consisting in that collision kinetic energy is in a great part accumulated in the rotor accumulators
30 featuring lower energy absorption capability before the rotor accumulators featuring higher energy absorption capability are actuated. Such a sequence of energy

absorption provides smoother operation of the chair according to the present invention during actuation of next rotor accumulators, even those of the greatest capability of energy absorption featuring the biggest moment of inertia.

The exemplary embodiments of the present invention are presented below in connection with the attached drawings on which:

Fig. 1 presents a top part view of a crane provided with a bumper crane substructure unit according to the present invention having kinetic energy absorption rotor arrangement;

Fig. 2 shows an enlarged view of the bumper crane substructure unit;

Fig. 3 shows a side view of the energy absorption rotor arrangement with rotor kinetic energy accumulators of the same moment of inertia with employment of toothed gears of different transmission ratios; and

Fig. 4 presents a side view of the energy absorption rotor arrangement with rotor kinetic energy accumulators of the differentiated moments of inertia with employment of toothed gears of different transmission ratios.

As presented in the embodiment of Fig. 1 and Fig. 2, a bumper crane substructure unit comprises an energy absorption rotor arrangement 1, in which three racks 2 separated from each other are slidably mounted which by medium of toothed wheels 3 drive three kinetic energy rotor accumulators 4, 5, 6 of differentiated moments of inertia. Between the beater element 10 and particular racks 2 gaps 7, 8, 9 are formed defining an idle stroke of the top plate 10 relative to the racks 2. The gap 9 between the beater element 10 and the rack 2 driving the toothed wheel 3 of the kinetic energy rotor accumulator 6 efficient for accumulating the biggest energy is larger than the gap 8 between the beater element 10 and the rack 2 driving the toothed wheel 3 of the kinetic energy rotor accumulator 5 efficient for accumulating medium energy, whereas the gap 7 between the top plate 13 and the rack 2 driving the toothed wheel 3 of the kinetic energy rotor accumulator 4 efficient for accumulating the smaller energy is the smallest. In order to decrease impact in the initial stage, during contacting the beater element 10 with particular racks 2, between the beater element 10 and each rack 2 elastic shock absorbing elements are arranged in forms of springs 15.

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The kinetic energy rotor accumulators 4, 5, 6 are rotatively installed on the separated body plates 11 attached by medium of a mounting flanges 16 to a building wall 17, whereas the racks 2 are slidably guided through the guides 18 mounted perpendicularly relative to the beater element 10. Through openings 19, 20 formed in the mounting flanges 16 enable for translocation of the racks 2 and guides 23 of the beater element 10 into the interior of the building wall 17.

The crane buffer 12 is attached on the axis of the rail 13 and is rigidly connected to the crane construction provided with a supporting beam 22 and moveable on rolls 21.

10 As shown in the embodiment of Fig. 3 in the kinetic energy absorption rotor arrangement 1 are employed kinetic energy rotor accumulators 6 of the same moments of inertia. A differentiation of capability of collision kinetic energy absorption and dissipation is in this embodiment obtained by employment of toothed gears of differentiated transmission ratio. In a case of toothed gear employment, a given transmission ratio is determined by the effective diameter of the toothed wheel 3a, 3b and 3c that cooperates with rack 2, and thus in the presented embodiments the kinetic energy rotor accumulator 6 driven by means of the toothed wheel 3a of the biggest effective diameter has the lowest kinetic energy absorption capability, the kinetic energy rotor accumulator 6 driven by means of the toothed wheel 3b of the medium effective diameter has the higher kinetic energy absorption capability, and the kinetic energy rotor accumulator 6 driven by means of the toothed wheel 3c of the smallest effective diameter has the highest kinetic energy absorption capability.

In the embodiment presented in Fig. 3, the toothed wheel 3a of the biggest diameter has the effective diameter two-fold bigger than corresponding diameter of the toothed wheel 3c of the smallest diameter, what in case of the same velocities of translocation of racks 2 and usage of kinetic energy rotor accumulators of the same moment of inertia results in that the kinetic energy rotor accumulator 6 driven by means of the toothed wheel 3c of the smallest effective diameter shall gain angular velocity two-fold greater than corresponding velocity of the kinetic energy rotor accumulator 6 driven by means of the toothed wheel 3a of the greatest effective diameter, thus it shall feature four-fold greater capability of rotational movement kinetic energy accumulation.

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The embodiment presented in Fig. 4 comprises kinetic energy rotor accumulators 4, 5 and 6 of differentiated moments of inertia and toothed gears of differentiated transmission ratios resulting from different effective diameters of the driving toothed wheels 3a, 3b, 3c. The kinetic energy rotor accumulator 6 of the biggest moment of inertia is driven by means of the toothed wheel 3a of the greatest effective diameter, and the kinetic energy rotor accumulator 4 of the smallest moment of inertia is driven by means of the toothed wheel 3c of the smallest moment of inertia. Such a construction provides a possibility of defining a smooth characteristic of a capability of kinetic energy during an impact of a bumper substructure unit according to the present invention.

In an alternative embodiment which is not illustrated on the drawing, where for driving the kinetic energy rotor accumulator of the greatest moment of inertia is employed a toothed gear with a toothed wheel of the smallest effective diameter, and for driving the kinetic energy rotor accumulator of the smallest moment of inertia is employed a gear with a toothed wheel of the greatest effective diameter, the biggest progressiveness of impact energy absorption shall be obtained.

In the described embodiments unidirectional couplings are also employed, though not presented on the drawing, and arranged between the toothed wheels 3 and kinetic energy accumulators 4, 5, 6. The function of these unidirectional couplings is transferring a torque onto kinetic energy rotor accumulators, and after absorption of energy, when angular velocity of the toothed wheel 3 shall be smaller than angular velocity of corresponding kinetic energy rotor accumulator 4, 5, 6, the unidirectional coupling is disconnecting thus it enables for unrestricted rotation of the kinetic energy rotor accumulator 4, 5, 6.

In a result of a differentiation of widths of the gaps 7, 8, 9 the kinetic energy rotor accumulators 4, 5, 6 are actuated successively beginning with the kinetic energy rotor accumulator 4 of the smallest moment of inertia, and ending with the kinetic energy rotor accumulator 6 of the biggest moment of inertia. In a case of a bigger collision energy all kinetic energy rotor accumulators 4, 5, 6 shall be driven, wherein the kinetic energy rotor accumulator 4 of the smallest moment of inertia shall gain in such a case the highest angular velocity, the kinetic energy rotor accumulator 5 of the medium moment of inertia shall gain a medium angular velocity, and the kinetic

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energy rotor accumulator 6 of the greatest moment of inertia shall gain the smallest angular velocity.

Patent Claims:

1. A bumper crane substructure unit comprising a crane buffer mounted on the rail axis and interconnected with a moveable crane construction and a kinetic energy absorption rotor arrangement fixed to a building wall on the line of the travel of the crane buffer, in which kinetic energy of progressive movement is transformed into kinetic energy of rotational movement, wherein the arrangement comprises a moveable beater element cooperating with racks interengaged with toothed wheels driving the kinetic energy rotor accumulators of a given moment of inertia, characterized in that at least two racks (2) of the kinetic energy absorption rotor arrangement (1) cooperating with the beater element (10) interengages with toothed wheels (3, 3a, 3b, 3c) of the kinetic energy rotor accumulators (4, 5, 6) of differentiated capabilities of energy accumulation, wherein between the beater element (10) and racks (2) interengaged with toothed wheels (3, 3a, 3b, 3c) of kinetic energy rotor accumulators (4, 5, 6) differentiated gaps (7, 8, 9) are defined providing differentiated idle stroke of the beater element (10) relative to the racks.
2. The bumper unit according to Claim 1, characterized in that the kinetic energy rotor accumulators (4, 5, 6) are rotatively mounted on the independent body plates (11) fastened to the building wall.
3. The bumper unit according to Claim 1 or 2, characterized in that the kinetic energy rotor accumulators (4, 5, 6) have differentiated moments of inertia.
4. The bumper unit according to Claim 1 or 2 or 3, characterized in that the kinetic energy rotor accumulators (4, 5, 6) are driven by means of toothed gears of differentiated transmission ratios that increase rotational velocities.
5. The bumper unit according any one of Claims 1-4, characterized in that the idle stroke of the rack (2) driving the toothed wheel (3) of the kinetic energy rotor accumulator (5, 6) having a capability of accumulation of higher energy, is greater than the idle stroke of the rack (2) driving the toothed wheel (3) of the kinetic energy rotor accumulator (4) having a capability of accumulation of lower energy.

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6. The bumper unit according any one of Claims 2-5, characterized in that the body plates (11) have through openings (19, 20).

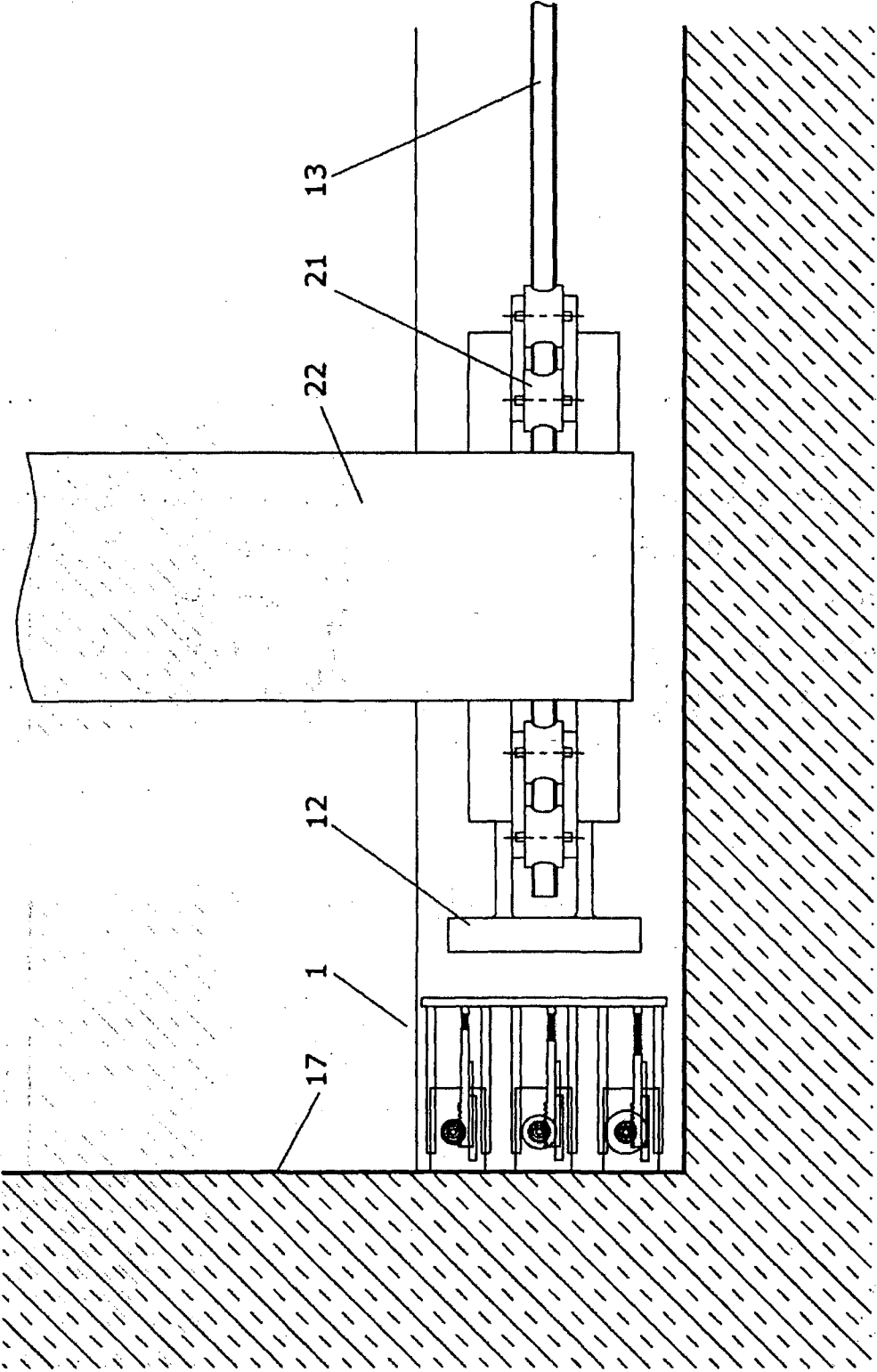
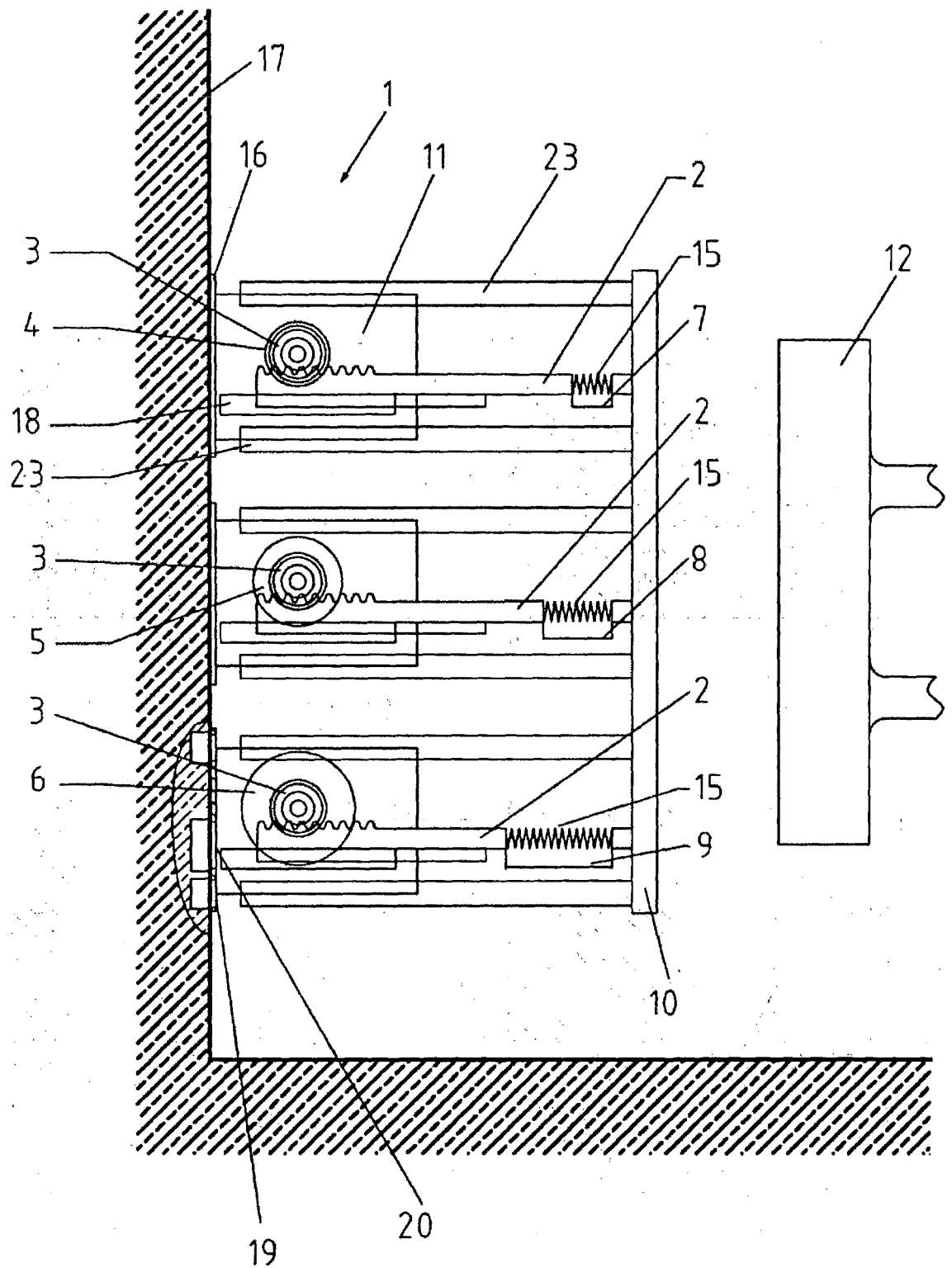


Fig. 1

**Fig. 2**

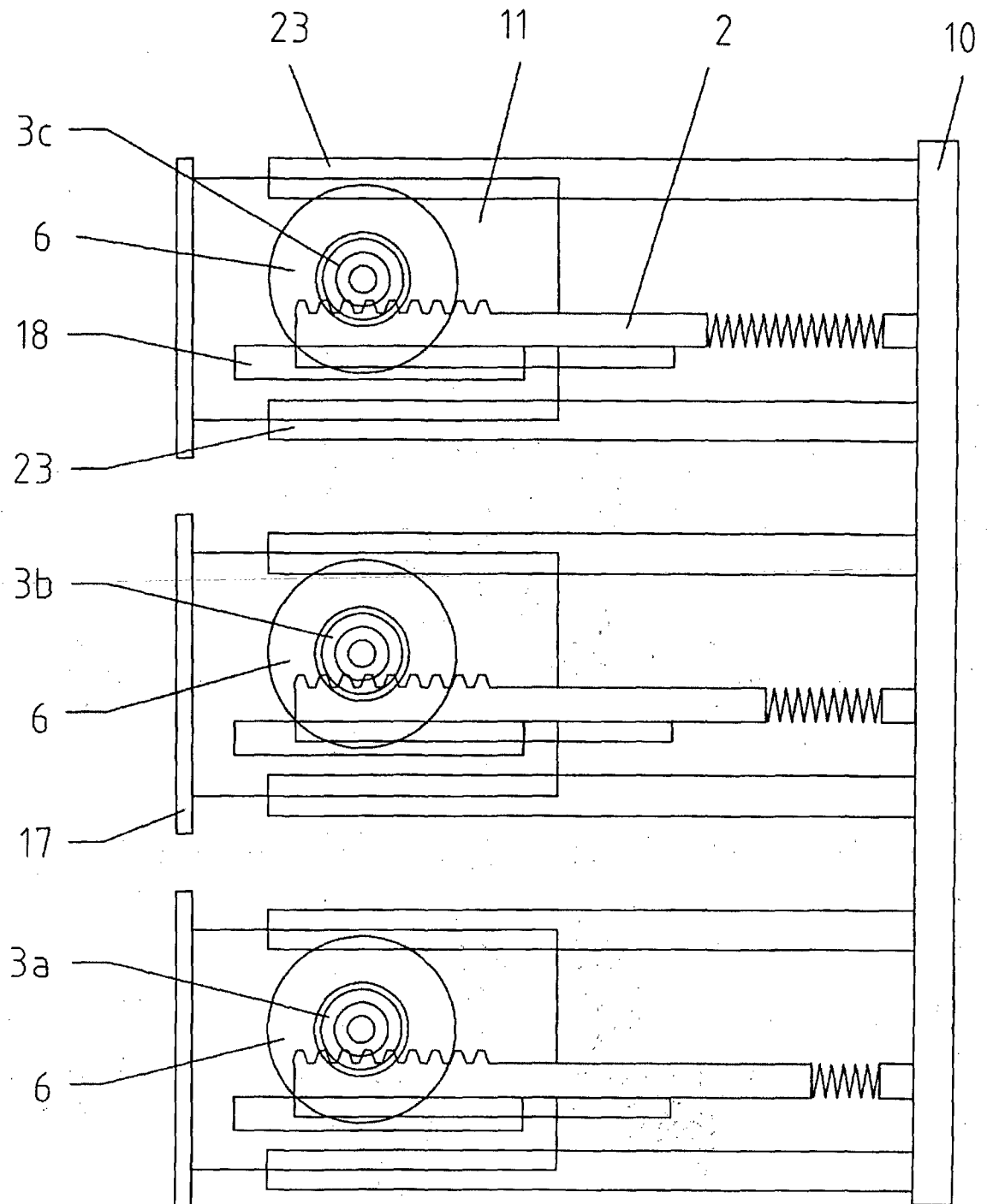
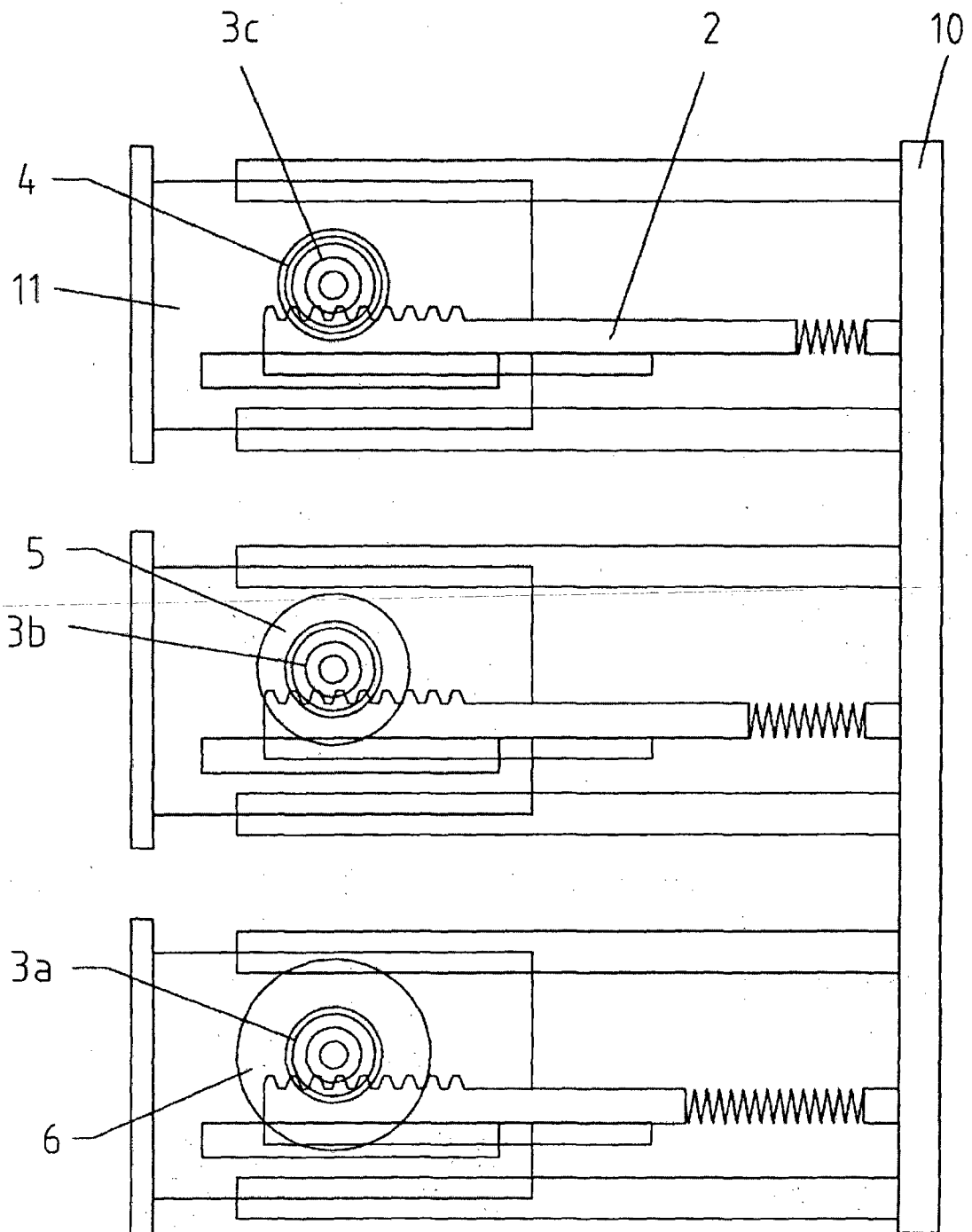


Fig. 3

**Fig. 4**