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(54) Title: INCLINED ELEVATOR

(57) Abstract

An inclined elevator connecting the floors of semi–detached terrassed dwellings adapted to reduce the horizontal inertia forces from molesting the passengers during stops and starts includes a cabin pivotally suspended from a carriage travelling on rails in a shaft or tunnel. Swinging of the carriage at each stop and start is controlled by a linear actuator pivotally connecting respective points on the cabin and the carriage by monitoring the angular velocity of the cabin from its deviation during stops and starts to its vertical position. The linear motion of the actuator is controlled by sensors measuring the acceleration and deacceleration of the carriage on the one hand, and the angular deviation of the cabin from its vertical position on the other hand. Signals are continuously transmitted from the sensors to an electronic controller which controls the velocity and position of the linear actuator and thereby the angular velocity of the cabin with the object of providing a minimum of horizontal inertia forces on the standing passengers.

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INCLINED ELEVATOR.

The invention relates to elevators and lifts for the transport of people to and from their homes in terrassed semi-detached houses built on hillsides,or between floors in hotels and other buildings erected on the same priciple.

BACKGROUND OF THE DISCLOSURE.

In the past few decades it has become the fashion to erect buildings on slopes of hills and mountains which up to then were thought unsuitable for this kind of settlement. The solution was building so-called terrassed semi-detached homes in the form of apartments built with certain portions overlapping and with large terrasses. This kind of building ensures the occupant much privacy without direct neighbours and presents him with the possibility to tend a small garden.

As in most multi-storey buildings elevator service must be provided, and these inclined elevators are being built in the form of a cabin running on rails on the floor in the open or in a tunnel; the cabin is pulled up and down by cable means and electric machinery, similar to that used with elevators running in vertical shafts. Now experience has shown that a relatively slow travelling speed of the inclined elevator had to be chosen in order to prevent the occupants from being pushed back and fore by the inertia forces during deceleration and acceleration of the cabin near the different stations.

The same effect does not occur in cable cars or mountain railways where the inertia forces are greatly reduced by the relative long braking and starting distances which do not much influence the average travelling speed owing to the large distance between stations. This does not apply to speed regulation of inclined elevators connecting the floors in terrassed homes where the distance between stations is only a few meters. With lifts in vertical shafts only vertical inertia forces are felt, and they do not throw the occupants sideways, but with the inclined elevator for terrassed homes it becomes necessary to choose a rather low speed. Now low speed means a longer travel time and long waiting periods for the persons at various stations or stories, and it is the object of the present invention to provide means that allow an inclined elevator to travel at higher speed while considerably reducing the action of the inertia forces on the occupants.

SUMMARY OF THE INVENTION.

The inclined elevator for terrassed semi-detached homes, according to the present invention. is designed for higher speed without the unpleasantness of horizontal inertia forces acting on the passengers.It includes a cabin pivotally suspended from a carriage which preferably runs on rails attached to the top of a tunnel or inclined shaft. As an alternative the carriage will travel on rails on the tunnel floor with the cabin suspended from a horizontal axle at the top of a structure erected on the carriage.

The pivot from which the cabin is suspended is a horizontal axle with its axis perpendicular to the direction of travel, causing the cabin to swing about this pivot during start and stop periods of the elevator near each station. Deceleration before a stop and complete halt at the station will deviate the cabin about a maximum angle without effect on the passengers. However the swing-back motion might be unpleasant, especially since the cabin has to be brought to vertical position at the station door at the end of the return swing. Similarly during start from a station the cabin would swing back-wards which would not affect the passengers, but it would continue to swing during the rest of the travel towards the next halt, again an unpleasant experience.

With a view to avoiding pendulous swinging of the cabin and to prevent strong inertia forces from acting on the passengers, the angular swinging motion of the cabin is controlled by an electrically operated linear actuator connecting a portion of the cabin with the carriage. The actuator is preferably controlled by sensor means sensitive to acceleration and deceleration of the carriage and the cabin, so as to regulate the speed at which the cabin is brought into vertical position again. As an alternative the sensor may control the actuator by sensing the angular deviation of the cabin relative to the carriage, selectively at start and at stop, during uphill and downhill travel. Or there may be a combination of sensor means of both kinds controllimg the actuator motor speed by means of an electronic controller.

As an alternative to the linear actuator it is proposed to mount a rotary actuator in concentric alignment with the pivot axle supporting the cabin, which is to moven the cabin in a direction and at a rotational speed required to obtain minimal inertia forces acting on the passengers.

It appears that both during starting and stopping of the cabin motion to a maximum deviation may go unhindered, but that during the return to vertical position, both during straight travel and complete standstill the cabin is to be controlled by the actuator assembly with a view to minimize horizontal inertia forces acting on the passengers. In order to reduce the magnitude of the acceleration or deceleration the time required for returning the cabin into vertical position may be different fromn the swing-back time without actuator control.

As an alternative the elevator cabin can be mounted on wheels that travel on an upwardly curved pair of rails which form the top portion of a carriage running on rails on the tunnel floor. The curvature has a focus non the vertical canterline of the cabin, and it becomes evident that the inertia forces would force the cabin to travel up and down the curved rails while rotating about the focus. Hereby the same effects as with the cabin suspension would be attained, and the same remedy would be used to 54 duce unpleasant forces on the passengers.

BRIEF DESCRIPTION OF THE DRAWINGS.

Figure 1 is a schematic side view of an inclined elevator travelling on rails attached to the roof of a tunnel,

Figure 2 is a section along lie 2-2 of Figure 1,

Figure 3 is a schematic side view of an inclined elevator travelling on floor rails with the cabin suspended from a cabin structure, and

Figure 4 is a schematic side view of an inclined elevator having the cabin supported in a curved cradle.

DETAILED DESCRIPTION OF THE DRAWINGS.

The inclined elevator shown in Figures 1 and 2 travels on rails 16 which are attached to the top 1 of a tunnel or an inclined shaft by a support structure 17. The elevator cabin 2 is suspended from a wheeled carriage 15 by means of a horizontal pivot in the form of an axle 3 which permits angular motion in forward and rearward direction as indicated by angle 6. The carriage is attached to a cable 13 which is pulled up and down by electric machinery at the top of the tunnel with its movements controlled by control means known to the art. A counterweight 14 is attached to the end of the cable running on rails 12 on the floor of the tunnel or shaft.

As said in the beginning, the pivotal suspension of the cabin has been chosen with a view to reducing the horizontal inertia forces on the passengers during stops and starts of the elevator. On the other hand, the cabin would swing pendulum-like at every stop until coming to a final rest, a feature to be avoided by the provision of a linear actuator 8 connecting a point on the cabin with a point on the carriage. It is the task of the actuator to control the angular deviation and the angular velocity of the cabin so as to reduce the inertia forces on the passengers to a agreeable degree. The motion of the actuator is either controlled by sensor and computer means or, as an alternative, pre-designed and programmed in accordance with the cabin behavior during stops and starts. The present drawing shows a sensor 19 mounted on the carriage which is onfigured to measure the carriage acceleration. A sensor 18 on the bottom portion of the cabin measures the acceleration perpendicular to the passengers' axis, and sensor 20 next to pivot 3 measures the angular deviation of the cabin from the vertical at every moment. The sensors transmit corresponding signals to a control system which transmits signals to the actuator motor and to the elevator drive motor respectively controlling the speed of the actuator and of the carriage. A more detailed description of the control operation will be tendered with reference to the embodiment illustrated in Figure 4.

Another embodiment of the inclined elevator is illustrated in FIgure 3 of the drawings,wherein a cabin 2 is supported by a carriage 4 travelling on rails on the floor of the shaft or tunnel. A steel structure 7 is erected on the carriage surrounding the cabin and supporting it on a horizontal pivot axle 3. The carriage is pulled up and down by cable 13, and a counterweight is provided at the other end of the cable in a manner known to the art, but is not shown in the drawing. The motion of the cabin is controlled by a linear actuator 8 which is connected to the structure by way of a sideways extending arm 9 to the bottom of cabin 2. Sensors 18 and 19 are attached to the bottom of the cabin and to the carriage 4 respectively. Operation of the actuator is the same as described with reference to the first embodiment of Figures 1 and 2.

Figure 4 finally illustrates an embodiment wherein the cabin is not suspended from the carriage, but moves along a circular path about a focus 23. For this purpose the carriage 24 features a pair of rails 27 having a curvature around focus 23, along which the cabin can travel back and fore by means of wheels 30 and counterwheels 31. As in the afore described embodiments, there are provided actuator and sensors for the control of the actuator. Operation of the elevator by electric machinery and angular deviation control are the same as described with reference to the elevator of Figure 1.

Reducing the inertia forces on the passengers with the aid of linear actuators and sensors placed in different locations will now be described with reference to all three embodiments of the elevator:-

Sensor 19 (or 29)is mounted on the carriage and measures the acceleration of the carriage and signals are transmitted to and from the control system of the elevator assembly. At zero acceleration the cabin should be in vertical position as recorded by sensor 20 on top of the cabin.

Sensor 18 (or 38) at the cabin's bottom measures the acceleration perpendicular to the passengers' bodies, which is to be reduced to a minimumm by action of the ctuator. In fact the center of gravity of an adult person- about 0.8 m above the floor - and the sensor could advantageously be mounted on the cabin at that level. On the other hand the actual acceleration at this level is readily calculated by the control system.

The signals emitted by the sensors are transmitted to the control system which is programmed to calculate the optimum angle for a minimum acceleration force on the passengers. Then it measures the actual angle 6 by means of sensor 20 and corrects any deviation from the desired condition.

In an alternative control system the sensor can be omitted and the actuator motion pre-designated and programmed. It is evident that owing to the backwards swinging of the cabin during starting and forward tilting during stopping of the elevator the inertia forces on the passengers are mainly in vertical direction and therefore not disturbing. On the other hand, rightening of the cabin from tilting position, especially the last phase will cause horizontal forces trying to push people sidewards. It is, therefore the task of the actuator to provide smooth landing of the cabin into vertical position by controlling the speed to be gradually reduced at the end of the return path.

C L A I M S :-

1. An inclined elevator adapted to interconnect separate semi-detached terrassed buildings erected on the slope of a mountain or a hill and to convey passengers between floors without molesting them by horizontal inertia forces during stopping and starting of said elevator which comprises,

a carriage travelling on rails inside an inclined shaft or tunnel said carriage being connected by cable means to electric machinery and controls configured to move said carriage between floors,

a cabin attached to said carriage by means of a horizontal pivot axle permitting swinging motion of said cabin about said pivot in forward and rearward direction,

a motor-driven actuator connecting a point on said cabin with a point on said carriage adapted to control the angular swinging motion so as to reduce the magnitude of horizontal inertia forces on said passengers during starting and stopping of said elevator.

2. The inclined elevator of Claim 1, whwerein said actuator is a linear actuator.

3. The inclined elevator of Claim 1, wherein the motion of said actuator is controlled by a first sensor mounted on said carriage measuring the acceleration, a second sensor mounted on said cabin in its bottom portion measuring the horizotal acceleration on the bodies of the passengers, and a third sensor measuring the angle of the cabin axis relative to its vertical position, said sensors

transmitting signals in respect of these measurements to electronic control means configured to issue signals to the motor controls of said actuator to move said actuator so as to obtain minimal horizontal acceleration forces on said passengers.

4. The inclined elevator of Claim 1, wherein the motion of aid actuator is controlled by programmed electronic control means.

5. The inclined elevator of Claim 1, wherein said carriage travels on rails attached to the top portion of said tunnel or shaft and wherein said cabin is atttached to said carriage by means of a horizontal hinge fastened to a structure underneath said carriage.

6. The inclined elevator of Claim 1, wherein said carriage travels on rails on the floor of said tunnel or shaft, and wherein said cabin is suspened from a pivot axle mounted at the top of a metal structure erected on said carriage.

7. An inclined elevator adapted to interconnect separate semi-detached terrassed buildings erected on the slope of a mountain or a hill and to convey passengers between floors without molesting them by horizontal inertia forces during stopping and starting of said elevator which comprises,

a carriage travelling on rails inside an inclined shaft or tunnel said carriage being connected by cable means to electric machinery and controls configured to move said carriage between floors, the top portion of aid carriage being in the shape of two parallel rails curved in the form of downwardly extending arc,

a cabin adapted to swing about a given angle in forward and rearward direction by means of wheels attached to the underside of said cabin and rolling on said curved rails on said carriage,

a linear actuator connecting a point on said cabin with a point on said carriage adapted to control the angular swinging motion so as to reduce the magnitude of horizontal inertia forces on said passengers during starting and stopping of said elevator.

8. The inclined elevator of Claim 7, wherein said rails on said carriage are curved about a focus lying at a given height near the centerline of said cabinin its vertical position.

9. The inclined elevator of Claim 7, wherein the motion of said actuator is controlled by a first sensor mounted on said carriage measuring the acceleration, a second sensor mounted on said cabin in its bottom portion measuring the horizotal acceleration on the bodies of the passengers, and a third sensor measuring the angle of the cabin axis relative to its vertical position, said sensors transmitting signals in respect of these measurements to electronic control means configured to issue signals to the motor controls of said actuator to move said actuator so as to obtain minimal horizontal acceleration forces on said passengers.

10. The inclined elevator as defined in Claims 1 through 5 and as described with reference to Figures 1 and 2 of the drawings.

11. The inclined elevator as defined in Claim 6 and as described with reference to Figure 3 of the drawings.

12. The inclined elevator as defined in Claims 7, 8 and 9, and as described with reference to Figure 4 of the drawings.

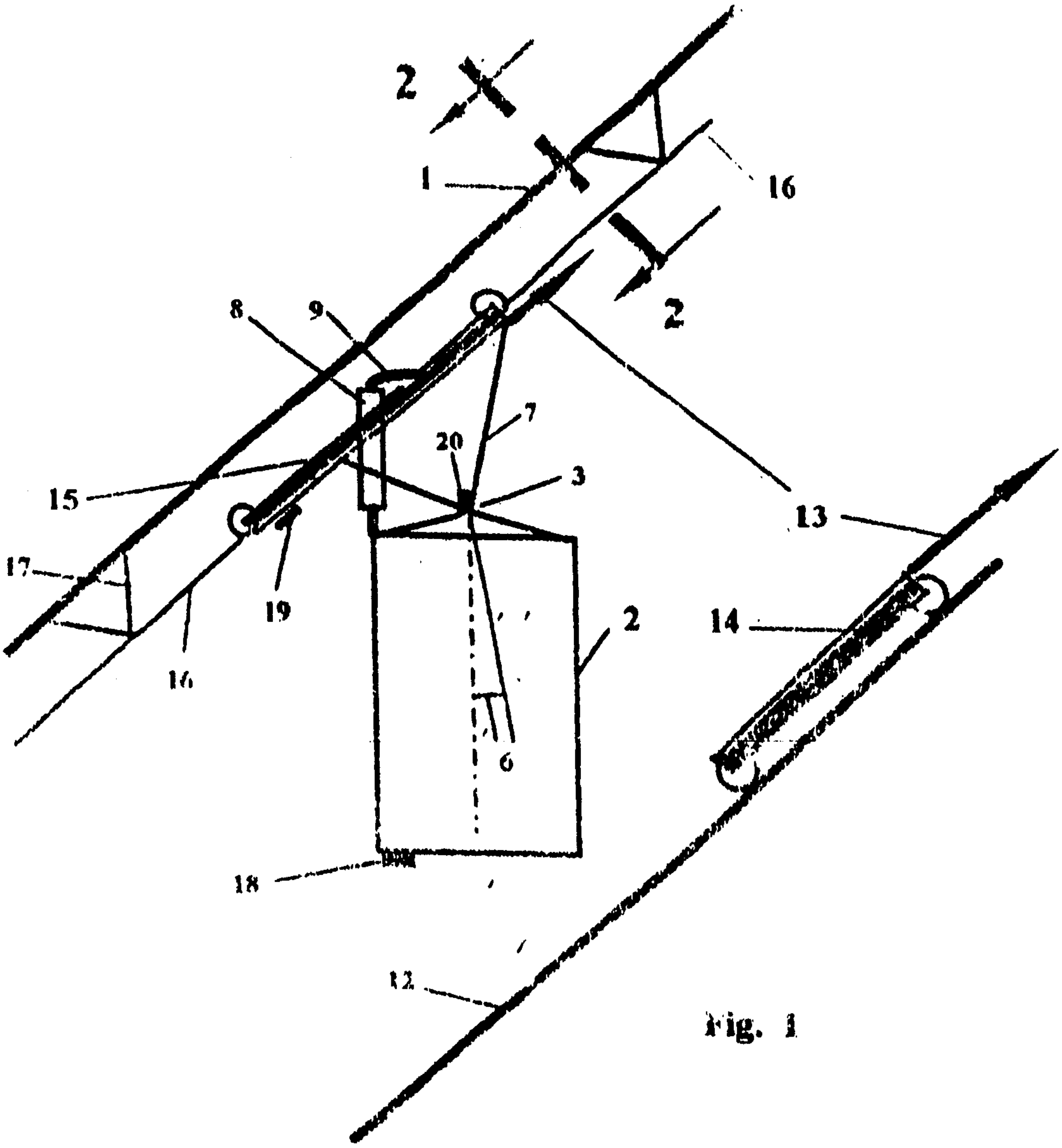

Fig. 1

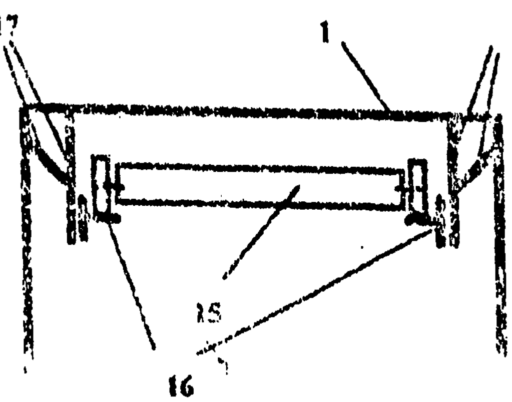

Fig. 2

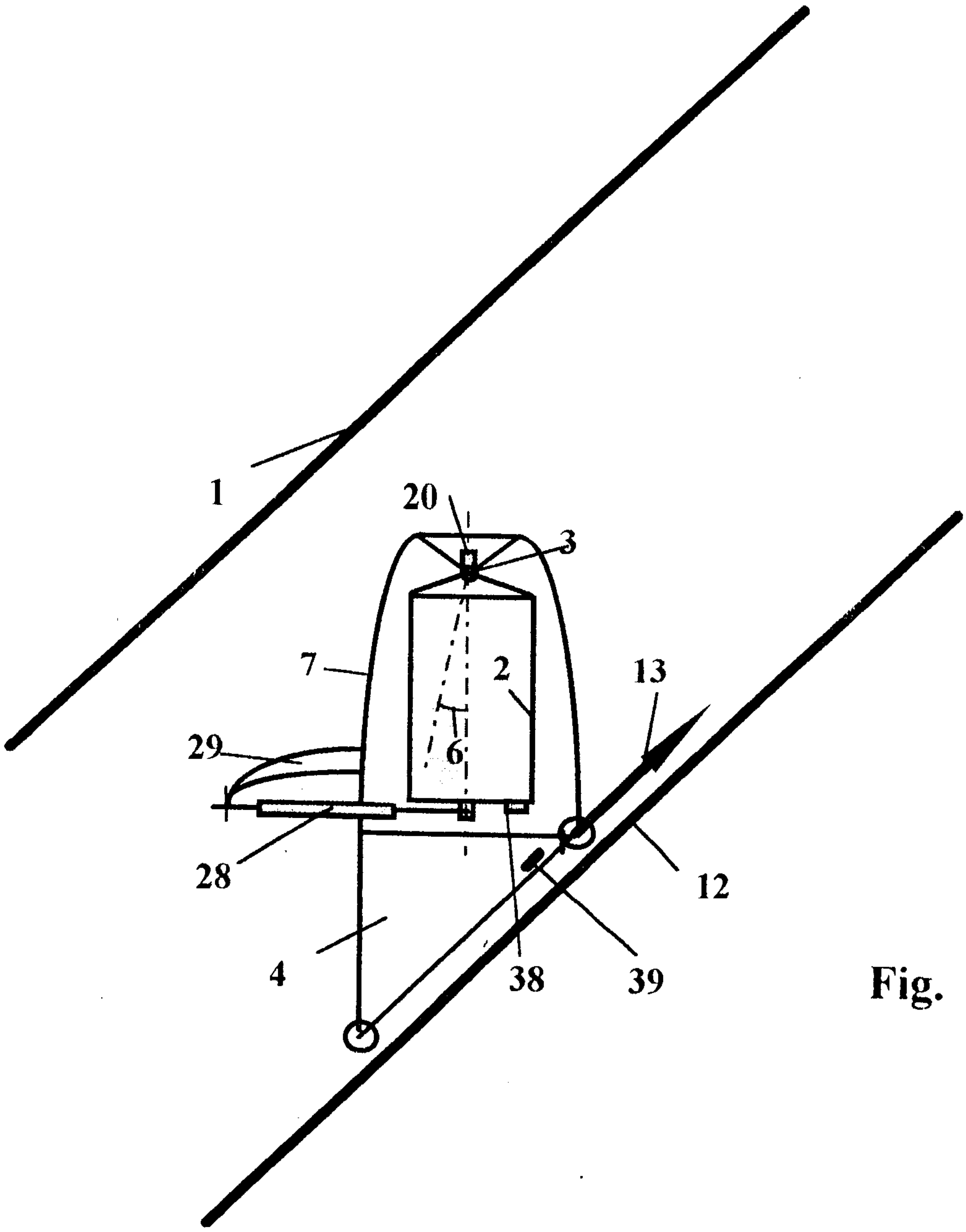

Fig. 3

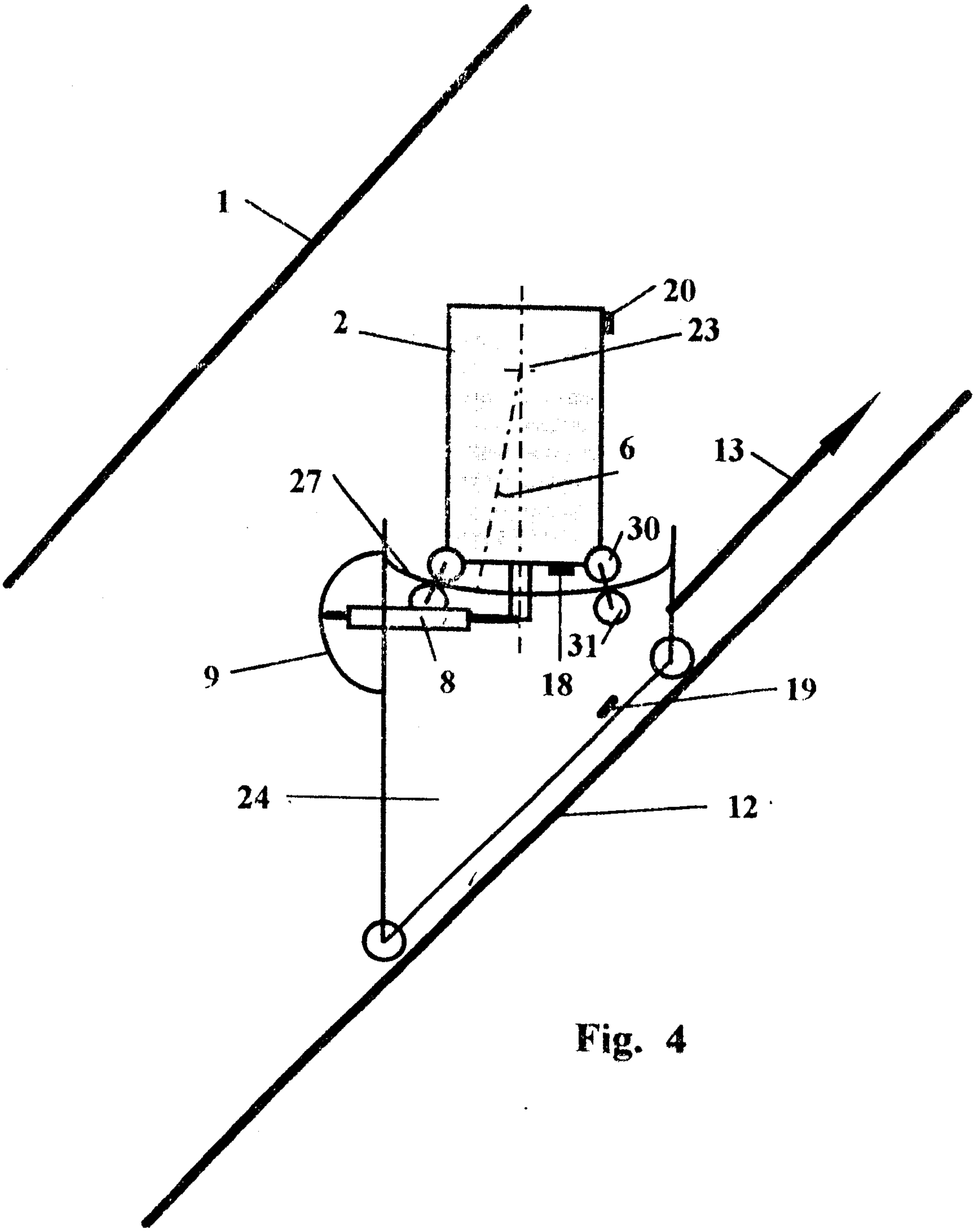

Fig. 4