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(71) Applicant: **KONE OY**
SF-00330 Helsinki 33 (FI)

(72) Inventors:
- **Häyrinen, Seppo**
  FIN-05800 Hyvinkää (FI)
- **Aulanko, Esko**
  FIN-04230 Kerava (FI)

(74) Representative: **Zipse + Habersack**
Kemnatenstrasse 49
D-80639 München (DE)

(54) Safety brake for an elevator

(57) Safety brake (14) for an elevator, enabling the movement of the elevator rope (8) to be stopped between a back stop (17) and a bilateral eccentric jaw (18) in both directions of rope movement. The safety brake is self-locking. Its energy source is a spiral conveyor spring (20) which drives a conveyor (19) that pushes the jaws towards the back stop (17), causing the rope to be squeezed between the jaw and the back stop. The conveyor spring is provided with a shaft and wound up by rotating the shaft by means of a winding motor. Between the shaft and the motor there is a magnetic coupling which, when de-energized, activates the safety brake.

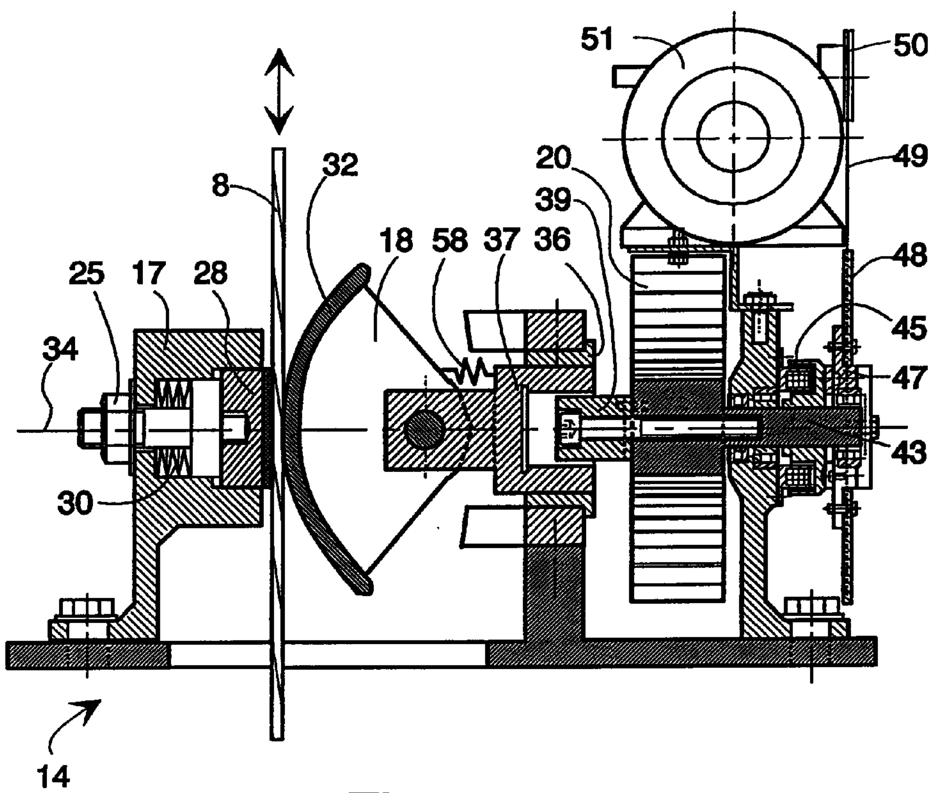

Fig. 4

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Description

The present invention relates to a safety brake for a rope suspension elevator as defined in claim 1.

In a certain type of elevator safety brake, a wedge-shaped gripper mounted between the elevator car and its guide rails stops the elevator from upward or downward movement. The wedge gripper is usually activated by means of a closed rope loop connected to the elevator car. The rope loop is vertically laid out in the shaft and it passes over diverting pulleys placed at its top and bottom ends, with an overspeed governor usually placed at the upper end. In an overspeed situation, the overspeed governor stops the rope loop and, as the rope is linked with the grippers, these are activated by the rope. After the safety brake action, operation of the elevator is restored by correcting the fault that led to an overspeed and then moving the elevator in the opposite direction relative to the direction of travel at the time of triggering. Moving the elevator in the opposite direction requires a great power.

A wedge gripper acting on the guide rails that works during downward travel is presented e.g. in US specification 4,819,765.

A wedge gripper acting on the guide rails that works during upward and downward overspeed is presented e.g. in US specification 5,096,020.

US specification 5,101,937 presents a wedge action safety brake acting on the elevator rope that works during upward and downward overspeed. In this solution, wedge housings with wedges are mounted around the elevator rope on both sides of the traction sheave. One of the wedge housings with a wedge functions during upward overspeed and the other during downward overspeed. A safety brake according to US 5,101,937 can be installed both on a new elevator and as an accessory on an old elevator. The wedge brake is provided with an overspeed governor with a rubber wheel leaning against the elevator ropes which activates the wedges. However, this solution has the same drawbacks as the above-mentioned safety brakes acting on the guide rails, in other words, it is necessary to move the elevator or the counterweight to release the safety brake. Other drawbacks can be found in the facts that the device requires a large space and that it needs two wedge housings with a wedge.

A method for stopping the rope of an overspeed governor is proposed in US specification 5,183,979, in which the governor rope stopped between two unilateral eccentric jaws functioning in one direction. One of the jaws acts as a back stop with spring action relative to a fixed part of the building while the other jaw is connected to a piston controlled by a solenoid. Two overspeed governors are needed, one for downward travel and the other, mounted in conjunction with the counterweight rope, for upward travel of the elevator. Both overspeed governors have their own eccentric jaws for stopping the governor rope. To make the eccentric jaws engage the governor rope, the solenoid is de-energized, whereupon the piston connected to the solenoid releases the respective eccentric jaw, allowing it to turn and engage the rope. The eccentric jaws turn, the rope is squeezed between the jaws and is stopped.

If we imagine stopping an elevator rope by the solution of US5,183,979, many deficiencies appear. Two devices are needed, one for each running direction of the elevator rope. As the eccentric jaw functions, it develops a progressively increasing force pressing the rope. To release the safety brake for normal operation, a force acting in the opposite direction relative to the pressing force needs to be developed. This force is then reduced or else the elevator is lifted in the direction opposite to the safety brake action. As an example of the order of magnitude of the force applied to the rope, a 1000 kg elevator with a rope friction coefficient of about 0.3 and a rope transmission ratio of 1:2 requires a force of about 30 kN, which is also the force needed to release the brake. Lifting the elevator by means of its hoisting mechanism after safety brake action is not always possible because e.g. the traction sheave friction is not always sufficient to achieve a sufficient hoisting force. In this case, e.g. a block and tackle is used to release the elevator.

The object of the present invention is to produce a new safety brake acting on the elevator rope and operating both in case of an upward overspeed and in case of a downward overspeed, a brake that develops a large force to stop the elevator, is advantageous in respect of price and easy to install in both new elevators and as retrofit in existing elevators. A further object is to achieve a safety brake that can be released with only a small force without lifting the elevator or its counterweight. The safety brake should also be easily applicable to hold the elevator during servicing of the elevator machinery.

To achieve the aims specified above, the safety brake of the invention is characterized by what is said in the characterization part of claim 1. Other features of the invention are presented in the other claims.

The invention has the following properties:

In accordance with the aims stated, the safety brake of the invention is small-sized and easy to manufacture as a separate unit. The safety brake is also easy to test prior to installation on an elevator and it can be easily installed on both new and old elevators.

The safety brake functions both in case of an upward overspeed and in case of a downward overspeed and its operation is voltage-independent and it can easily be associated with various inhibitions. [TK1]The safety brake of the invention is self-locking and requires only a small force to release it. The elevator or the counterweight need not be moved to make the safety brake ready for operation.Another advantage is that the safety brake can easily be operated by remote control and it can be used as a hold brake to hold the elevator or counterweight stationary e.g. while maintenance work is going on. Easy control of the safety brake allows easy inspection of safety brake operation.

A further advantage is that the structure of the safety brake is applicable for stopping the governor rope in both upward and downward directions.

In the following, an embodiment of the invention is described by the aid of drawings, in which

Fig. 1 illustrates the placement of the safety brake in the machine room of an elevator,

Fig. 2 presents the safety brake in top view,

Fig. 3 presents the safety brake in a normal operating situation of the elevator,

Fig. 4 shows the position of the safety brake components at the start of the braking action,

Fig. 5 shows the position of the safety brake components during upward braking,

Fig. 6 shows the position of the safety brake components during downward braking, and

Fig. 7 represents the structure of an energy storage for the safety brake.

Fig. 1 illustrates the placement of the safety brake 14 in an elevator. In an elevator shaft 1, an elevator car 2 supported by an elevator rope 8 moves vertically along guide rails 4 and 5. One end of the elevator rope 8 is attached to the top part of the elevator shaft, from where the elevator rope is passed over a diverting pulley 10 on the elevator car, through the safety brake 14 and then back up to the elevator machinery 11. From here, the elevator rope 8 is further passed over a second diverting pulley 12 to a diverting pulley 9 on the counterweight 3 and then again to the top of the elevator shaft, where the other end of the elevator rope is fixed. The counterweight moves along counterweight guide rails 6 and 7.

Fig. 2 presents the safety brake 14 of an elevator as seen from above along line A-A in Fig. 1. The main parts of the safety brake 14 are a back stop 17, a jaw 18, a conveyor 19, a conveyor spring 20 and a conveyor spring winder 21. The safety brake forms a compact unit assembled on a base 15 provided with an opening 16, through which the elevator rope 8 is passed between the back stop 17 and the jaw 18. The base 15 may consist of separate parts joined together by means of screws. The elevator rope 8 consists of a number of parallel ropes, in this case five ropes. The safety brake 14 is fixed to the base 15 in the elevator machine room 13 by a known technique, e.g. with screws or by welding. The back stop 17, conveyor 19 and spring winder 21 are fixed to the base 15 with their own fixing elements, preferably screws 22, 23 and 24. The jaw 18 is attached to the conveyor 19 with a joint 25 and a the conveyor spring 20 is fixed by one end to the spring winder 21 by means of a screw 26 via the mounting base and by the other end to the shaft of the spring winder 21.

Fig. 3 presents the safety brake 14 along section B-B in Fig. 2 in a position corresponding to normal elevator operation, where the elevator can move in the directions indicated by the UP-DOWN arrows. The frame 27 of the safety brake back stop 17 is fastened by its foot to the base 15 by means of screws 22.

The back stop 17 is a rectangular body and the side of its frame facing towards the ropes is provided with a slot and with a stop plate 28 in the slot. The stop plate is attached to the frame 27 with two screws 29. On the side facing towards the ropes, the stop plate 28 is coated with a friction material 54. The friction material has a suitable friction for stopping the rope and in addition it reduces the surface pressure applied to the rope during safety brake action. Mounted around the screws between the frame and the stop plate are discoidal springs 30. When a force is applied to the stop plate, the plate is pushed inwards into the slot. The jaw 18 consists of a jaw stem 31 and a ram part 32 having a cylindrical surface. The jaw is linked to the conveyor 19 by means of a joint 25 and sustained in a symmetrical balance position relative to the axial line 34 by means of a spring 58. In this symmetrical position, the cylindrical surface extends equally far above and below the axial line 34. The centre of curvature 59 of the cylindrical surface lies on the axial line 34 outside the joint 25, so the jaw is a bilateral wabbler turnable in two directions. The shape of the jaw can be varied, the jaw may be provided with grooves for each rope and its geometric form may differ somewhat from a cylindrical surface, and the cylindrical surface on either side of the axial line may be provided with a planar extension so that, at the final stage of the braking action, the rope will be squeezed between one of these planar parts and the stop plate 28.

The conveyor 19 consists of a frame part 35 attached to the base 15 by means of screws 23. The conveyor 19 has a bearing bush 36 on the axial line 34 and a piston 37 inside the bush 36. Thus, the piston can move with respect to the bush in the axial direction, but its rotation relative to the bearing 36 is prevented by a guide bar provided between the piston and the bearing bush. At the end pointing towards the jaw, the piston has a supporter 38 for the joint 25. Inside the piston there is a threaded cylinder 39 laid in the direction of the axial line, and the piston 37 and the threaded cylinder 39 have a thread 40 between them. The thread is self-locking, i.e. its pitch is such that the threaded cylinder 39 cannot be rotated by a force applied from the rope 8 towards the jaw 18 in the direction of the axial line 34. The conveyor spring 20 is a spiral spring one end of which is fixed to the frame 44 of the spring winder 21 and the other end to the shaft 43 (see Fig. 7). The shaft 43 has a boss in the region under the spiral spring. Mounted on the other end of the shaft 43 is a mechanism for operating the spring winder, attached to the shaft by means of a chain sprocket 48. Placed at this other end of the shaft is also a fixture 55 for a manual actuator 56. Shaft movement in the direction of the axial line 34 is prevented. The threaded cylinder 39 is fixed to the shaft 43 with a screw

41 and its rotation relative to the shaft 43 is prevented by a pin 42. When the threaded cylinder 39 is rotated, the shaft 43 is rotated as well and the piston 37 can move along the axial line 34, moving the jaw towards the elevator ropes 8. The threaded cylinder 39, shaft 43 and piston 37 constitute a self-locking screw 57. The threaded cylinder 39 and the shaft 43 can be integrated as a single part.

The spring winder 21 is fixed by its frame 44 to the base 15 by means of screws 24. The shaft 43 is supported by the frame 44 by means of bearings 46. Mounted with a bearing at the end of the shaft 43 is a cradle 47 to which the chain sprocket 48 is attached. Between the frame 44 and the cradle 47 there is a linkage controlled by a coupling 45. The coupling 45 is preferably a magnetic coupling with a field coil attached to the cradle and an armature which can move through a short distance in the direction of the axial line. When the magnetic coupling 45 is energized, its armature is linked to the cradle and the chain sprocket 48 can rotate the shaft 43. When the magnetic coupling 45 is de-energized, the linkage between the armature and the sprocket 48 is broken off and the shaft 43 with the armature is free to rotate. The chain sprocket 48 is driven by means of a chain 49 by another chain sprocket 50, which in turn is driven by a winding motor 51 via a gear 52. The gear is self-locking, in other words, the motor 50 cannot be rotated by the chain sprockets 48 and 50.

In a normal operating condition of the safety brake, the magnetic coupling 45 is energized, a continuous torque link exists between the motor 51 and the threaded cylinder 39, the jaw 18 is sustained in a horizontal position by the sustaining spring 58 between the jaw 18 and the frame part 35 of the conveyor 19 and the spiral conveyor spring 20 stores a charge of energy (the spring is tensioned). The conveyor spring 20 has been charged with energy prior to the operating situation by rotating the shaft 43 via the torque link by means of the motor 51. Fig. 3 does not show the limit switches required to stop the rotation after a sufficient number of revolutions because the use of such switches is obvious to a person skilled in the art.

Fig. 4 represents a situation where safety brake action has been started. The safety brake is activated by disconnecting the voltage to the magnetic coupling. This breaks the torque link between the armature of the magnetic coupling on the shaft 43 and the cradle 47, whereupon the conveyor spring 20 starts to rotate the shaft 43. The threaded cylinder 39 mounted on the shaft rotates with the shaft and pushes the piston 37 and the jaw 38 connected to it with a joint towards the back stop 17. In the situation depicted, the jaw 18 has pushed the ropes 8 onto the back stop 17, so the air gaps between the ropes and the back stop have disappeared. The situation presented in the figure is the same both in the case of upward overspeed and in the case of downward overspeed. An overspeed in the up direction may occur e.g. in an elevator whose counterweight exerts on the elevator car a pull that exceeds the weight of the elevator car and its passengers.

The elevator rope 8 is squeezed between the ram part 32 of the jaw 18 and the stop plate 28 of the back stop 17 and the jaw is turned about the joint 25 in the direction of rope movement. The friction between the rope 8 and the ram part 32 and between the rope and the stop plate 28 retards the rope movement, finally stopping it altogether.

Fig. 5 presents the final situation after an upward overspeed situation. The elevator rope 8 has been squeezed between the ram part 32 and the stop plate 28. Via the medium of the rope 8, the ram part 32 has pressed the stop plate 28 partially into the back stop 17, compressing the discoidal springs 30. The turning movement of the jaw 18 has been stopped by a stopper 33. In this condition, the safety brake develops the desired braking force. The braking force of the safety brake can be altered e.g. by replacing the discoidal springs 30 with springs having a different spring constant or by shifting the back stop 17 in the direction of the axial line 34. The use of a safety brake jaw of an eccentric shape is based on the fact that the eccentric shape develops an additional force acting in the same direction with the force pushing the jaw, so the pushing force exerted by the conveyor can be much smaller, in other words, the eccentric structure enhances the force applied to the rope.

Fig. 6 shows the position of the safety brake components after a downward overspeed. In respect of the safety brake components, the situation is the same as above except that the jaw has now turned downwards and its turning movement has been stopped by the other stopper 53.

Fig. 7 presents the conveyor spring 20 of the safety brake as seen from the direction of the axial line 34. The conveyor spring may consist of a single spiral spring element or several elements in parallel. The outer end of the spiral spring is attached with a screw 26 to the spring winder 21. The inner end of the spiral spring is fixed to the shaft 43. When the shaft is rotated, the conveyor spring is charged with energy, and this energy acts as a motor which drives the shaft 43 and the jaw conveyor connected to it. To charge the conveyor spring with energy, the shaft is rotated by the motor 51 as explained in the description of Fig. 3.

The up/down overspeed signal required for the activation of the safety brake is produced by a known technique, e.g. by means of an overspeed governor or tachometer or the like. The overspeed signal controls a switching device used to switch off the current to the magnetic coupling. The safety brake performs its complete braking sequence independently of external voltages under the control of its internal energy source, the spiral conveyor spring.

The safety brake is fully capable of being remotely controlled and the releasing and closing of the brake can easily be associated with various inhibitions of elevator operation.

The safety brake can be activated (closed) by disconnecting the power to the magnetic coupling, and this can be effected by various electric signals such as "doors open due to malfunction", "failure of mains supply", "elevator motor unstable", "excessive wear of operating brake", "serviceman's locking switch", "elevator out of use", and so on.

The release of the safety brake can be associated with appropriate electric inhibitions, such as signals indicating the correct state of the motor, brake, electric drive and safety equipment. The safety brake is provided with a manual release gear for use in the event of a power failure.

The safety brake is constructed as a separate unit whose testing is easy to carry out using mere elevator ropes running in a testing apparatus.

The bidirectional safety brake of the invention can also be constructed as a design in which the stoppers 33 and 53 and the hinged jaw 18 are mounted on the frame 27 of the back stop and the stop plate 28 is attached to the piston 37. When the coupling 45 is de-energized, the conveyor 19 moves the stop plate 28 towards the jaw 18 and the rope is stopped by the principle explained in the description of Fig. 4-6, i.e. the rope is arrested between the jaw 18 and the stop plate 28.

The safety brake can also be used for stopping the governor rope of the elevator in both directions. In this case, the elevator rope 8 in Fig. 3-6 would be replaced with a governor rope. In this application, the size of the safety brake and the forces required to stop the rope are substantially smaller than in a safety brake used for stopping the elevator.

It is obvious to a person skilled in the art that the embodiments of the invention are not restricted to the application described above, but that they may instead be varied in the scope of the following claims.

Claims

1. Safety brake designed to stop an elevator rope (8) from upward and downward movement, comprising a back stop and at least one hinged jaw of an eccentric shape, between which said elevator rope (8) passes and at least one of which is moved towards the elevator rope (8) to squeeze the elevator rope (8) between them to effect braking, said eccentric shape of the jaw enhancing the braking applied to the elevator rope (8) to stop its movement, characterized in that the jaw (18) is shaped as a bilateral wabbler whose eccentric shape enhances the pressure applied by the jaw (18) to the elevator rope (8) in both directions of the elevator rope (8) to stop both upward and downward movement of the elevator rope (8).

2. Safety brake (14) according to claim 1, characterized in that the back stop (17) or the jaw (18) is moved towards the elevator rope (8) by means of a conveyor (19) comprising a self-locking screw (57) that is capable of resisting rotation of the self-locking screw by a force opposite to that pressing the elevator rope (8), thus preventing the self-locking screw (57) from moving in a direction away from the elevator rope (8).

3. Safety brake (14) according to claim 2, characterized in that the conveyor (19) is connected to a spiral conveyor spring (20) whose one end is attached to the self-locking screw (57) and in which the energy required for moving the back stop (17) or jaw (18) is stored.

4. Safety brake (14) according to claim 3, characterized in that the safety brake (14) is provided with a spring winder (21) consisting of a motor (51) and a coupling (45) connecting the spring winder to the self-locking screw (59), said motor (51) being used to charge the conveyor spring (20) with a charge of energy required for moving the back stop (17) or the jaw (18).

5. Safety brake (14) according to claim 4, characterized in that the coupling (45) is a magnetic coupling such that when the magnetic coupling is de-energized, no torque link exists between the motor (51) and the self-locking screw (57), and when the magnetic coupling is energized, a torque link exists between the motor (51) and the self-locking screw (57).

6. Safety brake (14) according to any one of claims 1-5, characterized in that the elevator rope (8) is the governor rope.

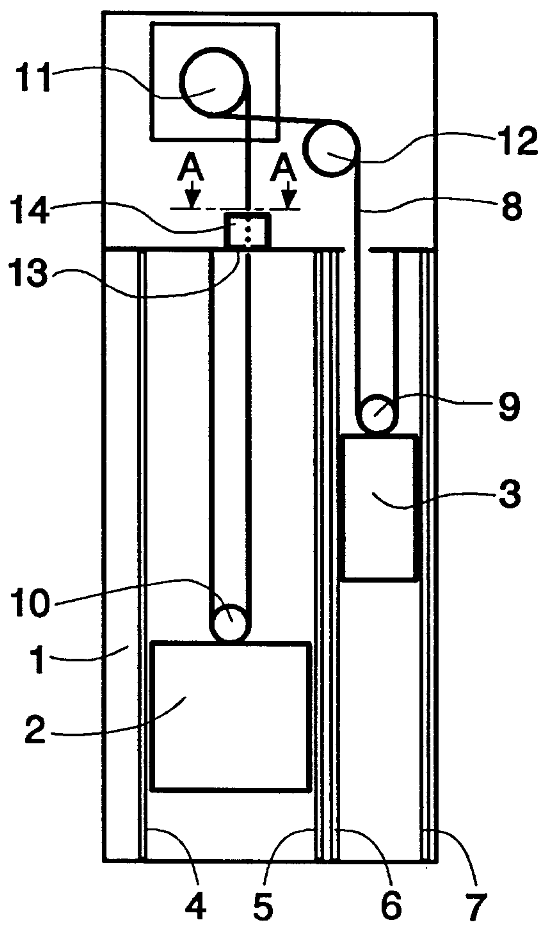

Fig. 1

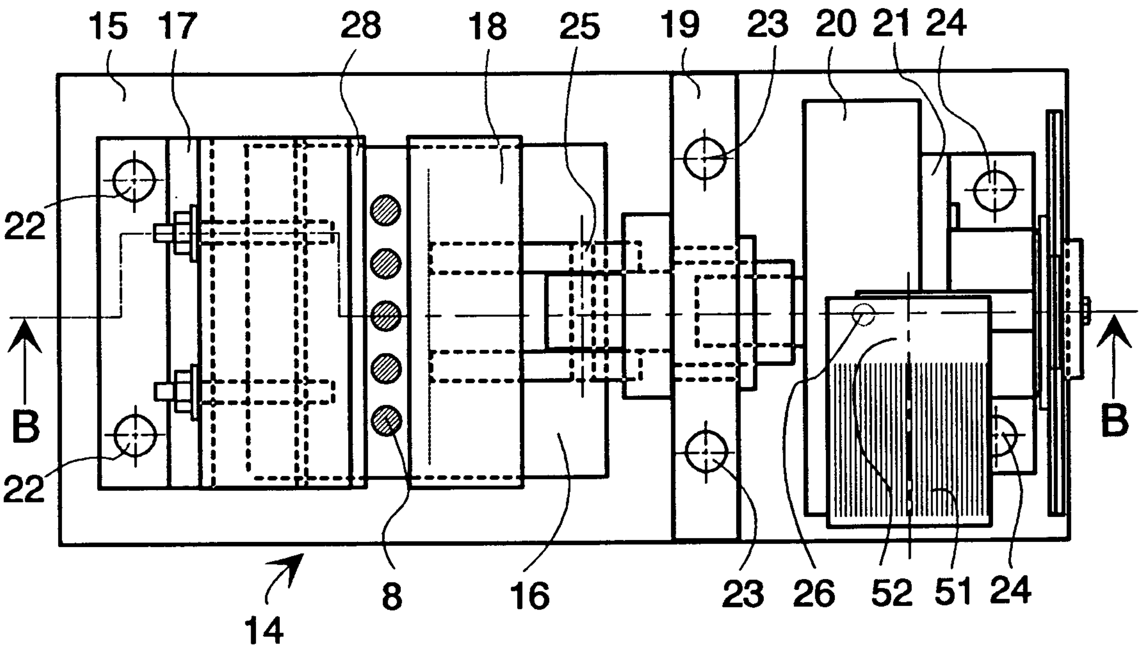

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Fig. 2

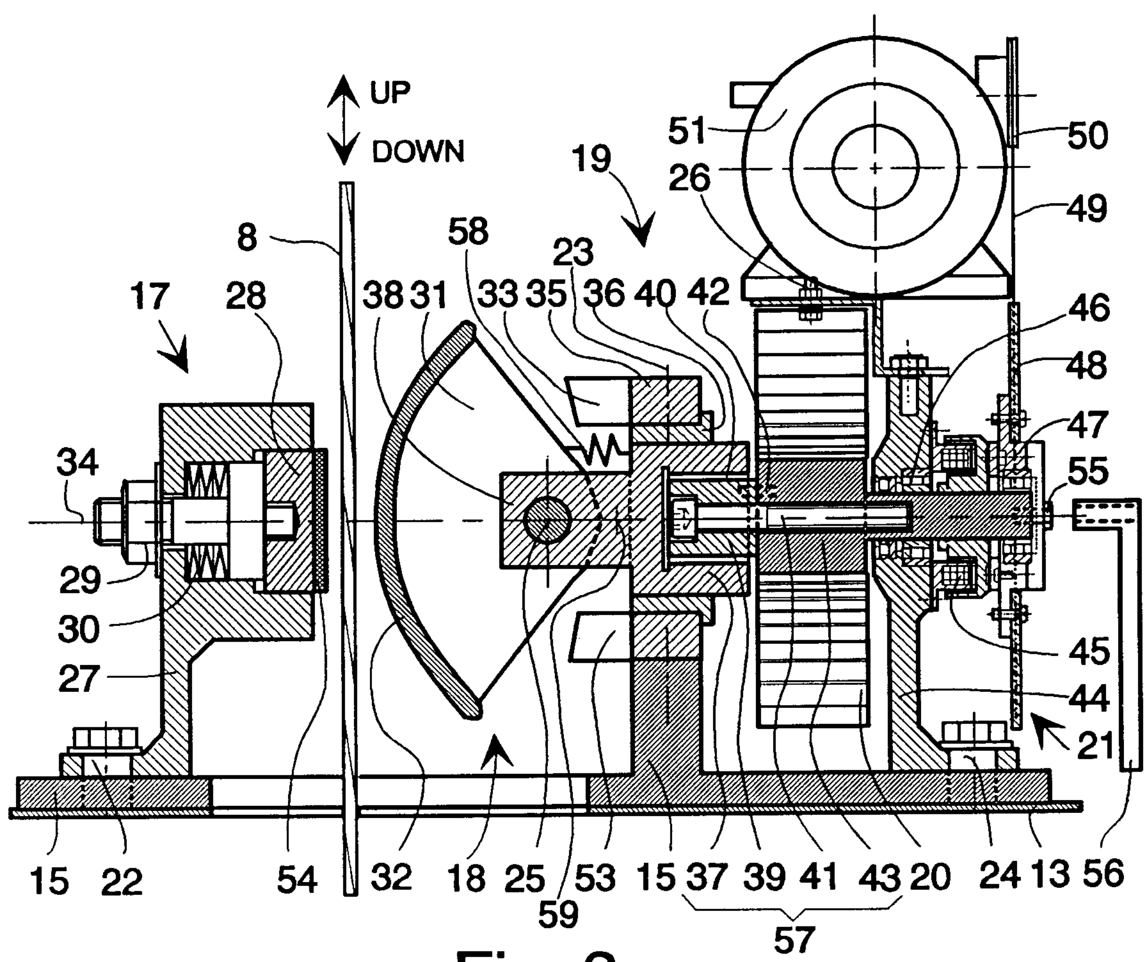

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Fig. 3

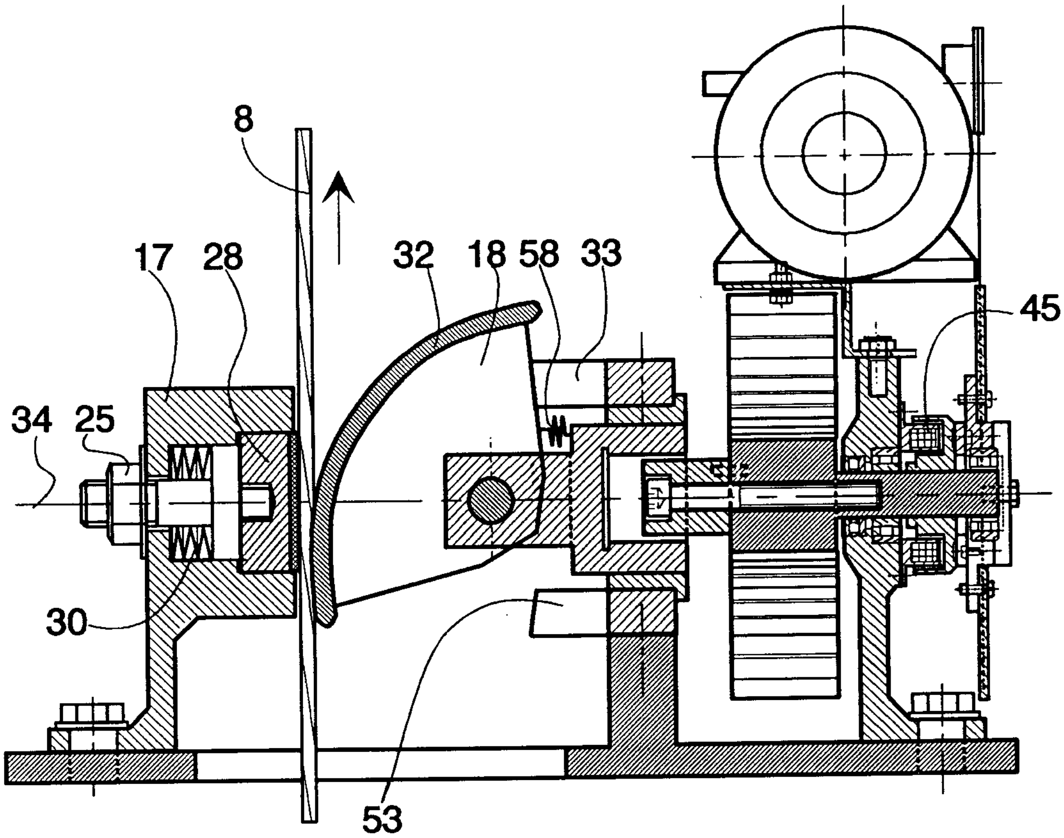

Fig. 5

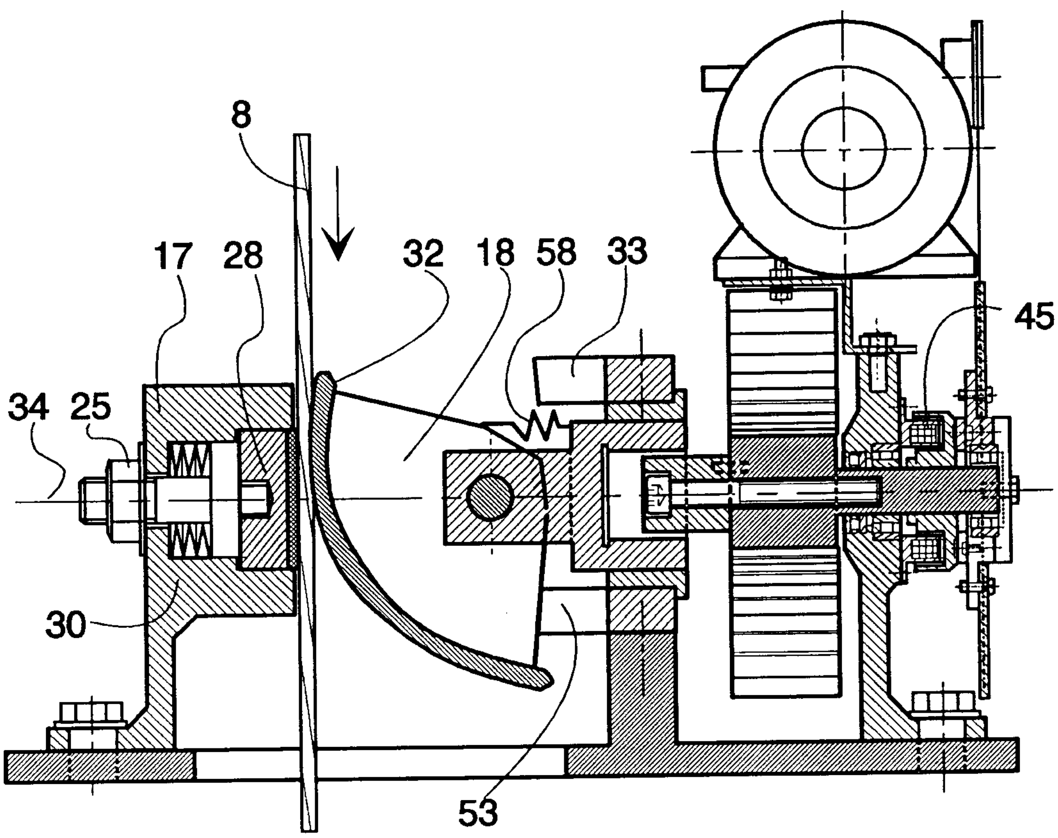

Fig. 6

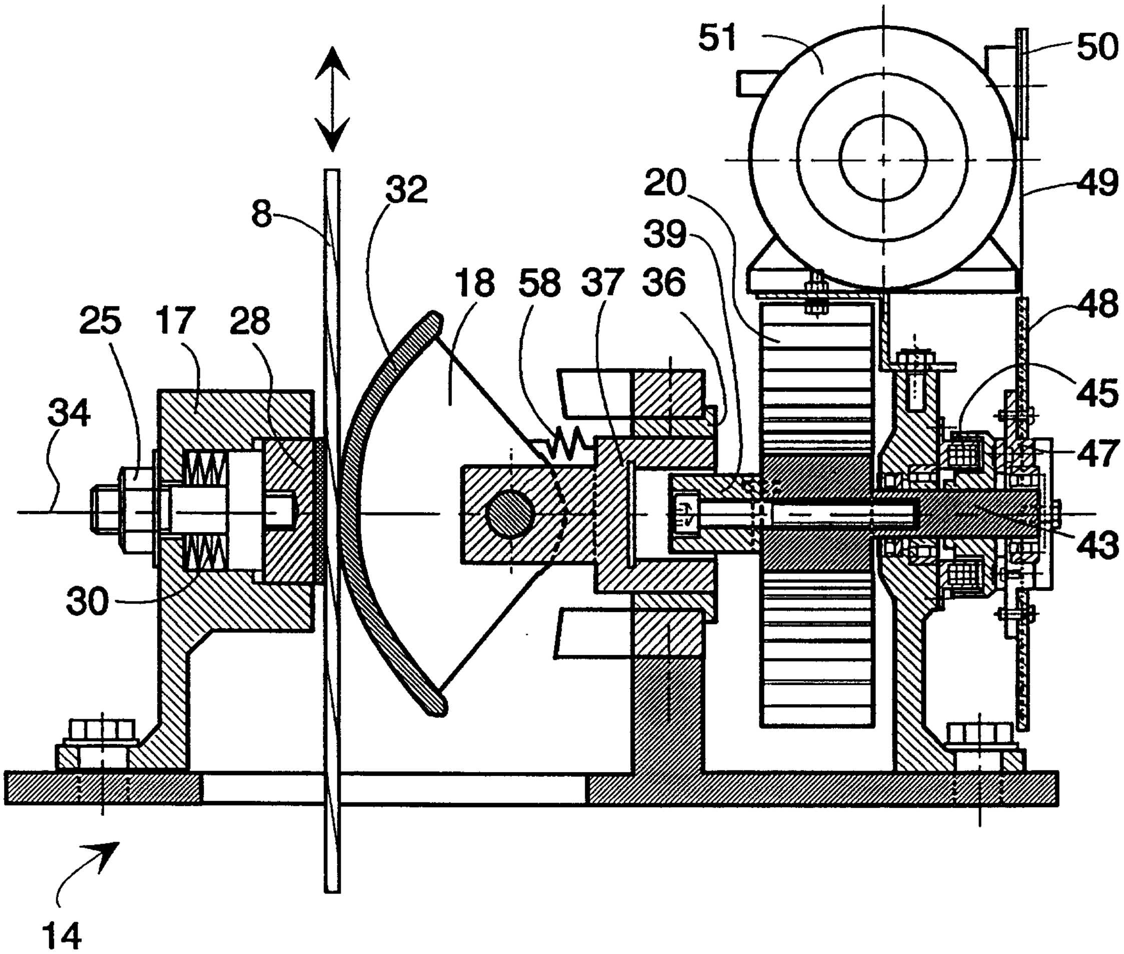
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Fig. 4

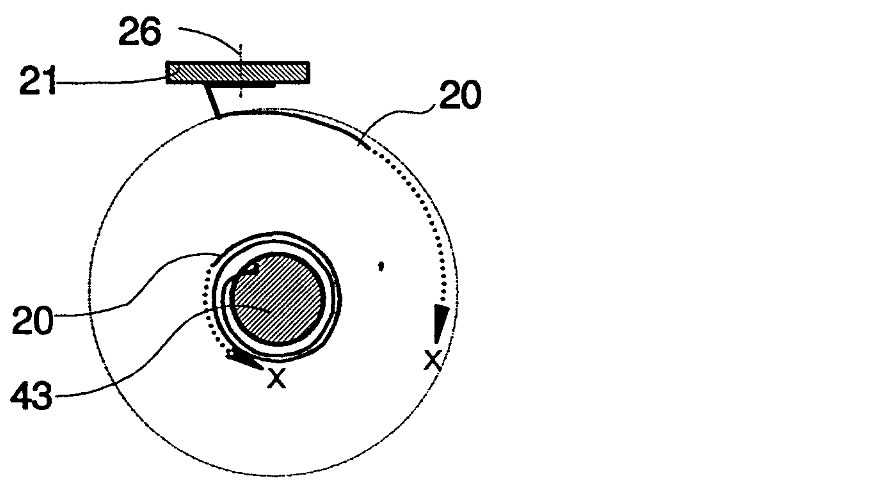
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Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 95 11 6413

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	CH-A-568 870 (SCHWEIZERISCHE EIDGENOSSENSCHA) 14 November 1975 * column 3, line 54 - column 4, line 11; figures 7,8 *	1	B66B5/24 B66B5/04
Y		2	
Y	FR-A-330 353 (MEECH) 17 August 1903 * page 1, line 50 - page 2, line 9; figures 3-5 *	2	
A	US-A-5 183 979 (SHERIDAN WILLIAM G ET AL) 2 February 1993 * abstract *	1-5	
A	US-A-3 976 168 (YAMAMOTO MAYJUE A) 24 August 1976 * abstract *	2,3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B66B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 January 1996	Sozzi, R

CATEGORY OF CITED DOCUMENTS

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