

Safety brake with retardation-dependent braking force

The invention relates to a safety brake, with a retardation-dependent braking force, for a load receiving means of a lift, which brake is triggered by a lift speed limiter in the case of excess speed of the load receiving means, wherein at least one brake wedge penetrates into a tapering gap between a resiliently supported pressure body of the safety brake and a guide rail of the load receiving means and thereby generates a braking force and wherein the magnitude of this braking force is dependent on the retardation occurring at the load receiving means.

In the case of usual safety brakes a safety brake base body engages around the guide web of a guide rail of the load receiving means and comprises at least one pressure body, which on the one hand forms, together with the guide web, a gap tapering in opposite direction to the direction of travel of the load receiving means and on the other hand is movable, counter to a spring element, perpendicularly to the guide web. In the case of excess speed of the load receiving means, a speed limiter mechanism displaces a brake wedge into the tapering gap between the pressure body and the guide web moving relative thereto, whereupon the brake wedge is drawn into the tapering gap by friction at the guide web up to an abutment at the base body and then slides along the guide web until standstill of the load receiving means. The pressure body is forced against the spring element by the wedge effect. The spring force resulting therefrom acts by way of the pressure body on the brake wedge and determines the perpendicular force arising between the brake wedge and the guide web and thus the arising frictional force acting as braking force at the load receiving means.

Such safety brakes have the disadvantage that the perpendicular force acting on the brake wedge is always of the same size independently of different useful loads in the load receiving means and other influences, such as, for example, the state and contamination of the brake surfaces, the instantaneous speed and the ambient temperature. This has the consequence that, in the case of braking, significantly different retardation values occur at the load receiving means. Since, for reasons for safety, a certain minimum retardation must be guaranteed, retardation values beyond the permissible limit value often result in the case of a minimum useful load.

There is known from DE 3934492 a safety brake, which is fastened to load receiving means of a lift, with a safety brake body constructed as a clasp with non-crossing clasp arms, in which on one side of the clasp joint the clasp arms embrace the guide web of a guide rail. One of these clasp arms at the guide rail side has a fixed friction element and
5 the other is formed as a pressure body which, together with the guide web, forms a gap tapering in the opposite direction to the direction of travel of the load receiving means. A brake wedge is mounted between the pressure body and the guide web and does not contact the guide web in normal operation. On the other side of the clasp joint a biased spring element produces a spreading force on the clasp arms, which in normal operation
10 act on an abutment limiting the opening width of the clasp arms.

In the case of excess speed of the load receiving means a speed limiter mechanism lifts the brake wedge, whereby this comes into contact with the guide web moving relative to the safety brake and is drawn by the web, through friction, into the tapering gap up to an
15 abutment. The consequentially arising clamping force spreads the clasp arms at the side of the guide rail, whereby, on the other side of the clasp, the biased spring element is pressed. The biasing force of this spring element now presses the friction element by way of the clasp arms on the one hand and the pressure body and brake wedge on the other hand against the guide web, whereby a braking force arises at the load receiving
20 means.

In order to adapt the braking force, which is produced by this safety brake, to the respective conditions influencing the braking process, i.e. to always be able to achieve the same retardation at the load receiving means, the safety brake constructed as a clasp has
25 at its clasp arms at the spring element side an electromagnet system which, in the case of a safety braking, counteracts the spring force of the spring element and thereby the perpendicular force acting on the brake wedge and thus reduces the braking force. The force effect of the lifting magnet system or the size of the braking force reduction is so regulated by a current regulator in dependence on the signal of a retardation measuring
30 sensor that the load receiving means is always braked with the same retardation.

Such a safety brake has the disadvantage that it requires a large installation area, especially because the electromagnet system has to act on relatively long clasp arms in order to be able to influence the large braking perpendicular force in a sufficient range.
35 Moreover, it requires a complicated electronic regulating device which imposes substantial

demands with respect to functional reliability. In addition, an emergency current supply is necessary so that this remains functionally capable even in the event of a power failure.

5 The present invention has the object of proposing a safety brake which always brakes the load receiving means with the same retardation independently of different useful loads in the load receiving means and of other influences, such as, for example, the state and the contamination of the brake surfaces, the instantaneous speed and the ambient temperature.

10 The solution of the stated object is recited in the characterising part of claim 1 with respect to its most significant features and in the following claims with respect to further advantageous constructions.

15 The safety brake according to the invention has significant advantages. It is based on safety brake technology known for a long time and needs little more installation space than a conventional construction. It does not require any electronic regulating device, which has to satisfy high demands in terms of technical reliability, and in the case of power failure is still functionally capable with only an emergency current supply. It is simple to understand, install and adjust. Vibration problems in consequence of regulating
20 fluctuations cannot arise. A large number of existing conventional safety brakes can be retrofitted with components according to the invention.

In an advantageous development of the device according to the invention the speed at which the brake wedge penetrates into the tapering gap between pressure body and guide
25 rail is limited during the entire penetration travel by a speed limiting device. It is thereby achieved that, in the case of safety braking, an abrupt build-up of the overall braking force and thus a correspondingly strong jolt on the load receiving means are avoided.

30 The stroke limiting device, which limits the penetration stroke of the brake wedge in dependence on the retardation of the load receiving means, preferably consists of a hydraulic system. Large forces, such as can occur in this connection, can be managed by hydraulic means on a smallest possible installation area.

35 In expedient manner the speed limiting device, which limits the penetration speed of the brake wedge, is also realised by hydraulic means. Such a solution is functionally reliable

and adjustable in simple manner.

In a particularly simple embodiment of the invention the said stroke limiting device for the brake wedge consists of a hydraulic cylinder with a piston rod, a hydraulic fluid container
 5 and a control valve arranged therebetween, wherein a retardation sensor so influences the control valve that this blocks the movement of the hydraulic cylinder and thus the further penetration of the brake wedge as soon as and for as long as the retardation of the load receiving means exceeds a specific value.

10 A further advantageous development of the invention consists in that the retardation sensor is a weight body which is movably connected with the load receiving means and the inertial force, which arises through the retardation of the load receiving means, of which influences the control valve by way of a lever system. The inertial force in that case usual acts against a spring, the spring constant of which is determined in dependence on
 15 the inertial force of the control valve stroke.

The weight body of the retardation sensor is preferably displaceably arranged on a first arm of a two-arm lever, so that there can be set at which retardation of the load receiving means the inertial force thereof has the effect of reversing the second lever arm of the
 20 control valve against the spring effect.

It is expedient to realise the speed limiting device for limitation of the penetration speed of the brake wedge in such a manner that an adjustable hydraulic flow valve limits the flow of the hydraulic fluid which flows from the hydraulic cylinder, which limits the penetration
 25 depth of the brake wedge, by way of the control valve to the hydraulic fluid container.

In a preferred embodiment the flow valve limiting the penetration speed of the brake wedge is constructed as an orifice valve or as an adjustable flow regulating valve. Orifice valves have a throttle effect virtually independent of temperature and viscosity of the
 30 hydraulic fluid. Flow regulating valves cause a constant throughflow independently of the prevailing pressure of the hydraulic fluid and thus guarantee a constant penetration speed of the brake wedge.

In a further embodiment of the invention the retardation sensor consists of a retardation
 35 sensor which is mounted at the load receiving means and in which, for example, a strain

gauge force sensor detects the inertial force, which results from the retardation of the load receiving means, of a measuring body and influences an amplifier circuit which electromagnetically actuates the control valve.

- 5 A further advantageous development of the invention consists in that the hydraulic fluid container is constructed as a pressure storage device. In this manner the entire stroke and speed limiting system for the brake wedge is a closed hydraulic system standing under low excess pressure. Air inclusions, which are caused by vibrations, in the hydraulic fluid and the contamination thereof are thus excluded, which ensures a highest
10 functional reliability of the system. Moreover, automatic resetting of the hydraulic cylinder after an instance of braking is effected by the mentioned excess pressure instead of by a compression spring.

- In a preferred embodiment of the safety brake this comprises a single hydraulic block
15 which contains all connecting ducts of the hydraulic system, wherein all other components of the hydraulic system are either integrated in this block or fastened thereto.

Embodiments of the invention are illustrated in Figs 1 to 3 and explained in more detail in the following description.

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Fig. 1 shows, schematically, an example of an installation situation of the safety brake according to the invention in a lift installation,

Fig. 2 shows, in schematic illustration, the safety brake according to the invention
25 with one brake wedge per guide rail and with an open hydraulic fluid container and

Fig. 3 shows a variant of the safety brake with two brake wedges per guide rail, with a pressure storage device as hydraulic fluid container and with an
30 electrical drive control of the control valve.

Fig. 1 shows a lift installation with its most important components. Recognisable are two guide rails 1, a load receiving means 2 guided by guide shoes 7 at the guide rails 1, a drive unit 3, a counterweight 4, support cables 5, a lift speed limiter 6 with a limiter cable
35 11, and two safety brakes 8 according to the invention with a trigger lever 9 and a trigger

connecting element 10.

In the event of safety braking the lift speed limiter 6 blocks a limiter cable 11, which triggers the two safety brakes 8 by way of the trigger lever 9 and the trigger connecting
 5 element 10, whereby the load receiving means 2 is braked.

In Fig. 2 there is to be recognised one safety brake 8 according to the invention, the housing 15 of which engages around the web of a guide rail 1 and comprises a brake wedge 13 which protrudes into a tapering gap between a pressure body 14 and the web of
 10 the guide rail 1. The pressure body 14 is supported relative to the housing 15 of the safety brake by way of spring elements 16. The arrow 17 is a symbol for a trigger mechanism, which is not illustrated in more detail here and which in the case of excess speed of the load receiving means 2 is activated by the lift speed limiter 6 via limiter cable 11 and trigger lever 9 and introduces the brake wedge 13 into the mentioned tapering gap. The
 15 brake wedge 13 thereby goes into contact with the guide rail 1 moving relative to the safety brake and is drawn by the rail into the tapering gap, since the contact surface between the brake wedge 13 and pressure body 14 is arranged to be particularly low in friction through coating or roller mounting. Due to the wedge action, the brake wedge 13 forces the pressure body 14 against the spring elements 16, which thereby build up a
 20 pressure force. These press the brake wedge 13 by way of a pressure body 14 against the guide rail 1, which is supported at the housing 15, which engages therearound, of the safety brake. The thus-arising friction between the guide rail 1 and the brake wedge 13 as well as between the guide rail 1 and the housing 15 acts as a braking force on the load receiving means 2. The magnitude of this braking force is proportional to the depth of
 25 penetration of the brake wedge 13 into the tapering gap, since the spring elements 16 are compressed in proportion to the depth of penetration. This depth of penetration is, in the case of a safety brake according to the invention, determined by a variable abutment, which in accordance with the invention is formed by a hydraulic cylinder 18 with a piston rod 19. The cylinder chamber remote from the piston rod 19 of the hydraulic cylinder 18 is
 30 connected by way of a flow valve 20 and a control valve 21 with a hydraulic fluid container 22, wherein these connections can be constructed as pressure-tight pipe ducts or as connections within a hydraulic block. The flow valve 20 is constructed as an orifice valve or as a flow regulating valve with a non-return valve and has the task of so influencing the outflow of the hydraulic fluid from the hydraulic cylinder 18 that the brake wedge 13 in the
 35 case of braking is drawn into the tapering gap at controlled speed, so that the jolt occurring

at the load receiving means 2 at the start of braking is reduced. A construction of the flow valve 20 as a flow regulating valve has the advantage that the throughflow of the hydraulic medium is kept constant independently of the pressure ratios. The control valve 21 has the task, when actuated, of interrupting the outflow of the hydraulic fluid from the hydraulic cylinder 18, wherein the actuation takes place by way of a retardation sensor 23. This comprises a weight body 24 mounted to be displaceable on the horizontal limb of a pivotably mounted bellcrank 25, wherein the mounting 26 thereof stands in mechanical connection with the load receiving means 2. On retardation of the load receiving means 2 from downward travel the inertial force of the weight body 24 in the bellcrank 25 causes a moment, which is proportional to the retardation, about the mounting 26 thereof. The other limb of the bellcrank 25 acts with a corresponding force on an actuating element 27 of the control valve 21, wherein it has to overcome the counter force of a spring 28 which seeks to keep the actuating element 27 in the position corresponding to the throughflow setting of the control valve 21. The displaceability of the weight body 24 on the bellcrank 25 makes it possible to adjust the switching point of the control valve 21 to different retardation values. In order to avoid vibration problems during a braking process, the movement of the bellcrank 25 is damped by an adjustable hydraulic damping element 29.

Safety braking with the safety brake according to the invention takes place as follows:

The trigger mechanism (arrow 17) lifts the brake wedge 13 until this is clamped in place in the tapering gap between the pressure body 14 and guide rail 1. Due to the constructional measures explained in the foregoing the friction between the brake wedge 13 and guide rail 1 is higher than between the brake wedge 13 and pressure body 14, which has the consequence that the guide rail 1 moving relative to the safety brake draws the brake wedge 13 into the tapering gap, wherein the brake wedge 13 simultaneously moves the piston rod 19 of the hydraulic cylinder 18 upwardly and in that case the hydraulic fluid disposed in the hydraulic cylinder 18 is displaced via the flow valve 20 and the open control valve 21 to the hydraulic fluid container 22. The flow valve 22 in that case looks after a controlled speed of penetration of the brake wedge 13.

As described in the foregoing, in this process there arises a depth of penetration of the brake wedge 13 proportional to the braking force acting on the load receiving means 2. If during penetration of the brake wedge the retardation of the load receiving means reaches a defined value, the retardation sensor 23 set to this value then reacts in that the inertial

force of the weight body 24 brings, by way of the bellcrank 25 and against the spring 28, the control valve 21 into the blocked state. A further penetration of the brake wedge 13 and an undesirably high retardation of the load receiving means 2 is thereby prevented. If the retardation of the load receiving means during the braking process falls below the set value, then the retardation sensor 23 would again release throughflow through the control valve 21 and enable a deeper penetration of the brake wedge until the set retardation value was achieved again. For resetting of the safety brake into the initial state after safety braking, the load receiving means is moved oppositely to the braking direction. The brake wedges in that case move out of the tapering gap and the hydraulic cylinder 18 is brought by a resetting spring 30 into its initial position, wherein the hydraulic fluid flows back out of the hydraulic fluid container 22, which is disposed higher, by way of the control valve 21 and the non-return valve of the control valve 20 and refills the corresponding piston chamber.

Fig. 3 shows a variant of the safety brake according to the invention with two brake wedges 13. This variant has the advantage relative to that according to Fig. 2 that the housing 15.1 does not, in the case of braking, have to execute a transverse movement for equalisation of the air gap 30 (Fig. 2), which is required in operation, between the housing 15 (Fig. 2) and the guide rail 1. The hydraulic cylinder 18.1 controlling the penetration speed of the brake wedge 13 here acts synchronously on the two brake wedges 13 by way of a bridge element 31.

In Fig. 3 the hydraulic fluid container 22 (Fig. 2) of the embodiment according to Fig. 2 is replaced by a pressure storage device 32, whereby the hydraulic system is completely closed relative to the environment and is protected against air ingress and contamination. The pressure storage device 32, which generates a low excess pressure, also looks after resetting of the hydraulic cylinder 18.1 after a safety braking.

An electromagnetic variant for drive control of the control valve 21.1 is similarly illustrated in Fig. 3. It comprises a retardation sensor 23.1, which has, as an integrated unit, a force measuring device on the basis of strain gauges, which device detects the inertial force of a weight body and generates an electrical signal at an amplifying and switching unit 33, which in turn acts on the actuating electromagnets 34 of the control valve 21.1.

The essential functions and effects of this variant of safety brake correspond with those of

the variant according to Fig. 2.

With analogous adaptation the safety brake according to the invention can obviously also be used as safety brake means for securing the load receiving means 2 against excess speed in upward direction.

Reference Symbol List

	1	guide rail
	2	load receiving means
	3	drive unit
5	4	counterweight
	5	support cable
	6	lift speed limiter
	7	guide shoe
	8	safety brake
10	9	trigger lever
	10	trigger connecting element
	11	limiter cable
	12	-
	13	brake wedge
15	14	pressure body
	15	housing
	16	spring element
	17	symbol for trigger mechanism
	18	hydraulic cylinder
20	19	piston rod
	20	flow valve
	21	control valve
	22	hydraulic fluid container
	23	retardation sensor
25	24	weight body
	25	bellcrank
	26	mounting (of the bellcrank)
	27	actuating element
	28	spring
30	29	damping element
	30	air gap
	31	bridge element
	32	pressure storage device
	33	amplifying and switching unit
35	34	actuating electromagnet

Patent Claims

1. Safety brake, with a retardation-dependent braking force, for a load receiving means of a lift, which brake is triggered by a lift speed limiter (6) in the case of excess speed of the load receiving means, wherein at least one brake wedge (13) penetrates into a tapering gap between a resiliently supported pressure body (14) and a guide rail (1) of the load receiving means and thereby generates a braking force and the magnitude of this braking force is dependent on the retardation occurring at the load receiving means, characterised in that the safety brake comprises a stroke limiting device (18, 18.1) which limits the penetration stroke of the at least one brake wedge (13) in dependence on the retardation of the load receiving means (2).
2. Safety brake according to claim 1, characterised in that it comprises a speed limiting device which adjustably determines the speed of the brake wedge (13) during the penetration stroke thereof.
3. Safety brake according to claim 1, characterised in that the stroke limiting device which limits the penetration stroke of the brake wedge (13) in dependence on the retardation of the load receiving means (2) is a hydraulic system influenced by a retardation sensor (23).
4. Safety brake according to claim 2, characterised in that the speed limiting device which adjustably determines the speed of the penetration stroke of the brake wedge (13) is a hydraulic system.
5. Safety brake according to claim 3, characterised in that the hydraulic system comprises a hydraulic fluid container (22), a hydraulic cylinder (18, 18.1) which limits by the piston rod (19) thereof the penetration stroke of the brake wedge (13) and which is connected with the container by way of a control valve (21, 21.1), and a retardation sensor (23, 23.1) which as soon as and for as long as a defined retardation of the load receiving means (2) is exceeded so influences the control valve (21, 21.2) that this blocks the hydraulic cylinder (18, 18.1) and thus prevents further penetration of the at least one brake wedge.
6. Safety brake according to claim 5, characterised in that the retardation sensor (23)



comprises a weight body (24) which is movably connected with the load receiving means (2) and which influences the control valve (21) by way of a lever system in the case of retardation of the load receiving means (2).

5 7. Safety brake according to claim 6, characterised in that the weight body (24) of the retardation sensor (23) is displaceably arranged on a first lever arm of a two-arm lever (25).

10 8. Safety brake according to one of claims 5 to 7, characterised in that the hydraulic cylinder (18, 18.1) limiting the penetration stroke of the brake wedge (13) and an adjustable hydraulic flow valve (20) belong to the speed limiting device, wherein the valve limits the flow of the hydraulic fluid from the hydraulic cylinder (18, 18.1) to the hydraulic fluid container (22, 32) via the control valve (21, 21.2).

15 9. Safety brake according to claim 8, characterised in that the adjustable hydraulic flow valve (20) is an orifice valve or a flow regulating valve.

20 10. Safety brake according to claim 5, characterised in that the retardation sensor (23.1) is a device comprising a mechanical-electronic force sensor which detects the inertial force of a measuring body occurring in the case of retardation and which actuates the control valve (21.1) by means of an electromagnet (34) via an electronic amplifying circuit (33).

25 11. Safety brake according to claim 5, characterised in that the hydraulic fluid container is a pressure storage device (32).

30 12. Safety brake according to one of claims 3 to 11, characterised in that a single hydraulic block per safety brake contains all connecting ducts of the hydraulic system, and all other hydraulic components are either integrated in this block or mounted thereon.

