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(54) **HYDRAULIC ELEVATOR CAR BRAKE UNIT WITH CONTROLLABLE BRAKING POWER**

HYDRAULISCHE BREMSEINHEIT FÜR AUFZUGSKABINE MIT STEUERBARER BREMSLEISTUNG

UNITÉ DE FREIN DE CABINE D’ASCENSEUR HYDRAULIQUE AVEC PUISSANCE DE FREINAGE POUVANT ÊTRE COMMANDÉE

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Description

State of the Art

[0001] Elevator car brake units are known in different embodiments and are necessary for very different purposes of operating an elevator.

[0002] For a long time elevators were only equipped with mechanically operated elevator car brake units which were activated by the speed governor rope remaining behind the elevator car in the case of overspeed.

[0003] In recent times the requirements for elevator car brake units are constantly growing. There is the wish that elevator car brake units do not only manage cases of emergency such as overspeed or the free fall of the elevator car. Instead, it should also be possible to use them as a brake, for instance in order to reliably prevent unintended car movement of an elevator car standing in front of a landing from prematurely leaving the landing, for instance under the influence of the changing weight of its loading. Example of this can be seen in EP 0648703 or DE 202004017587 U1.

[0004] Therefore, mechanically operated elevator car brake units are increasingly put aside and hydraulically operated elevator car brake units are used more often. Increasing demands are also made on these elevator car brake units. Recently, such elevator car brake units are also desired to dispose of a regulation of the brake force itself in the case of emergency. At least the elevator car brake units are to be as unobtrusively as possible during operation, they especially must not interfere with the driving comfort due to excessively abrupt application, and/or "gripping", or noise development during application.

Object of the invention

[0005] Having said that, it is the object of the invention to propose an elevator with at least one hydraulic elevator car brake unit which allows an effective open or close loop control of the brake force applied by the elevator car brake unit.

Inventive solution

[0006] This task is solved with the technical features of the elevator described in claim 1.

[0007] According to the invention, an elevator with an elevator car moving along guide rails up and down is provided. In most cases such an elevator car possesses no incorporated drive itself, but it is hoisted by means of at least one hoist rope and/or a hydraulic cylinder.

[0008] The inventive elevator comprises an open or close loop controlled hydraulic brake for decelerating the elevator car, in particular in case or irregular ride conditions as, for example, in case of overspeed.

[0009] The brake comprises at least one hydraulic actuator acting with its piston rod onto a brake pad. The words "acting onto" are preferably understood as "directly acting onto", however, in particular cases a broad sense of this words is appropriate. In such cases the words read "indirectly acting onto by means of a lever system". It can be sufficient that only one brake pad or brake lining of a pair of brake pads or linings is directly actuated by the piston rod. The piston rod is pre-stressed by a main spring unit in closing direction with a force that generates a brake friction. Usually this main spring unit generates the maximum brake friction determining the capacity of the brake. If a plurality of hydraulic actuators is provided, they will generate the maximum brake friction determining the capacity of the brake altogether.

[0010] The piston rod is connected to a piston which, depending on the hydraulic pressure prevalent in a first working chamber assigned to the piston, and, possibly, depending on the hydraulic pressure prevalent in a second working chamber assigned to the piston, completely or partly compensates the force of the main spring unit.

[0011] The speed with which the brake applies, and/or the resulting force with which the brake lining operated by the piston rod is pressed against the rail is open or close loop controlled by means of a hydraulic pressure source. The pressure side of the pressure source charges aforementioned first working chamber of the at least one piston with hydraulic fluid. The suction side of the pressure source is capable to suck hydraulic fluid from a second working chamber of the at least one piston.

[0012] Finally, an additional control line is provided that interconnects the first working chamber and the second working chamber. The actual flow rate of hydraulic fluid through the control line is determined by a control valve that is preferably designed as a remote control valve.

[0013] The working principle of the control line and the control valve determining the actual flow through it is as follows:

If the control valve is fully open, a pressure equalization between the first and the second working chamber can take place. Consequently the piston pre-stressed by at least one main spring unit can displace hydraulic fluid from the first into the second working chamber so that the brake applies. This will take place despite the fact that the pressure source may (dependent from the hydraulic layout) at the same time still tend to charge the first working chamber with pressurized hydraulic fluid while it tends to draw off (suck) synchronously hydraulic fluid from the second working chamber. The fully open control line will provide for pressure compensation also in regard to that.

[0014] If the control valve is fully closed, no pressure compensation via the pressure compensation line is possible between the first working chamber and the second working chamber. Due to the fact that the pressure source charges the first working chamber with pressurized hydraulic fluid while it draws off hydraulic fluid from the second working chamber (without any pressure compensation via the pressure compensation line being possible), the piston will be displaced into direction of the second working chamber until the piston has reached fully open position - that way the brake is released.

[0015] It is clear that the extent of pressure compensation between the first working chamber and the second working chamber can be open or close loop controlled by actuating the control valve that way that it is neither fully opened nor fully closed so that its actual hydraulic resistance determines the extent of the braking force applied.

Preferred Embodiments provided by the Sub Claims

[0016] A very preferred embodiment provides that the said at least one valve is a switching valve for exclusive on-off-service. Such a valve is no proportional valve. A proportional valve is characterized in that it controls the flow rate through its hydraulic path by bringing its valve body into a stationary position intermediate between "fully closed" and "fully opened" leaving free a defined hydraulically effective cross-section which corresponds to the desired flow rate. The aforementioned valve for exclusive on-off-service is characterized in that it possesses a valve body that cannot adopt a stationary intermediate position between "fully closed" and "fully opened", at least as long as energized. The only stationary positions that may be adopted (depending on the particular design) by the valve body are the positions "fully closed" or "fully opened".

[0017] The flow rate through the hydraulic path is controlled by repeated switching of the valve body back and forth between "open" and "close" - preferably this switching back and forth should take place repeatedly within one second. Ideally, the switching frequency amounts to 15 Hz or more.

[0018] It is advantageous if the valve for exclusive on-off-service is a seat valve, i.e. a valve having a valve seat that comes into sealing (fluid tight) contact with the valve body if the valve is closed.

[0019] The valve for exclusive on-off-service is preferably controlled by pulse width modulation, or frequency, or a mixture thereof.

[0020] There are two different modes for accomplishing said switching back and forth:

[0021] The first mode is to switch that way that the valve body comes at rest on its valve seat before switching over so that the valve body starts to move in opposite direction again. In the same way the valve comes at rest on the stopper that defines its "maximum-open-position" before switching over again. That way the hydraulic resistance of the valve can be controlled by determining how long the valve is fully closed and how long the valve is fully opened per time interval.

[0022] The second mode is called the "ballistic" mode: There is always a switching over from moving the valve body in one direction to moving it in opposite direction before the valve body comes at rest on the valve seat. In the same way there is a switching over again before the valve comes at rest on the stopper that defines its "maximum-open-position". That way the number of "hits" between the valve body and the valve seat and/or the stopper is drastically reduced, being positive in regard to wear and/or fatigue of the contact zones.

[0023] A mix of the first and the second operation mode is possible.

[0024] In each case one can call this valve a "pulsed" valve. This allows a very dynamic control as it is required to precisely master - as an example - frictional conditions that may vary along the guide rail within short distances, and/or to master a rope break when the elevator car is positioned only a few meters above the pit. An important advantage is that a pulsed valve is clearly more tolerant in regard to solid particles polluting the hydraulic fluid, because the pulsed valve does (different from a slide valve) not stay stationary in a position which forms a narrow gap that may be clogged by small particles carried by the hydraulic fluid.

[0025] According to another preferred embodiment, the hydraulic system comprises in addition to the pressure control line with the control valve a throttling line with a throttle control valve for noise reduced application of the hydraulic brake during or after landing of the elevator car, and/or a short-circuit line with a short-circuit valve for quick brake application in case of emergency, and/or a brake release line with a brake release valve for releasing the brake without activation of an hydraulic pump to such an extent that a new ride can start.

[0026] The aforementioned throttling line makes a soft application of the brake possible, that way avoiding the emission of audible noise when the elevator car brake applies when the elevator car has come or is coming to a standstill in a landing in order to avoid unintended car movement. That essentially improves the comfort of the ride. When the throttle control valve V3 is fully open, the throttling line still represents a hydraulic resistance that is preferably bigger than the hydraulic resistance of the control line and/or the short-circuit line when their according valves are fully open.

[0027] The provision of an additional short-circuit line with a short-circuit valve for quick brake application provides for redundancy. If the short-circuit valve is a valve that opens when not being energized, the system becomes absolutely fail-safe - when an emergency happens, the brake will apply even in case of power blackout and/or battery failure. The hydraulic resistance of the short-circuit line is preferably very small. That way the hydraulic fluid can be quickly displaced from one of the working chambers to the other working chamber, making the brake apply as fast as possible.

[0028] An additional brake release line with a brake release valve once again improves the comfort of the ride.

[0029] This brake release line interconnects the at least one actuator holding the brake actually closed upon actuation of the brake release valve with a pressure accumulator, or even at least one other brake actuator that exerts in this moment no braking action. That way a pressure compensation between the at least one active brake actuator and the pressure accumulator, or the at least one inactive brake actuator can take place. That releases the active brake actuator(s) at least to such an extent that a new ride can begin. The advantage is that it is not necessary in this phase to operate the hydraulic pump in order to at least partially release the brake. Later on, as soon as the travel speed of the elevator car is high enough to oversound or to mask the noise generated by the hydraulic pump, the hydraulic pump is activated to provide for full brake release and/or activated to charge the pressure accumulator or the at least one other brake actuator that has been involved into the silent brake release.

[0030] Preferably, the hydraulic supply unit comprises a hydraulic pump or a hydraulic pressure generator that is activated at least during performance of the inventive open or close loop control method without being itself speed, torque, or frequency, or power consumption controlled anyhow. At other times the hydraulic pump is preferably completely turned off. Here, the variation of the speed with which the pump is operated may be a consequence of the varying load conditions, there should normally be no external influencing or controlling of the speed. That decreases the expense compared to a speed-variable pump.

[0031] A preferred embodiment provides that the hydraulic cylinder is a double acting cylinder forming a first and a second working chamber. These working chambers are interconnected with one another that way that the same amount of hydraulic fluid as displaced from the first working chamber is taken up by the second working chamber when the piston moves. Such a hydraulic cylinder can be called a "double-rod" or "double stroke" cylinder. The big advantage of such a "double-rod" or "double stroke" cylinder (with equal piston-rod diameters) is that the full amount of hydraulic fluid that is displaced from one working chamber can - preferably directly - be taken up by the other working chamber. It is not necessary to vent a part of the displaced hydraulic fluid into the tank or reservoir and to feed it in again into the hydraulic system and out of the tank later.

[0032] Accordingly, only short ducts for the hydraulic fluid are required so that the stability and the response of the open or close loop control are improved. Moreover, the natural aging process of the hydraulic fluid is retarded due to the fact that a hydraulic system not always discharging a part of the hydraulic fluid into a tank gives the atmospheric oxygen, atmospheric humidity, and, maybe, particles of soil less detrimental access to the hydraulic fluid. That is important for an elevator car brake that has to be stable over long periods.

[0033] Preferably, the elevator comprises an elevator car brake with two or more hydraulic actuators, whereas at least the first working chambers or the second working chambers have a direct fluidal interconnection in the shape of a common rail. In some cases a first common rail is provided that interconnects all first working chambers and a second common rail that interconnects the second working chambers. In other cases a common rail may be divided by a valve into two parts when the valve is closed. That allows to define two, or two groups of actuators that can be operated independently from each other.

[0034] Another important option is to proceed that way that in the beginning of a departure the elevator car brake is opened by means of the pressure stored in a pressure accumulator, while the hydraulic pump starts with a delay. Preferably, the hydraulic pump is not started before the elevator car has reached at least 50 % of its regular travel speed. Another possibility is to drive the pump with a speed increasing according to the actual travel speed of the car during acceleration. That improves the ride comfort essentially: In order to avoid unintended car movement, the elevator car is secured during landing by means of applying the brake. In case that the hydraulic brake is reopened by starting the hydraulic pump before the elevator car has begun to move again, even the rather low noise of a modern hydraulic pump is clearly audible and therefore disturbs the impression of a comfortable ride. Instead the hydraulic pump will be started with a delay. Hence the hydraulic pump will not be started before the elevator car travels again with a speed that produces a driving noise sufficient for over-sounding the noise emission of the hydraulic pump.

[0035] Preferably, the brake comprises at least two of the initially defined hydraulic actuators being assigned to at least one brake pad, whereas one of these hydraulic actuators is used under regular operation as a hydraulic pressure accumulator delivering the pressure required for opening the elevator car brake in the beginning of a departure without operating the hydraulic pump. According valves required for performing such an operation are provided.

[0036] The basis for this approach is the following trick: In order to open a first brake pad belonging to a set of first brake pads applied to the guide rail for blocking against unintended car movement, at least to such an extent that the travel of the elevator car can start again, another, second brake pad of a second set of brake pads is moved in direction onto the guide rail to an extent that does not hinder the start. The movement of said second brake pad displaces that volume of hydraulic fluid that is required to open the first brake pad. Even if not required, it may be that one or both of said brake pads are dragged now along the guide rail, however, this is harmless. As soon as the elevator car has gained speed again, the hydraulic pump is started and provides now for fully retracting/lifting off the brake pads.

[0037] The aforementioned second brake lining whose hydraulic cylinder is used as a pressure accumulator, is preferably a brake pad belonging to an additional brake that is to be applied to the guide rail in case of an emergency only. In this case it is preferred to avoid that this second brake lining comes into dragging contact with the guide rail in other than emergency cases. Hence a design and/or steering should be chosen that stops moving this brake lining in direction to the guide rail before it contacts the guide rail in that way that the hydraulic cylinder assigned to this brake lining can be used as a pressure accumulator, too.

[0038] An according operation is possible, if a plurality of actuators operates the same brake pad: The actuators pressing actually onto the brake pad are released by moving the other, inactive actuators in direction onto the brake pad.

[0039] Alternatively it is possible to provide one hydraulic actuator that may be of the same type like the hydraulic actuators operating the brake pads, whereas this actuator is not assigned to a brake pad. The sole and only purpose of such an actuator may be to form a pressure accumulator that delivers the necessary amount of hydraulic fluid that is required to open the first braking pad as depicted before.

[0040] Preferably, the hydraulic elevator car brake used for performing the inventive method comprises an acceleration sensor, the signal of which is used in order to control the brake force, preferably in such a way that it is ≤ 1 g.

[0041] It is a preferred option that the elevator car brake comprises several hydraulic actuators acting all onto the same brake lining. Depending on the size of the currently needed brake force, all or individual actuators of one elevator car brake unit are activated. That way it is possible to tune the required brake force.

[0042] It is a further option that the elevator car brake comprises several hydraulic actuators acting onto different brake linings. Depending on the size of the currently needed brake force, all or individual actuators of one elevator car brake unit are activated. That way it is not only possible to tune the required brake force. A main advantage is that it is possible that way to completely save one or more brake linings for performing an emergency braking while being sure that these brake linings have not been subject of wear during regular operation of the elevator the time period before.

[0043] During standby of the elevator car the hydraulic pump is switched off while one or more valves are operated in such a way that the elevator car brake applies and develops its full brake force or the brake force necessary to prevent unintended car movement. That way the elevator car can be hold in standby position without any unintended car movement and with a minimum or no expenditure of energy.

[0044] Independent from the invention embodied by the claims discussed up to now, protection is sought for a method for open or close loop control of a hydraulic elevator car brake with a hydraulic actuator which has at least one piston rod that is pre-stressed by a main spring unit in closing direction with a force necessary for generating the required brake force (the definition given above for this applies here, too), whereas the piston rod is connected to a piston which, depending on the hydraulic pressure applied to it, completely or partly compensates the force of the main spring unit, characterized in that the resulting force with which the brake lining operated by the piston rod is pressed against the rail is open or close loop controlled by means of a speed-controlled and/or torque-controlled and/or multi-quadrant-operated motor which, as first alternative, depending on the actual needs, either drives a hydraulic pump in such a way that the hydraulic pump conveys hydraulic fluid and thus reduces the resulting force acting on the brake lining, or which acts as a generator or a braking motor braking a hydraulic pump in such a way that a - preferably close or open loop controlled - stream of the hydraulic fluid flows back via the hydraulic pump driven by the hydraulic fluid in the opposite direction of its actual conveying direction and thus increases the resulting force acting on the brake lining, and which, as second alternative, depending on the actual needs, drives a hydraulic pump in such a way that the hydraulic pump either conveys hydraulic fluid and thus reduces the resulting force acting on the brake lining, or that a leakage flow flows back via the hydraulic pump in the opposite direction of the conveying direction and thus increases the resulting force acting on the brake lining.

[0045] As another alternative concept, depending on the needs of the actual elevator operating conditions, the motor drives a hydraulic pump in such a way that the hydraulic pump either conveys oil and thus reduces the resulting force acting on the brake lining, or that a leakage flow flows back via the hydraulic pump in the opposite direction of the conveying direction and thus increases the resulting force acting on the brake lining. For generating such a leakage flow it can be sufficient, if the motor holds the hydraulic pump in standstill.

[0046] Further modes of operation, advantages and design possibilities of the invention result from the embodiments described by means of the figures.

List of Figures

[0047]

Fig. 1 shows a first basic concept for realizing the elevator in accordance with the invention.

Fig. 2 shows a second basic concept for realizing the elevator in accordance with the invention.

Fig. 3a shows a hydraulic piping diagram for a first embodiment of a car brake unit according to the invention using two separate groups of actuators, different on-off valves and a control valve for exclusive on-off-service.

Fig. 3b shows a hydraulic piping diagram for a second embodiment of a car brake unit according to the invention using two separate groups of actuators, a speed variable pump drive, but no control valve for exclusive on-off-service.

Fig. 3c shows a hydraulic piping diagram for a third embodiment of a car brake unit according to the invention using only one group of actuators, an additional pressure accumulator, and a control valve for exclusive on-off-service.

Fig. 3d shows a hydraulic piping diagram for a fourth embodiment of a car brake unit according to the invention using two groups of actuators, different on-off valves and a control valve for exclusive on-off-service.

Fig. 3e shows the same hydraulic piping diagram as Fig. 3d, while Fig. 3e visualizes the direction of flow through the individual hydraulic valves.

Fig. 3f shows a slight modification of the hydraulic piping diagram according to Fig. 3d, the valve V4 is modified here.

Fig. 3g shows a slight modification of the hydraulic piping diagram according to Fig. 3d, here the valves V3 and V4 shown by Fig. 3d are replaced by a combined valve V34.

Fig. 3h shows a hydraulic piping diagram for a seventh embodiment of a car brake unit according to the invention using only one group of actuators, an additional pressure accumulator, different on-off valves and a control valve for exclusive on-off-service arranged in a special fashion.

Fig. 3i shows a hydraulic piping diagram for an eighth embodiment of a car brake unit according to the invention being closely related to the construction according to Fig. 3h - using only one group of actuators, an additional pressure accumulator, different on-off valves and two control valves for exclusive on-off-service arranged in a special fashion.

Fig. 3j shows a hydraulic piping diagram for a ninth embodiment of a car brake unit according to the invention using two group of actuators, and a control valve for exclusive on-off-service arranged in a special fashion together with the other valves.

Fig. 3k shows a hydraulic piping diagram for a tenth embodiment basing on a reduced variant of the ninth embodiment.

Fig. 3L shows the principle of a hydraulic configuration that can be used if the pressure source for open or close loop controlling of one or more actuators 11 is not the hydraulic pump 19 itself, directly, without intermediate means.

Fig. 4a shows a hydraulic piping diagram for an eleventh embodiment using two separate groups of actuators, a speed variable pump drive and several on-off valves.

Fig. 4b shows a hydraulic piping diagram for a twelfth embodiment basing on the same fundamental principle as the embodiment according to Figure 3b and being simplified compared to the embodiment shown by Fig. 4a.

Fig. 5 shows a view diagonally from the front for a constructive execution example of the invention.

Fig. 6 shows a view diagonally from the front, in section along A-A for the constructive execution example of the invention shown in Fig. 5.

Preferred embodiments depicted by the figures

General preliminary remarks

[0048] Some general preliminary remarks on the elevators described here within the framework of the preferred embodiments are to be made which apply to all embodiments:
The elevator consists of a preferably gearless designed elevator drive 1 and an elevator car 4 which is led longitudinally - when traveling along the elevator car guide rails 2 - by means of guidance devices 3, and which shows the form of a closed cabin as a rule.

[0049] The elevator is preferably a rope elevator which is held at a number of support ropes which are not represented figuratively and which are mostly led via a traction sheave driven by the elevator drive which is also not shown.

[0050] From there the support ropes run directly or indirectly to a counterweight which can be moved at counterweight rails, which is also not represented figuratively here. They are attached to it or they bear the counterweight mounted in a block and tackle arrangement.

[0051] The elevator in accordance with the invention preferably dispenses with the so-called drive brake, or uses the latter only for reasons of redundancy. In this connection a "drive brake" is not the regenerative operation of the drive for reasons of possible energy recovery, but an additional mechanical brake which as a rule affects a brake drum or disc which is coupled with the drive shaft in order to avoid unintended car movement during landing, for example.

[0052] The elevator dispenses with a traditional overspeed governor embodied as a circulating rope which is attached to the elevator car, and thus compulsorily operated by it, and which runs via an overspeed governor which brakes the rope in the case of a certain speed being exceeded, and thus generates a mechanical force which activates the gripping device of the elevator car, and thus brings the elevator car to a standstill.

[0053] Instead, the elevator in accordance with the invention is equipped in most cases with a shaft copying device. As a rule, the latter consists of a route reference

5 which is fixedly attached next to the elevator car 4 along the traffic route, and a displacement sensor 6 which is attached to the elevator car and interacts with the route reference 5. In this case the shaft copying system cannot only determine the way, but can instead or preferably determine the related speed and/or acceleration information.

[0054] Alternatively the shaft copying system can also or additionally (redundancy) consist of a measurement installation which gathers information on route, speed, and/or acceleration via one or more wheels rolling at the rails and/or guide rails.

[0055] Again, alternatively or additionally, the shaft copying system can consist of a contact-free working range finder which permanently or close meshedly measures the current distance to a reference fixed point which is preferably located in the shaft pit and/or the shaft head and gathers the necessary rout, speed and/or acceleration information in this way. Preferably the shaft copying device measures the absolute position via at least one reference point e.g. in the shaft pit.

First basic concept

[0056] Fig. 1 shows the functional concept for an elevator of the type described above which can be used for the realization of a first embodiment of the invention.

[0057] In the case of this first concept, the elevator in accordance with the invention is equipped with a safety brake ESB which preferably consists of at least two electrically operated elevator car brake units 7a, 7b, which are attached to the elevator car at different positions and affect the guide rails. As a rule, each of the elevator car brake units forming the safety brake is designed in such a way and controllable by the control 10 of the elevator car that the speed or force can be influenced with which its brake linings apply. The said control 10 of the elevator car can be a control exclusively assigned to the brakes that does not steer other functions like opening or closing of the car doors, for example. For steering this other functions the elevator car may be equipped with another control, embodied as a separate part and not depicted by Figs. 1 or 2. The said control exclusively assigned to the brakes may be physically integrated into the brake units.

[0058] That way it is possible to improve the ride comfort - for example because a softer application of the brake linings after landing becomes possible, emitting no or less noise. Optionally the safety can be improved, too, because it can be considered to initiate the braking slower and therefore softer in case of an irregular ride condition. For the realization of the safety brake ESB preferably elevator car brake units are used which will be described in detail later on within the framework of this application.

[0059] In addition, the elevator in accordance with the invention is equipped with an electrically operated additional brake ESG which itself preferably consists of at least two electrically operated additional brake units 8a, 8b which are attached to the elevator car at different positions and affect the guide rails. The additional brake ESG is also controlled by the control 10 of the elevator car. For sake of completeness it is to be mentioned that this control 10 of the elevator car may optionally be a control that is exclusively assigned to, and possibly integrated into the car brakes. Then it can be called control 10 of the elevator car brake. It may be advantageous to design the additional brake in such a way that its response time is always minimal and its response intensity is always maximal - both compared to the safety brake and its preferably variable response times and response intensities. In this case brake units in the style of conventional brake mechanisms, safety catches and progressive safety gears can be used. However, contrary to the customary, these are designed in such a way that they alone do not apply the necessary brake force, but only part of it, while the rest of the maximally necessary brake force is applied by the safety brake. Thus, contrary to the standard, the worst case of the free fall is controlled by the safety brake and the additional brake together, to the effect that these necessarily have to interact.

[0060] It should be mentioned that the control of the safety brake ESB and the control of the additional brake ESG is preferably accomplished by the above-mentioned control of the elevator car, alternatively at least one of these brakes can also be controlled and/or triggered from a central elevator control.

[0061] For the realization of the additional brake ESG preferably also such brake units are used as described later within the framework of this application, i.e. brake units which can be operated cascadedly and wnicn combine the brake units necessary for the realization of the safety brake and the additional brake to a single elevator car brake unit.

[0062] Preferably, a power distribution is made between the safety brake ESB and the additional brake ESG, to the effect that one of the two brakes can apply at least 40 %, even better at least 45 % of the brake force which is necessary for the safe control of the free fall with full elevator car load, while the part of the brake force missing for 100 % is applied by the other brake. Insofar as the two brakes are not fully or essentially equal, which is preferred, the additional brake ESG is preferably the one which can apply a higher portion of the brake force.

[0063] For the realization of the invention it can be advantageous, according to the teaching of this first concept, if the safety brake ESB and the additional brake ESG are attached to different places of the elevator car. The brake units 8a, 8b of the stronger responding additional brake ESG are preferably attached in the lower half and ideally in the lower quarter of the elevator car. The elevator car brake units 7a, 7b of the softer responding safety brake ESB are preferably attached in the upper half and ideally in the upper quarter of the elevator car.

[0064] As already mentioned, a control 10 of the elevator car can be provided which travels with the elevator car 4. This control 10 is of the above-mentioned type. The control 10 of the elevator car preferably communicates with the elevator control 9 which carries out the total management of the elevator unit. Nevertheless, as a rule, the control 10 of the elevator car is designed in such a way that it can act autonomically, i.e. perform autonomically an open or close loop control.

[0065] As a rule, the control 10 of the elevator car or the elevator car brake itself (the brake unit itself) is equipped with an emergency power supply so that even in the case of power failure it can at least keep the additional brake ESG open and control it.

[0066] As a rule, the already mentioned control 10 of the elevator car is directly linked to the shaft copying system, thus constantly receives without detour via or processing by the central elevator control 9 current route, speed and/or acceleration information by means of which it can determine the current position and the current movement state of the elevator car.

[0067] Independent from the shaft copying system and the route, speed, and/or acceleration information delivered by it, the control 10 of the elevator car can additionally comprise at least one, better at least two acceleration sensors which independently generate an acceleration signal or use acceleration signals of sensors already included in the brake units. It is an option to design the brakes that way that they can be directly actuated by the acceleration signal of the aforementioned acceleration sensors.

[0068] As has already been mentioned, preferably, the control 10 of the elevator car is directly linked to the ESB safety brake 7a, 7b, and the ESG additional brake 8a, 8b, to the effect that the control 10 of the elevator car can activate the safety brake ESB (and, if necessary, the additional brake ESG) autonomously, without involvement of the central elevator control 9.

[0069] Preferably, the control 10 of the elevator car includes two independently acting circuits, one of which controls the ESB safety brake 7a, 7b, taking into consideration the shaft copying system, and the other one controls the ESG additional brake 8a, 8b, taking into consideration the information received from the at least one additional acceleration sensor.

[0070] The control 10 of the elevator car is in combination with the safety brake ESB and the additional brake ESG as well as (optionally) the central elevator control designed in such a way that at least one, better several and preferably all following conditions can be realized:

Free fall:

[0071] If free fall is detected, for instance due to the occurrence of an irregular high acceleration signal, and there is no power failure, preferably both, the safety brake ESB and the additional brake ESG are activated so that they brake together. Hereby the activation of the safety brake ESB is preferably carried out in such a way that it applies with maximum speed. The same applies preferably to the additional brake ESG, insofar as the latter is not constructed in such a way that it always applies with maximum speed after its activation.

[0072] Hereby the safety brake ESB and the additional brake ESG are designed in such a way that they in collaboration, altogether catch an elevator car allocated with nominal load with a deceleration of 0.2 g to 1 g, while the deceleration with an empty elevator car can rise above 1 g.

[0073] As a rule, the activation of the safety brake ESB will take place with the help of the signal delivered by the shaft copying system and with the help of at least one first circuit of the elevator car brake. The activation of the additional brake ESG can take place via the above-mentioned at least one additional acceleration sensor or with the help of at least one independent further circuit of the control for the elevator car brake.

[0074] If free fall is detected, e.g. due to the occurrence of an irregular high acceleration signal while power fails at the same time, the safety brake ESB responds due to the power failure unless it has been activated before due to over-acceleration on the basis of the signal delivered by the shaft copying system or the at least one acceleration sensor. As a rule, an inevitable application (closing) of the safety brake ESB in the case of power failure takes place, because the forces keeping it in open position collapse as a result of the power failure. The additional brake ESG is different. It is connected to the emergency power supply which actually keeps it open so that the additional brake ESG is still not activated per se due to the power failure, but preferably because of the fact that the at least one additional acceleration sensor delivers an acceleration signal which shows the free fall, or the control for the elevator car brake detects insufficient deceleration of the car by the ESB. Should the emergency power supply fail, too, then the additional brake ESG will apply, too, due to de-energizing.

[0075] Here again both brakes are designed in such a way that they are in collaboration able to catch an elevator car allocated with nominal load with a deceleration of 0.2 g to 1 g, while the deceleration with an empty elevator car can rise above 1 g.

Emergency stop:

[0076] In the case of an emergency stop without power failure, for instance because one of the elevator shaft doors was opened during the ride, the safety brake ESB is activated by the safety circuit, while the additional brake remains inactive. The safety brake preferably applies with maximum speed.

[0077] Hereby the safety brake is preferably designed in such a way that it causes a deceleration < 1 g with this kind of activation, as a rule because its maximum available deceleration is innately under 1 g.

[0078] Analogously the same applies to the interference of emergency stop and power failure, with the difference that the safety brake is activated by the power failure, unless the safety circuit has responded before.

Overspeed, roped:

[0079] If, e.g. due to the occurrence of a super-elevated speed signal (maybe in the case of a simultaneously uncritical acceleration signal), overspeed is detected in roped condition, and there is no power failure, the safety brake ESB will be activated, while the additional brake ESG is kept open. The safety brake preferably applies with maximum speed. Hereby the safety brake is designed in such a way that it applies a deceleration < 1 g. As a rule, the activation of the safety brake will take place with the help of the signal delivered by the shaft copying system.

[0080] Analogously the same applies to the interference of overspeed in roped condition and power failure, with the difference that the safety brake is activated by the power failure, unless the safety circuit has responded before.

Landing:

[0081] The safety brake ESB is activated, the additional brake ESG is kept open.

[0082] The activation of the safety brake ESB takes place deceleratedly, to the effect that the speed, with which the safety brake applies until it reaches is maximum brake and/or holding force, is reduced in order not to create disturbing noises.

[0083] If there is a power failure in the stop, the safety brake ESB closes completely due to the power failure (unless it has already done so) and remains closed for the time of the power failure. However, the additional brake ESG remains open.

[0084] The safety brake ESB will always be closed in such a way that it keeps the elevator car in a certain position, if the elevator car has stopped in the correct position of the stop, independent from the current weight of the elevator car which changes due to loading and unloading at this stop.

[0085] It can be convenient to not abruptly, but deceleratedly open the safety brake ESB after the loading and unloading process in such a way that the elevator car does not noticeably sag by some mm under the influence of a now possibly heavier load before the actual ride starts. The control 10 of the elevator car is designed accordingly.

Standby:

[0086] If the elevator car is in standby, i.e. in its waiting position for the next ride, the safety brake ESB will remain closed, in order to reduce the energy consumption. However, the additional brake ESG is kept open and remains on standstill, in order to be able to intervene immediately, if the free fall occurs for any reason.

Emergency terminal slow down:

[0087] The safety brake ESB and the control assigned to it are preferably designed that way that the safety brake will close as soon as it has been detected that the elevator car approaches the lowermost or uppermost landing with a speed that is too high for a regular stop.

Emergency rescue:

[0088] The safety brake ESB and the control assigned to it are preferably designed that way that an automatic emergency rescue will take place when pressing a button: Upon according activation, the safety brake ESB is partially opened so that the elevator car can move - even without motor power driven by the predominant weight force of the car or the counterweight - with a restricted speed into the adjacent landing. During this operation the motor carrying the traction sheave will be preferably short-circuited in order to generate a braking torque.

Protected space in the pit or the shaft head:

[0089] The safety brake ESB and the control assigned to it are preferably designed that way that they will automatically provide for a protected space in the pit or the shaft head as soon as it has been detected that a person has entered the pit or the shaft head.

Second basic concept

[0090] Fig. 2 shows the functional concept for an elevator of the type described above which can be used for the realization of a second embodiment of the invention.

[0091] In the case of this embodiment, the elevator in accordance with the invention is equipped with a safety brake ISB which consists of at least one, preferably two electrically operated elevator car brake units 7'a, 7'b which are attached to the elevator car at different positions and affect the guide rails.

[0092] The safety brake ISB is designed and controllable in such a way that the speed of its application can be influenced, and that its brake force is also influenceable, preferably by means of a close loop control.

[0093] Unlike the first embodiment of the invention, no additional brake is provided here. The safety brake ISB is designed in such a way that it is able to master all possible regular and irregular operating conditions alone. For this purpose each of the elevator car brake units 7'a, 7'b, is provided with at least one actuator - better several actuators - which preferably consists of several piston/cylinder units, not least for the purpose of reaching partial redundancy.

[0094] Furthermore, as a rule, an emergency power supply is provided which feeds the safety brake ISB and mostly the shaft copying system as well.

[0095] The special thing about this system is that it is designed and construed in such a way that the brake forces applied by the elevator car brake units can be open loop controlled and/or preferably close loop controlled.

[0096] An own acceleration sensor 10a, 10b, is preferably allocated to each elevator car brake unit 7'a, 7'b, the signal of which is the basis for the open or preferably close loop control of the brake force of the corresponding elevator car brake unit 7'a, 7'b. The corresponding acceleration sensor 10a, 10b, is preferably integrated into and/or attached to the corresponding elevator car brake unit. Ideally, the corresponding signal processing and the generation of the control and/or regulation signal for the elevator car brake unit 7'a and/or 7'b also take place directly in and/or at the corresponding elevator car brake unit. For this purpose, it is preferably the case that each elevator car brake unit is designed in such a way that it works hydraulically autonomically, i.e. each elevator car brake unit has an own hydraulic pump 19, an own equalizing tank or pressure equalizing vessel 20, and the complete set of hydraulic valves, lines and other hydraulic auxiliary installations which are necessary for its operation.

[0097] The several elevator car brake units are connected to each other - preferably directly, however, at least via the control of the elevator car brake. Hence their corresponding signals and/or activities can be compared to each other in order to detect possible faults at an early stage. Ideally there is even a double connection: Between the several elevator car brake units there is both a direct information exchange via the signal line 10c and an indirect information exchange via the control of the elevator car brake.

[0098] If a fault is detected, the elevator car will be stopped after reaching the next stop.

[0099] The system is designed in such a way that at least one, better several and preferably all of the following conditions can be realized.

Free fall:

[0100] If free fall is detected, e.g. due to the occurrence of a correspondingly high acceleration signal, the brake applies with maximum speed and is preferably close loop controlled in such a way that a deceleration < 1 g is set, ideally in the form of a medium deceleration between 0.5 g and 0.7 g. As has been mentioned before, an acceleration sensor 10a, 10b, is allocated to each elevator car brake unit, the signal of which is used for adjusting. Since there is a close loop control, it is not important with which load the elevator car is assigned, the deceleration as requested is adjusted in any case.

[0101] This applies, too, also in case of a power failure as long as the emergency power supply goes properly into effect.

[0102] If free fall is detected, e.g. due to the occurrence of a correspondingly high acceleration signal, and if also a total power failure occurs (blackout line current and failure of emergency power supply), the safety brake ISB will respond due to the power failure, unless it has been activated before due to over-acceleration on the basis of the signal delivered by the shaft copying system. The latter will take place, as a rule, due to the fact that the forces keeping it in opened position collapse as a result of the total power failure.

Emergency stop:

[0103] In the case of an emergency stop, for instance because one of the elevator shaft doors has opened during the ride, the safety brake ISB is activated by the safety circuit. The safety brake preferably applies with maximum speed. The safety brake is then preferably close loop controlled in such a way that it causes a deceleration < 1 g, ideally in the form of a medium deceleration between 0.5 g and 0.7 g.

[0104] Analogously, the same applies to the interference of emergency stop and total power failure (blackout line current and failure of emergency power supply), with the difference that the safety brake is activated by the power failure, unless the safety circuit has responded before. In this case, the safety brake will produce the maximum deceleration.

Overspeed (roped):

[0105] If, e.g. due to the occurrence of a super-elevated speed signal (maybe in the case of a simultaneously uncritical acceleration signal), overspeed is detected in roped condition, the safety brake will be activated. The safety brake preferably applies with maximum speed and is then preferably controlled in such a way that a deceleration < 1 g is set, ideally in the form of a medium deceleration between 0.5 g and 0.7 g.

Landing:

[0106] The safety brake ISB is activated.

[0107] The activation of the safety brake preferably takes place by means of a throttled valve or by open or close loop control, to the effect that the speed with which the safety brake applies is influenced and/or reduced by the throttle or the open or close loop control in order not to create disturbing noises. This can mean that the safety brake closes with full force, however, it takes some time until the full force is available.

[0108] If there is a total power failure in the stop (blackout line current and failure of emergency power supply), the safety brake ISB closes completely due to the power failure (unless it has already done so) and remains closed for the time of the power failure.

[0109] The safety brake will always be closed in such a way that it keeps the elevator car in a certain position, if the elevator car has stopped in the correct position of the stop, independent from the current weight of the elevator car, which changes due to loading and unloading at this stop.

Emergency terminal slow down:

[0110] The elevator car brake ISB and the control assigned to it are preferably designed that way that the safety brake will close as soon as it has been detected that the elevator car approaches the lowermost or uppermost landing with a speed that is too high for a regular stop.

Emergency rescue:

[0111] The elevator car brake ISB and the control assigned to it are preferably designed that way that an automatic emergency rescue will take place when pressing a button: Upon according activation, the elevator car brake ISB is partially opened so that the elevator car can move - even without motor power driven by the predominant weight force of the car or the counterweight - with a restricted speed into the adjacent landing. During this operation the motor carrying the traction sheave will be preferably short-circuited in order generate a braking torque.

Protected space in the pit or the shaft head:

[0112] The elevator car brake ISB and the control assigned to it are preferably designed that way that they will automatically provide for a protected space in the pit or the shaft head as soon as it has been detected that a person has entered the pit or the shaft head.

The hydraulic working principle of the elevator car brake units in accordance with the invention

[0113] In advance a general information in regard to the inventive brake units has to be given.

[0114] Theoretically, the provision of only one single of the inventive car brake units is sufficient. Preferably, an elevator car is equipped with at least two of the inventive car brake units that interact with different rails.

[0115] In advance some general information in regard to the valves has to be given.

[0116] Valves hereinafter referenced as V1 are the so-called short-circuit valves that block or open a so called short-circuit line which directly interconnects a first working chamber 14 and a second working chamber 15 of a hydraulic actuator. This valve will be opened in case if an emergency braking is necessary for putting an end to irregular running conditions. This valve V1 is for making the brake fail-safe, because it guarantees quick brake application, even if other valves do not work properly.

[0117] Unless otherwise defined, valves hereinafter referenced as V2 are the so-called control valves that open or close loop control the instantaneous braking power during braking. Preferably, the valves of the type V2 are realized as so-called valves for exclusive on-off-service, as explained in greater detail before.

[0118] Valves hereinafter referenced as V3 are so-called throttle control valves for opening or closing a throttling line for noise reduced application of the hydraulic brake during or after landing of the elevator car. The throttle control valves may themselves produce a throttling effect, and/or the throttling line may itself produce the required throttling effect, as explained in greater detail before.

[0119] Valves hereinafter referenced as V23 are combined valves that realize both, the function of the aforementioned valve V2 and the function of the aforementioned valve V3.

[0120] Valves hereinafter referenced as V4 are brake release valves opening or closing a brake release line for releasing the brake without activation of an hydraulic pump at least partially to such an extent that a new ride can start.

[0121] Valves hereinafter referenced as V34 are combined valves that realize both, the function of the aforementioned valve V3 and the function of the aforementioned valve V4.

[0122] Unless something else is explicitly provided, a valve is a proportional valve and no switching valve.

[0123] Unless something else is explicitly notified, all valves are valves that are opened, i.e. that allow passage of hydraulic fluid when being de-energized.

[0124] In the Figures this is indicated by the spring element that presses onto the moveable valve body. The rule is that as soon as - for whatever reasons - no power supply for the valves is available anymore, the valves open and apply maximum brake force that way.

[0125] Fig. 3a shows a hydraulic piping diagram of an inventive car brake unit to be used in the claimed elevator.

[0126] The car brake unit comprises a first group of hydraulic actuators 11.1.1 up to 11.1.x and a second group of hydraulic actuators 11.2.1 up to 11.2.x. Each of these actuators comprises a cylinder 12 with a piston 13 dividing the cylinder into a first working chamber 14 and a second working chamber 15. Moreover, each of these actuators comprises a piston rod 31 acting onto a brake lining 16 and a spring element 17 that is part of the main spring unit responsible for producing the required brake force even in case of breakdown of hydraulic pressure.

[0127] In regard to the brake linings 16 the following has to be notified with general effect to all embodiments: Each of the two or several actuators can affect (press upon) one single brake lining or a common brake lining.

[0128] As one can see, all first working chambers 14 of the actuators 11.1.1 to 11.1.x are in direct hydraulic interconnection, they are connected in series along one hydraulic loop 114. Moreover, all second working chambers 15 of the actuators 11.1.1 to 11.1.x are in direct hydraulic interconnection, in series along a hydraulic loop 115 that forms a "common rail". If the valve V4 is open, the first working chambers 14 of all existing hydraulic actuators are connected in series as all the second working chambers 15 are.

[0129] The hydraulic pump and the control valve V23 are positioned upstream in front of the working chambers

14. The expression "upstream" is used here and everywhere in this application related to the pumping direction of the hydraulic pump 19 under single-quadrant operation. That means that the pressure side D of the pump 19 is upstream of the first working chambers 14, while the suction side S of the pump 19 is downstream of the second working chambers 15.

[0130] The short-circuit valve V1 is positioned downstream behind the working chambers 14. Only the valve V4 is positioned between two functionally identical working chambers, in this particular case between two first working chambers 14.

[0131] Regular conditions provided, the hydraulic pump runs during braking down the elevator car to standstill continuously without speed-, power-, torque- or frequency-control under single-quadrant operation. The pressure side D of the hydraulic pump 19 feeds the first working chambers 14, while the suction side S of the hydraulic pump 19 is connected to the second working chambers 15 so that it can draw-off hydraulic fluid from there. A check-valve CV is provided in order to make sure that there is no backflow of hydraulic fluid via the pump 19 when the pump is shut off and when the valve V23 is closed.

[0132] A control line 39 is provided that directly interconnects the hydraulic loop 115 of the second working chambers 15 with the hydraulic loop 114 of the first working chambers 14. The control line 39 is operated by the control valve V23.

[0133] When the hydraulic pump 19 is conveying hydraulic fluid, while the control valve V23 is continuously fully closed, the brake will be released quickly, because the hydraulic pump draws off hydraulic fluid from the second working chambers 15, pumping it into the first working chambers 14 - this happens with the hydraulic actuators 11.1.1 to 11.1.x, if valve V4 is closed, and with all hydraulic actuators 11.1.1 to 11.2.x, if valve V4 is opened.

[0134] In case the control valve V23 is continuously fully opened, the control line 39 short-circuits the hydraulic loop 114 of the first working chambers 14 with the hydraulic loop 115 of the second working chambers 15 so that the brake will apply quickly, because the hydraulic fluid will be displaced from the first working chambers 14 to the second working chambers 15. The enduring pumping action of the hydraulic pump 19 will in this case remain without effect, because the hydraulic pump is short-circuited, too.

[0135] Starting from this insight, it becomes clear that the amount of hydraulic fluid that flows from the first working chambers 14 into the second working chambers 15 can be controlled by tuning the instantaneous, hydraulic resistance of the control valve V23 accordingly. As explained above, the "opening degree" of valve V23 can be remote controlled by the controller assigned to the valve V23, for example by tuning the frequency with which the valve body moves back and forth.

[0136] As already described above, the valve V23 is able to realize a throttling effect, that way providing for a slow brake application during or after landing. That way an unintended car movement can be avoided without generating noise.

[0137] As one can see, additionally a short-circuit line 40 is provided that directly interconnects the hydraulic loop 114 of the first working chambers 14 with the hydraulic loop 115 of the second working chambers 15. The short-circuit line 40 is operated by the short-circuit valve V1. In case of emergency braking, the valve V1 is opened as well as the valve V23 in order to produce quickest possible braking action of the hydraulic actuators 11.2.1 to 11.2.x. Even if all other valves should jam, the valve V1 makes the actuators 11.2.1 to 11.2.x braking. Normally all valves are opened for emergency braking so that the hydraulic fluid can be displaced as fast as possible from the first working chambers 14 into the second working chambers 15.

[0138] The valve V4 has several functions.

[0139] At first the valve V4 makes it possible to actuate actuators 11.1.1 to 11.1.x and 11.2.1 to 11.2.x separately from each other. That way it is possible to realize the above mentioned concept "ESB and separated ESG" with one of these brake units. As long as the valve V4 is kept closed, only the ESB-function is realized by means of the actuators 11.1.1 to 11.1.x. Upon additional opening of the valve V4 and/or the valve V1, the actuators 11.2.1 to 11.2.x perform the ESG-function.

[0140] Moreover, the valve V4 makes it possible to release the actuators 11.1.1 to 11.1.x when the car is on train to start a new ride, while the hydraulic pump 19 is still shut down in order to avoid audible noise emission, while the elevator car stands still at a landing.

[0141] For that purpose the valve V4 is opened so that via the loops 114 and 115 a pressure compensation between the first working chambers and the second working chambers of the actuators 11.1.1 to 11.1.x and 11.2.1 to 11.2.x will take place. In consequence, the actuators 11.2.1 to 11.2.x close partially, releasing the actuators 11.1.1 to 11.1.x that way partially. The braking forces are now at least to such an extent lowered that the elevator car can start a new ride - without starting the hydraulic pump 19 during standstill of the elevator car in the landing.

[0142] The hydraulic pump 19 will be started after the new ride has begun, preferably not before the riding-noise of the elevator car is at least as loud as the noise emitted by the hydraulic pump so that the noise of the hydraulic pump does not impact the comfort of the ride.

[0143] Preferably, the valve V4 provides for a throttled hydraulic interconnection of the actuators 11.1.1 to 11.1.x with the actuators 11.2.1 to 11.2.x. That way the pressure compensation between said groups of actuators will not take place suddenly and therefore audibly upon opening of the valve V4, but retarded without emitting an acoustic pulse.

[0144] Fig. 3b shows a hydraulic piping diagram of an inventive car brake unit to be used in the claimed elevator that is closely related to the car brake unit shown by Fig.

3a and explained before.

[0145] All things explained before apply to the embodiment according to Fig. 3b, too - as far as the differences explained hereinafter do not prevent this.

[0146] The only difference of the embodiment according to Fig. 3b compared to that of Fig. 3a is that the check valve CV is omitted and that the valve V23 is functionally split up into the valves V2 and V3.

[0147] That allows to operate the hydraulic pump under two-quadrant operation, as explained in greater detail below when discussing Figs. 4a and 4b: The instantaneous hydraulic pressure in the first and the second working chambers 14 and 15 is open or close loop controlled by operation the hydraulic pump in conveying direction or reverse as hydraulic generator or retarder for the flow of hydraulic fluid. In this particular case, the valve V2 is preferably no valve for exclusive on-off-service. Its only function is to prevent a small leakage through the hydraulic pump that causes an unwanted pressure equalization between the first and second working chambers, for example upon longer standby of the elevator car during nighttime.

[0148] The valve V3 serves for slow application of the brake at landing without noise emission, as explained above.

[0149] Figure 3c shows a hydraulic piping diagram of an inventive car brake unit to be used in the claimed elevator that is modified compared to the embodiment according to Fig. 3a.

[0150] This embodiment uses only one group of hydraulic actuators 11.1.1 up to 11.1.x and an additional pressure accumulator 111. Preferably, the pressure accumulator 111 is constructed identical to the actuators 11.1.1 et al., except for the fact that the piston rod 31 of the pressure accumulator is not assigned to a brake pad. It has the advantage that even if the piston rod 31 of the pressure accumulator moves when the first working chamber is emptied in order to release the actuators 11.1.1 up to 11.1.x, this does not lead to a dragging contact between a brake pad assigned to its piston rod and the braking rail.

[0151] In regard to one working chamber - preferably the second working chamber 15 - all the actuators 11.1.1 to 11.1.x and the pressure accumulator are permanently in direct hydraulic interconnection. That means that their second working chambers, including the second working chamber of the actuator, are connected in series along one hydraulic loop 115 that forms a permanent "common rail" for these hydraulic working chambers.

[0152] In regard to another working chamber - preferably the first working chamber 14 - all the actuators 11.1.1 to 11.1.x are in direct hydraulic interconnection. That means that the first working chambers 14 are connected in series along one hydraulic loop 114. The pressure accumulator 111 with its first working chamber is connected to the hydraulic loop 114, too, if the valve V4 is opened. Otherwise the pressure accumulator 111 is cut off.

[0153] A hydraulic pump 19 is provided that directly connects the upstream end of the hydraulic loop 114 (pressure side of the pump) with the downstream end of the hydraulic loop 115 (suction side of the pump). The pump is subject of single-quadrant operation, as explained above. Moreover, a pressure equalizing vessel 20 can be provided.

[0154] Due to this design, all actuators 11.1.1 to 11.1.x can only be activated synchronously. That means that one single elevator car brake of this type cannot be used in order to realize an ESB as well as an ESG, as explained above. Instead, this type of elevator car brake is provided for the ISB operation as explained above.

[0155] Different to what is disclosed by Figure 3a, the valves V1 and V3 are here not provided at the ends of the hydraulic loops 114 and 115. Instead, the hydraulic loops or lines connecting the valves V1 to V3 with the hydraulic loops 114 and 115 branch off in the middle of the hydraulic loops 114 and 115 between two neighbouring hydraulic actuators. That means that this embodiment possesses more than one valve that controls a hydraulic line or loop which is branching off between two adjacent, functionally identical working chambers. In this embodiment, such valves are at least the valves V2 and V3. The control line 39 of the valve V2 branches off from the hydraulic loop 114 between two first working chambers 14 (one upstream and one downstream) and it branches off from the hydraulic loop 115 between two second working chambers 15 (one downstream and one upstream). The throttled line 41 that is controlled by the valve V3 is arranged according to the same principle as the control line 39.

[0156] That makes it possible to divide the individual functions of the valves completely from each other. Consequently it is possible to design the valves V2, V3, and V4 completely independent from one another.

[0157] Another advantage of this hydraulic design is the fact that it is not necessary to energize any valve during stay of the elevator car in front of a floor. Nevertheless, the full braking power is available.

[0158] In particular it is possible to apply the brake without noise emission in front of a landing by means of the throttled valve V3.

[0159] It is possible to release the brake without operating the hydraulic pump when the elevator car is going to start another ride. For this purpose the valve V4 will be opened. That way a part of the hydraulic fluid accumulated in the first working chamber 14 of the pressure accumulator 111 will be pressed into the first working chambers of the actuators 11.1.1 to 11.1.x so that these actuators are released at least to such an extent that the new ride can begin.

[0160] The open or close loop control of the braking power instantaneously applied is possible by means of the valve V2 designed for exclusive on-off-service, as explained above.

[0161] Fig. 3d shows the hydraulic piping diagram of another type of the inventive car brake unit to be used in the claimed elevator.

[0162] The hydraulic car brake unit comprises, as explained before in regard to Fig. 3c, one group of hydraulic actuators 11.1.1 up to 11.1.x and another group of hydraulic actuators 11.2.1 to 11.2.x.

[0163] Once again, in regard to one hydraulic working chamber - preferably the second hydraulic working chamber 15 - all the actuators 11.1.1 to 11.2.x are in direct hydraulic interconnection. That means that all working chambers 15 are permanently connected in series along one hydraulic loop 115 that forms a common rail.

[0164] In regard to another working chamber - preferably the first working chamber 14 - the actuators are divided into two groups by means of the valve V4: As long as this valve V4 is closed, there is one group of actuators 11.1.1 to 11.1.x having such working chambers (chambers 14, for example) that are permanently in direct hydraulic interconnection, and another group of actuators 11.2.1 to 11.2.x where such working chambers are permanently in direct hydraulic interconnection, too.

[0165] A hydraulic pump 19 is provided that directly connects the upstream end of the hydraulic loop 114 (pressure side of the pump) with the downstream end of the hydraulic loop 115 (suction side of the pump). The pump is subject of single-quadrant operation, as explained above. Moreover, a pressure equalizing vessel 20 can be provided.

[0166] There is another loop in the shape of the throttled line 41 connecting the upstream end of the hydraulic loop 114 with the downstream end of the hydraulic loop 115. This throttled line 41 is opened or shut off by means of the valve V3. Opening of the valve V3 allows a soft applying of the brake pad(s) operated by the first group of actuators 1.1.1 to 11.1.x, without audible noise emission or with reduced noise emission. For that reason the valve V3 exerts a throttling effect or controls a loop with a throttling effect.

[0167] The valves V2 and V1, that are themselves arranged in parallel, are situated in a hydraulic loop that directly interconnects the first working chambers 14 of the second group of actuators 11.2.1 to 11.2.x via the downstream end of the hydraulic loop 114 with the upstream end of the hydraulic loop 115.

[0168] In order to prevent unintended car movement during landing, only one group of actuators is activated, here it is the group 11.1.1 to 11.1.x. This group of actuators is activated so that braking action is produced by opening the valve V3 controlling the throttling line 41. Via this throttling line 41 hydraulic fluid can be displaced from the first working chambers 14 of the actuators 11.1.1 to 11.1.x into their second working chambers 15.

[0169] In order to release the brake without operating the hydraulic pump when the elevator car is going to start another ride, the valve V4 will be opened. That way a part of the hydraulic fluid accumulated in the first working chambers 14 of the second group of actuators 11.2.1 to 11.2.x will be pressed into the first working chambers 14 of the first group of actuators 11.1.1 to 11.1.x so that these actuators are released at least to such an extent that the new ride can begin.

[0170] For performing an open or close loop controlled overspeed braking of the elevator car, the valve V2 open or close loop controls the braking power generated by the actuators 11.1.1 to 11.2.x. The hydraulic pump conveys hydraulic fluid into the first working chambers 14 of the actuators 11.1.1 to 11.1.x, and via the loops 118, 119, and the check valve CV2 in direction to the first working chambers 14 of the actuators 11.2.1 to 11.2.x, while hydraulic fluid is drawn off by the pump from all the second working chambers 15 via the loop 115 (common rail). The lower the actual hydraulic resistance of the control valve V2, the lower is the actual pressure in the first working chambers - the higher the actual braking force will be.

[0171] Due to its specific layout, the performance of an ESB/ESG operation as explained above is not possible to a practical relevant extent.

[0172] The check valve CV2 allows charging of the group of actuators 11.2.1 to 11.2.x, which served before for opening the brake without operating the hydraulic pump 19: If the pump feeds pressurized hydraulic fluid into the upstream end of the hydraulic loop 114, this fluid can reach the working chambers 14 of the actuators 11.2.1 to 11.2.x via the check valve CV2.

[0173] The check valve CV1 prevents during standstill of the hydraulic pump a detrimental leakage from flowing via the hydraulic pump from the upstream end of the loop 114 to the downstream end of the loop 115.

[0174] Fig. 3e does not show an independent embodiment. Instead, the embodiment shown by Fig. 3e is the same as shown by Fig. 3d. Fig. 3e serves only to make the direction of the hydraulic flow through the valves visible by means of an according arrow within the picture of the valve body. That way it becomes visible that the valves V1 and V2 use a common hydraulic loop in order to conduct the hydraulic fluid leaving said valves into the hydraulic loop 115 connecting all second working chambers 15 in line.

[0175] That way is becomes visible that the hydraulic flow through the valve V4 is bidirectional. Next, it becomes visible that the hydraulic flow through the valve V3 (when opened) is directed from the hydraulic loop 114 to the hydraulic loop 115.

[0176] Fig. 3f shows a slightly different embodiment compared to Fig. 3e, these both embodiments are closely related. For that reason, all the things explained for the embodiments 3d and 3e apply to the embodiment according to Fig. 3f accordingly.

[0177] The only difference between the aforementioned Figs. 3d and 3e, and the embodiment according to 3f is to be seen in regard to valve V4. In this embodiment according to Fig. 3f, the valve V4 is designed that way that it is closed when not energized, while in the other, aforementioned embodiments the valve V4 is opened when not energized. This modification of design serves to save energy, if the elevator car is waiting in front of a landing.

[0178] Fig. 3g shows a hydraulic piping diagram of an inventive brake unit to be used in the claimed elevator that is closely related to the brake units as shown before by Figs. 3d and 3e as well as 3f. For that reason, the things explained above for these Figures apply here accordingly.

[0179] The only difference is that the valves V3 and V4 have been merged now. These two valves are replaced by a combination valve V34. This replacement is possible without problems, because the valves V4 and V3 used before must always be operated in adverse direction, that means if the valve V3 has been closed, the valve V4 has been opened and vice versa.

[0180] In order to explain this, one has to give thought to what happens when the elevator car has come to standstill at the landing. At this moment, the valve V34 is switched that way that it performs the hydraulic function that was performed before by valve V3.

[0181] In order to perform the function of the previous valve V3, the valve V34 is switched that way that it directly interconnects, via a throttled passage, the hydraulic loop 114 downstream behind the actuator 11.1.x with the hydraulic loop 115 that forms the aforementioned "common rail" for the second working chambers 15, as directly shown by Fig. 3g. That way the hydraulic fluid can be displaced from the first working chambers 14 of the hydraulic actuators 11.1.1 to 11.1.x into the second working chambers 15 of these hydraulic actuators 11.1.1 to 11.1.x. Consequently, these hydraulic actuators close (due to throttling) without noise emission and generate braking action which hinders unintended car movement. As soon as the elevator car is going to start a new ride, the valve V34 switches over into its other working position. In this position (shown as active or energized position by Fig. 3g) the valve V34 interconnects the working chambers 14 of the actuators 11.2.1 to 11.2.x with the working chambers 14 of the hydraulic actuators 11.1.x to 11.1.x so that all working chambers 14 of all actuators are now interconnected by a "common rail" in the shape of the continuing loop 114. That way a part of the hydraulic fluid accumulated in the working chambers of the hydraulic actuators 11.2.1 to 11.2.x can be displaced into the working chambers 14 of the hydraulic actuators 11.1.1 to 11.1.x which are released that way without operating the hydraulic pump 19 at this stage - at least to an extent that allows to start the new ride. That means that the hydraulic pump 19 will not be started before the elevator car has reached again a sufficient speed producing travel noise to such an extent that the noise emission of the hydraulic pump 19 is not disturbing anymore.

[0182] An advantage of this hydraulic layout by means of the combination valve V34 is that one separate valve can be emitted, that reduces the costs.

[0183] A disadvantage is that to some extent "a pressure loss" will take place for a little moment when the valve V34 is switching over between its both positions, because during the switching over a hydraulic short-circuit occurs for a very short moment. This disadvantage could be compensated by designing the valve V34 as a slider valve. However, slider valves are sensitive in regard to dirt, and show normally a certain internal leakage that is disturbing here, too.

[0184] Figure 3h shows a hydraulic piping diagram of another embodiment of the inventive car brake unit to be used in the claimed elevator.

[0185] In this Figure only one actuator 11.1.1 is shown. However, this embodiment is not restricted to the use of one actuator. Instead, a set of actuators 11.1.1 up to 11.1.x can be used. The only thing that has to be done is to interconnect all working chambers 14 and all working chambers 15 of these actuators by means of loops 114 and 115 that are embodied as common rails.

[0186] In this embodiment downstream below the working chamber 14 the valves V1, V2 and V3 are provided. These valves are arranged in a hydraulic parallel manner. Parallel loops comprising these valves lead into a common loop 116 that goes directly to the suction side of the hydraulic pump 19.

[0187] Upstream in the hydraulic loop 114 going to the first working chamber 14 of the actuator, the valve V4 is provided. The input side of the valve V4 is interconnected with the pressure side of the hydraulic pump 19.

[0188] The special thing here is the pressure accumulator 111 that is directly interconnected with the suction side of the hydraulic pump 19 as well as with the pressure side of the hydraulic pump 19.

[0189] Another very specific design used here is the interconnection loop 117 that provides for a direct passage from the loop 116 to the second working chamber 15 of the hydraulic actuator.

[0190] The valve V2 is used for open or close loop control of the braking force in case of an emergency braking. In case of an emergency braking, the valve V4 is energized that way that it fully opens the hydraulic loop comprising this valve V4. In case of emergency braking, the hydraulic pump is constantly operated as described in greater detail above. Having that in mind, it is clear that the actual hydraulic resistance of the control valve V2 (depending on the switching operation actually performed) determines how much of the hydraulic fluid pressed by the pressure side of the hydraulic pump 19 into the first working chamber 14 (that is interconnected via the valve V2 and the hydraulic loop 116 directly with the suction side of the hydraulic pump 19) flows back to the suction side of the hydraulic pump.

[0191] It is clear that a fully closed valve V2 results in a maximum speed of releasing the brake, because all the pressurized hydraulic fluid pressed by the hydraulic pump 19 into the first working chamber 14 moves the piston of the hydraulic actuator in direction to the second working chamber 15.

[0192] On the other hand it is clear that a fully opened valve V2 produces via the first working chamber 14 a direct short-circuiting between the pressure side of the hydraulic pump 19 and its suctions side. It allows a displacement of hydraulic fluid out of the first working chamber 14 via the hydraulic loops 116 and 117 into the second working chamber 15, that way making the brake applying.

[0193] The valve V3 commands a throttle passage or is throttled itself. As explained above, the valve V3 serves for silent application of the brake during landing in order to avoid unintended car movement.

[0194] An interesting point here is the valve V4. If, during landing, the hydraulic pump is shut down, the release of the brake for starting a new ride again is accomplished by means of the pressure accumulator 111 and the valve V4. The valve V4 opens. That way the pressure accumulator displaces via the throttle 21 hydraulic fluid out of its first working chamber 14 through the valve V4 into the first working chamber 14 of the hydraulic actuator 11.1.1. The increasing pressure in the first working chamber 14 leads to a displacement of hydraulic fluid out of the second working chamber 15 of the hydraulic actuator 11.1.1. That way the brake is released to such an extent, at least, that the new ride can begin.

[0195] As soon as the elevator car has sufficient speed to oversound the noise of the hydraulic pump 19, this hydraulic pump 19 is energized again. It may provide at first for full release of the brake. Hereinafter the valve V4 may be closed. Nevertheless, the hydraulic pump 19 is still able to recharge the accumulator 111 again, because this accumulator is, as already mentioned, directly interconnected with the pressure side as well as with the suction side of the hydraulic pump 19.

[0196] Figure 3i shows a slightly different embodiment compared to Figure 3h. Nevertheless, these both embodiments are closely related. For that reason, all the things explained for the embodiment 3h apply to the embodiment according to Figure 3i accordingly.

[0197] The only difference between this embodiment according to Figure 3i and the embodiment according to Figure 3h is that the throttle 21 has been omitted. This omission is possible, because also the valve V4 has been exchanged against the valve V5. The valve V5 is a controllable valve like the valve V2 is. That means that the valve V5 is identical to the valve V2, or it works at least according to the same basic principle as the valve V2.

[0198] The valve V5 is used together with the valve V2 for open or close loop control of the braking force in case of an emergency braking. In case of an emergency braking, the valve V5 is energized that way that the actual hydraulic resistance of the control valve V5 determines how much of the hydraulic fluid pressed by the pressure side (first working chamber 14 of the pressure accumulator 111 and / or pressure side of the hydraulic pump 19) flows into the first working chamber 14 of the hydraulic actuator and thereby releases the brake, because all the pressurized hydraulic fluid pressed by the hydraulic pressure side of the hydraulic accumulator 111 (resp. pump) into the first working chamber 14 moves the piston of the hydraulic actuator in direction to the second working chamber 15.

[0199] Due to the fact that all actuators used for this embodiment are interconnected by loops 114 und 115 that are embodied at common rails, this embodiment cannot be used for realizing an ESB/ESG in the above mentioned sense.

[0200] For the same reason, a cascading operation first actuating one set of actuators, and next actuating another set of additional actuators is not possible.

[0201] An advantage of this embodiment is that it is not necessary to energize valves during standby of the elevator car in a landing.

[0202] Another advantage is that the hydraulic pressure accumulator 111 can be charged completely independent from the working of the actuators being responsible for braking.

[0203] Finally, important functions are completely independent so that important components like the valves V2 and V3 can be designed completely independent from each other.

[0204] These advantages apply to what is shown by Fig. 3h, too.

Excursion:

[0205] The solutions shown by Fig. 3h and by Fig. 3i make it clear preferred, but not mandatory, to use the hydraulic pump itself as a pressure source during open or close loop controlled braking. Instead, the pressure accumulator 111 can deliver the hydraulic pressure that is required to open or close loop controlled pressing the brake linings against the rail assigned to it.

[0206] Figure 3j shows the hydraulic piping diagram of another embodiment of the inventive car brake unit to be used in the claimed elevator.

[0207] Once again, the hydraulic car brake unit comprises a first group of hydraulic actuators 11.1.1 up to 11.1.x. and a second group of hydraulic actuators 11.2.x while x can be "1" or a value between "1" and "n".

[0208] As explained above, one chamber of these hydraulic actuators, preferably the second working chamber 15, is in direct hydraulic interconnection by means of a hydraulic loop 115 that forms a common rail.

[0209] In regard to the other working chamber - preferably the first working chamber 14 - only a first group of the hydraulic actuators 11.1.1 to 11.1.x is in direct hydraulic interconnection, while another one or group of hydraulic actuators 11.2.x is not in permanent direct hydraulic interconnection in regard to the working chamber 14.

[0210] This embodiment is characterized by the fact that all its valves are arranged together with the hydraulic pump arranged upstream of the first working chambers.

[0211] Once again, the pressure side D of the hydraulic pump 19 is connected to the loop 114 upstream in regard to the first working chamber of the first group of actuators 11.1.1 to 11.1.x. On the other hand, the suction side of the hydraulic pump 19 is directly interconnected to the hydraulic loop 115 forming the common rail for all actuators 11.1.1 to 11.1.x and 11.2.x. That way the valve V2 allows an open or close loop controlled application of brake force by the first group of actuators 11.1.1 to 11.1.x. If the valve V2 is completely closed, then the hydraulic pump 19 pressurizes with full power the first working chambers 14 of the said first group of hydraulic actuators. At the same time there is a maximum of suction by the hydraulic pump 19 via the loop 115 out of the second working chambers 15. That means that the hydraulic actuators are released with maximum speed.

[0212] If, on the other hand, the valve V2 is fully opened, then the hydraulic pump 19 is completely short-circuited so that it cannot influence the first group of hydraulic actuators 11.1.1 to 11.1.x. On the contrary, the first working chambers 14 of the said first group of hydraulic actuators, and the second working chambers 15 of the said first group of hydraulic actuators, and the first working chambers 14 of the second group of hydraulic actuators, and the second working chambers 15 of the said second group of hydraulic actuators (via the check valve) are short-circuited, too, via the fully opened valve V2. That means that maximum of braking force is applied. If the status of the valve V2 is somewhere between fully closed and fully opened, it is clear that an accordingly low or high braking force will be applied.

[0213] Also here the valve V3 serves for silently closing the brake during landing in order to realize protection against unintended movement. The valve V3 interconnects, as described already before, via a throttled path the first working chambers 14 with the second working chambers 15 of the second one or group of hydraulic actuators 11.2.x, making this or these actuators applying the brake that way.

[0214] Also the valve V4 has the same function as already explained before. The valve V4 allows interconnecting the first working chambers 14 of the first group of actuators with the first working chambers 14 of the second group of actuators, making the actuators of the second group releasing that way. In the explanations before it is clear that also this embodiment cannot be used in order to realize the ESB/ESG function. Also the cascading application of different parts of the brake is not possible. In order to keep the elevator car in safe stand while in front of a landing, two valves have to be energized.

[0215] Also here it is possible to charge that part of the brake that is used as a pressure accumulator independently from the rest of the brake.

[0216] Figure 3k shows an embodiment that is closely related to the embodiment according to Figure 3j. The only difference is that the brake has been simplified in Fig. 3k. The valves V3 and V4 have been omitted. The consequence is that neither a silent closing nor a silent releasing of the brake during landing end before departure from the landing is possible. This embodiment is reduced to an emergency brake being capable of performing a close or open loop controlled braking.

[0217] Fig. 3L shows the principle of a hydraulic configuration that can be used if the pressure source for open or close loop controlling of one or more actuators 11 is not the hydraulic pump 19 itself, directly, without intermediate means.

[0218] The pressure source is realized here in the shape of a hydraulic pressure accumulator 111. The valve V2 open or close loop controls with its hydraulic resistance whether and how much hydraulic fluid will be pressed by the pressure accumulator into the first working chamber 14 of the brake actuator 11. At the same time the hydraulic pressure accumulator is able to take up hydraulic fluid displaced out of the second working chamber 15 and / or hydraulic fluid short circuited by the control valve V2.

[0219] The pressure accumulator is preferably a "double stroke", "double rod" cylinder with the piston therein forming a first accumulator chamber and a second accumulator chamber, whereas the cylinder is designed that way that the equal amount of hydraulic fluid displaced from the first accumulator chamber is taken up by the second accumulator chamber when the piston, preferably driven by a spring, moves.

[0220] The hydraulic pump 19 is only operated when recharging of the pressure accumulator 111 is required.

[0221] Fig. 4a shows the hydraulic piping diagram of one of the elevator car brake units which can be used for the realization of one of the two presented concepts. This embodiment comes close to the embodiment of Fig. 3b, because here, too, the control over the brake force applied is not exerted by means of a control valve V2, but by means of the hydraulic pump itself.

[0222] Typically, the brake does not consist of a single, but of several hydraulic actuators which are again constructed similarly, preferably two or more pieces.

[0223] Accordingly the right area of Fig. 4a schematically shows three hydraulic actuators 11.1 to 11.3, each of which consists of a cylinder 12 with a piston 13, preferably separating the corresponding cylinder in a first working chamber 14 and a second working chamber 15 located opposite each other on both sides of the piston 13 - for reasons of a better overview the reference numbers 12, 13, 14 and 15 are only marked for the first actuator 11.1.

[0224] Each hydraulic actuator interacts with two brake linings 16 which affect a rail and/or an elevator car guide rail 2.

[0225] As long as there is sufficient hydraulic pressure in the corresponding first working chamber 14, the hydraulic actuator keeps its piston and/or the connected piston rod against the tension of its corresponding spring element 17 in ventilated position, where no compressive force is applied to the allocated brake lining 16. The spring elements 17 commonly form the so-called main spring element.

[0226] A hydraulic pump 19 is preferably driven by an electric motor 18 to ensure the supply with hydraulic pressure. Typically, but not necessarily a pressure equalizing vessel 20 is provided, which balances the bulk volume and the thermal expansion of the hydraulic fluid and possible micro-leakages.

[0227] With one side, which is the pressure side D during normal operation ("Opened brake/reduced brake action"), the hydraulic pump 19 is connected to the first working chambers 14 of the hydraulic actuators, and with the other side, which is the suction side S during normal operation, it is connected to the second working chambers 15 of the hydraulic actuators.

[0228] It is not irrelevant which type of pump is used for performing the inventive concept. For all proposed solutions a vane pump is the matter of preferred choice. For multi-quadrant operation sometimes the use of a piston pump is most preferred as hydraulic pump 19, preferably a pump/motor with a multiplicity of cylinders. This is because a piston pump is, when coupled to an appropriate electric motor, in particular suited for realizing a dual-quadrant-operation ("Zweiquadrantenbetrieb"). A dual-quadrant-operation is understood here as a mode, wherein the pump is one time operated as a pump that presses hydraulic fluid into the working chamber, and wherein the pump is another time operated as a hydraulic motor which is driven by the hydraulic fluid that leaves the aforementioned working chamber, whereas the hydraulic motor is charged by the electric motor with a braking torque determining the speed of the hydraulic fluid flowing out of the working chamber.

[0229] Like all the other embodiments, this embodiment is preferably characterized by the fact that it is operated as a closed system. That means that the hydraulic pump does not pump hydraulic fluid from a storage tank into the working chamber of a hydraulic cylinder, which will be discharged, when the time has come, back into the storage tank. Instead, the hydraulic pump circulates the hydraulic fluid from a working chamber 14 located at a first side of the respective hydraulic piston to a working chamber 15 that is located on the opposite side of the hydraulic piston. That enables a particularly quick and sensitively responding open or close loop control of the speed inherent to the hydraulic fluid that leaves the working chamber that is provided for holding open the brake, or that flows into aforementioned working chamber. This is because the closed system allows the two-quadrant-operation without time lag (that may otherwise be caused by the necessity to re-intake again the hydraulic fluid from the tank, where it is without pressure).

[0230] An externally controllable valve V2 (can be an ordinary slider valve here) is provided. If the latter is closed, it separates the working chambers 14 from the branch of the hydraulic system where the hydraulic pump 19 and the second work chambers 15 are located. This valve facilitates to keep the brake open almost without energy expenditure - if the valve V2 is closed, the first working chambers which are under pressure and ensure the overcoming of the force acting from the springs 17 in the direction of closing the brake will be separated from the remaining hydraulic circuit, and the pressure inside will be "locked" so that only the little power for keeping the valve closed has to be applied.

[0231] Additionally, a second externally controllable hydraulic valve V1 is provided, which hydraulically short-circuits the first work chambers 14 and the second work chambers 15 of the hydraulic actuators in its opened condition, i.e. which ensures a hydraulic interconnection that presents no essential obstruction for the pressure equalization between the first and the second working chambers, and where especially no throttle element is arranged, i.e. no element which arbitrarily increases the hydraulic resistance.

[0232] Optionally, a third externally controllable hydraulic valve V3 is provided, which ensures a throttled fluid passage between the first working chambers 14 and the second working chambers 15. As explained above, the throttle effect can be based on the valve V3 itself, or a narrower piping and/or from regular piping with a built-in throttle 21 connected in series with the valve.

[0233] During normal operation, the first working chambers 14 are filled with hydraulic fluid under pressure, all valves are closed, and the hydraulic pump stands preferably still. The brake linings 16 are thus kept in their opened position, without special energy expenditure being necessary, for there is no need for more than an energization of the valves keeping the valves in their closed position.

[0234] In order to cause the application of the brake as quickly as possible, (preferred) the control 10 of the elevator car opens the valve V1 and V4 so that the hydraulic pressure collapses in the working chambers 14 by means of a pressure equalization between the working chambers 14 and 15, taking place via the valve V1 and V4 (hydraulic actuators 11.1). After the pressure equalization has taken place, the brake lining or linings 16 are pressed against the rail and/or an elevator car guide rail 2 with maximum force given by the spring element or elements 17, thus the brake responds in a very short period of time with its nominal brake force, i.e. with its maximum brake force.

[0235] In order to cause a delayed application of the brake (for example to arrest the car when being landed without generating audible noise), the control 10 of the elevator car only opens the valve V3. Therefore the pressure between the first and the second working chambers 14, 15 is released only in a delayed manner, the time course of the pressure reduction is specified here by throttle 21. This results in the fact that the brake applies in a delayed manner without producing audible noise.

[0236] The valve V2 can be used to further influence the speed with which the brake applies, if necessary:
The valves V1 and V3 (if available) remain closed. The valve V2 is opened, the hydraulic pump 19 is activated simultaneously or before.

[0237] Theoretically, the hydraulic pump 19 can, among other things, also be used in such a way that it develops a certain pumping effect in the direction of the working chambers 14 which, however, is only so big that the leakage flow of the hydraulic fluid which has been displaced by the effect of a spring element 17 from the corresponding working chamber 14 is bigger than the pumping effect so that the speed with which the hydraulic fluid is displaced from the corresponding working chamber 14 can be controlled or regulated via the current delivery rate of the hydraulic pump in order to influence the speed or force which the brake applies. The hydraulic pump is then preferably operated oscillatingly around the area where the leakage flow of the hydraulic fluid, which the corresponding spring element tries to push back via the pump, is in balance with the flow of the hydraulic fluid so that the pump speed only has to be reduced a little bit for the current reduction of the brake force, and has to be increased a little bit for the current increase of the brake force.

[0238] Precondition for such an operation mode is the use of a pump that shows a non-neglectable leakage when being not driven or when being driven with reduced power.

[0239] In the case of high quality hydraulic pumps, and especially piston pumps, the leakage flow will be too little in order to be able to let the hydraulic pump influence the speed with which the hydraulic fluid is displaced from the corresponding working chamber 14 in the described manner. As an alternative, the hydraulic pump is then alternately used as a pump driven by the electric motor in conveying direction, or as a "hydraulics motor" which drives the electric motor - maybe in generator mode - that means in the opposite direction of the conveying direction during pump operation. By means of corresponding electric wiring of the motor running as a generator, the torque can be set against which the "hydraulic motor" has to work and/or the revolutions per minute of the "hydraulic motor" can be set. All this influences the speed with which the brake applies.

[0240] For this purpose, a speed-controlled, or better speed-regulated motor is used for driving the hydraulic pump. The hydraulic pump is preferably operated oscillatingly around the area where the leakage flow of the hydraulic fluid which the corresponding spring element tries to push back via the pump is in balance with the flow of the hydraulic fluid so that the pump speed only has to be reduced a little bit for the current reduction of the brake force, and has to be increased a little bit for the current increase of the brake force. Thus, the force with which the spring element or elements 17 press the brake lining or linings 16 against the rail can be counteracted more or less so that the current brake force can be controlled or regulated quite well.

[0241] Where appropriate, the valve V2 can furthermore dispense with the valve V3. This can take place either actively by means of the hydraulic pump being specifically controlled in the described manner in such a way that the pressure balance between the chambers is slower. Where appropriate, in the case of corresponding design of the hydraulic pump, this can also take place passively, by means of the leakage flowing via the pump.

[0242] It is worth to be mentioned that it may be advantageous to operate the hydraulic pump that way that it pumps the hydraulic fluid actively from the working chambers 14 into the working chambers 15, and thus ensures an even quicker application of the brake with maximum brake force - compared to the mere hydraulic "short-circuit" by opening the valve V1.

[0243] It should be mentioned that an elevator car brake unit according to the embodiment of Fig. 4a is especially suited to realize the first concept presented above by means of Fig. 1. This is the fact, because another valve V4 can be provided with the help of which one or several actuators (in the case shown in Fig. 4a actuator 11.1) can be optionally switched on or off.

[0244] Two of the elevator car brake units shown in Fig. 4a are sufficient in order to realize the above mentioned concept made of two safety brakes ESB and two additional brakes ESG, because a first part of the actuators (in the case of the embodiment shown in Fig. 4a the actuators 11.2 and 11.3) realizes all functions allocated to the safety brake, while one or several actuators (in the case of the example shown in Fig. 4a the actuator 11.1) is or are switched on with the help of the valve V4. The valve V4 is activated, if it is necessary to realize the function allocated to the additional brake and to apply the maximum brake force in order to control e.g. the free fall.

[0245] Fig. 4b shows the hydraulics' wiring diagram of another, simplified version of the brake units which can especially be used for the realization of the above mentioned second basic concept by using the motor and the hydraulic pump in order to open or close loop control the brake force.

[0246] In order to realize a certain redundancy, two or more synchronously operated actuators 11.1 and 11.2 are used here. The possibility of a cascaded operation of the actuators 11.1 and 11.2 is not provided here, where it is especially about an efficient manufacturing for large series, but can be useful, if necessary.

[0247] The valve used has also been optimized with regard to costs for this execution example. There is also an externally controllable valve VI, which hydraulically short-circuits the first working chambers 14 and the second working chambers 15 of the hydraulic actuators in its open condition, i.e. ensures a hydraulic connection which does not considerably impede the pressure between the first and the second working chambers. The valve V1 will always be operated, if the brake is to be applied more quickly. The valve V2 is responsible for the slower application of the brake. As soon as the latter is opened, the forces of the spring element or elements 17 press hydraulic fluid as leakage flow along the pump organ of the hydraulic pump 19, or via the pump which is alternatively currently operated as "hydraulic motor" in the direction of the chamber 15. Depending on the revolutions per minute with which the pump runs, it influences the speed of the stream of hydraulic fluid that flows from the chamber 14 into the chamber 15. The speed of brake application and, where applicable, the current brake force can be regulated or controlled in the same way as described above.

The concrete execution of the elevator car brake units in accordance with the invention

[0248] Figs. 5 and 6 show a practical embodiment of one of the brake units which are preferably used within the framework of the invention.

[0249] With regard to Fig. 5, the following can be detected:

The elevator car brake unit comprises a hydraulic control block 22.

[0250] Ideally, all hydraulic components are located in control block 22 and/or are directly flanged to it without using a hose. It is best, if also the brake calliper is an integral part of the control block at least essentially or completely (not represented figuratively). Otherwise, the design corresponds to the following description by means of the figures.

[0251] Mostly the hydraulic actuators 11.1 to 11.3 are flanged to one side of the control block 22, in the present case three actuators. They are hydraulically connected directly to the corresponding borings in the complementary contact surfaces of the hydraulic control block 22, preferably via borings in their contact surfaces. The pressure springs 33, which are reached through by the piston rods 31 of the actuators (which cannot be recognized as such in Fig. 5), can also be clearly seen. The pressure springs 33 commonly form the main spring unit, from a functional point of view they correspond to the springs 17, which are shown in the Figs. 3a to 4b.

[0252] A fixing bracket 23 is preferably flanged to the adjacent side at an angle of the control block, which carries the actual brake calliper 24 in which the brake linings 16 attached to the brake lining carriers 25 are kept in such a moveable way that they can be placed or pressed against the surface of a rail from two sides.

[0253] Together with the actuators 11.1 to 11.3, the control block 22 forms a self-contained hydraulic system, i.e. it carries the hydraulic pump 19 and its drive, and/or motor 18, the valves VI, V2 and, if available, also V3 and V4 (or V23/V34) as well as the pressure equalizing vessel 20. A separate piping is superfluous insofar as all lines necessary for the connection of the individual hydraulic components are shown in the control block by means of suitable borings with the exception of the lines directly leading to the hydraulic pump 19, or directly exiting from it by means of suitable borings. This kind of execution has the advantage that the hydraulic line system is very rigid, unnecessary elasticities, as normally almost inevitably play a role, are mainly avoided. This is especially important where the brake force is to be regulated with the help of the hydraulic pump, or where importance is attached to the fact to be able to create a defined throttled pressure drop by the mere opening of a valve which causes the brake linings to gradually close over a certain, delayed period until the full brake force has been reached after some time.

[0254] Preferably, an own electronic control and at least one acceleration sensor are allocated to the control block 22 which, however, is not represented figuratively here. As can be learned from the information above, the current brake force of the elevator car brake unit can be determined and open loop or preferably close loop controlled with the help of the acceleration sensor.

[0255] The elevator car brake unit comprising the mentioned components is preferably designed in such a way that it is capable of plug&play at least on the hydraulic side, i.e. only needs a connection to the power supply and to the signaling network, but no installation works on the hydraulic side anymore.

[0256] The brake calliper 24 is preferably designed as a box with a baseplate all around the main side of which preferably boundary elements R protrude, cf. Fig. 5. The boundary elements R are disconnected at the places opposite each other where a U-shaped passage 26 has to be created for the rail interacting with the brake linings, cf. again Fig. 5.

[0257] The brake unit is not least characterized in that the brake linings 16 are not mounted slidingly in the brake calliper 24, but are kept flexibly with play to the brake calliper 24.

[0258] For this purpose, the brake linings 16 are attached separately, or divided into several partial linings to a brake lining carrier 25, preferably screwed.

[0259] As can be seen best in Fig. 6, each of the brake lining carriers 25 is reached through by a leaf spring package 27 for this purpose, which protrudes on both sides from the corresponding brake lining carrier and creates there an eye 28 which facilitates the attachment of the leaf spring package to the brake calliper 24 with the help of a retaining screw 29 reaching through it. Preferably, the leaf spring package 27 of the one brake lining carrier 25 is screwed to a leg of the U-shaped passages 26, while the leaf spring package 27 of the other brake lining carrier 25 is screwed to the other, opposite leg of the U-shaped passages 26. It should be emphasized that the leaf spring packages 27 only have a guiding function and are thus functionally not related to the main spring unit or the auxiliary spring unit, and especially cannot be regarded as a part of the same. They especially do not provide any noticeable resistance to the engaging of the brake.

[0260] Hereby, the two eyes 28 of each leaf spring package 27 are designed differently. The eye leading in the direction of the downwards movement (installation according to its scope of use) is designed in such a way that it picks up the retaining screw 29 allocated to it virtually free of play. Therefore big tensile forces can be transferred via this eye, which occur when catching the elevator car. In contrast, the lagging eye in the direction of the downwards movement is designed in such a way that it creates a floating bearing together with the allocated retaining screw 29 in such a way that the leaf spring package 27 can basically deform unhinderedly, while being pressed to the rail without hindering tensile stresses in the direction parallel to the longitudinal axis of the individual leaf springs preventing this, as would be the case with leaf springs which are firmly clamped on both sides by means of retaining screws 29 positioned in the eyes without play.

[0261] It can be seen that each of the two brake lining carriers 25 is pinned or - as is the case here - screwed with the help of spring anchoring screws 30 to the leaf spring package preferably in the area of its center so that the brake lining carrier 25 cannot be removed from its leaf spring package 27. As a rule this screwing also absorbs the transverse brake forces, i.e. the forces which occur as a reaction to the braking friction acting between the rail surface and the brake linings.

[0262] It is also interesting that each of the brake lining carriers is partly overlapped at its upper and lower front-end margin in the overlap area marked with "U" from the brake calliper 24 and/or the boundary element R of the brake calliper 24, cf. Fig. 5. This increases the safety, since even in the case of failure of the supporting effect of a leaf spring package, the corresponding brake lining carrier 25 cannot be pushed out of the brake calliper 24, but instead still transfers brake forces, now, however, in direct contact between the brake calliper 24 and the brake lining carrier 25, which is not present in the case of proper function.

[0263] Up to here the opposite brake lining carriers 25 are "mirrored" identically in construction.

[0264] A fundamental difference is the fact that only one of the opposite brake lining carriers 25 is directly impinged with force from the hydraulic actuators 11.1 to 11.3. This brake lining carrier holds the so-called active brake linings.

[0265] The three actuators 11.1 to 11.3 can be easily recognized in Fig. 6, which show a cylinder 12 and a piston 13 connected to the piston rod 31, whereas the piston 13 divides the cylinder 12 in a first working chamber 14 and a second working chamber 15, as shown in Figs. 3a, b and 4a, b - whereby, for reasons of a better overview, the reference numbers 12, 13, 14, 15 are only marked in the first actuator in Fig. 6, but also correspondingly apply to the actuators 11.2 and 11.3.

[0266] The brake lining carrier 25 which is to be impinged directly with the force of the actuators 11 is preferably not connected to the piston rods 31 of the actuators 11. The piston rods 31 can preferably transfer exclusively compressive forces to the rear side of the brake lining carrier 25 not facing the brake linings 16, and the brake lining carrier basically does not transfer any shear forces to the piston rods 31 due to its special position at the leaf spring package 27. Although in contrast to Figs. 3a, b, and 4a, b, several actuators commonly affect one single brake lining carrier 25, this allows for operating the brake lining carrier depending on the size of the currently necessary brake force with the aid of all actuators 11.1 to 11.3 together, or only with the aid of one or a reduced number of actuators. Furthermore, such a design helps to protect the piston rod sealings and the piston rod guidances.

[0267] As has already been mentioned in connection with Fig. 5, each of the piston rods 31 bears a pressure spring 33 which is preferably designed as a coil spring. It is positioned between the piston rod 31 and the brake calliper 24 in such a way that it forces the piston rod 31 in closing direction as long as there is no hydraulic pressure at the piston 13 connected to it. These pressure springs 33 define the nominal force with which the brake lining carrier 25 is pressed against the rail e.g. in the case of power failure and thus the nominal brake force. Thus, the whole of the pressure springs is also called main spring unit here. Vice versa, the piston rods 31 will be forced in open position against the action of force of the pressure springs 33, if there is corresponding hydraulic pressure in the first working chambers 14. If all piston rods are in open position, the brake lining carrier 25 can be brought from the applied position to the ventilation position together with the brake linings 16 held by it by means of the leaf spring package allocated to it.

[0268] Preferably, each piston rod 31 reaches through the pressure spring 33 allocated to it which leans against the brake calliper 24 and/or its boundary element which has been mentioned above with its side not facing the brake lining carrier, and with its other side against a spring plate 34 connected to the piston rod 31.

[0269] The opposite brake lining carrier 25 which is not to be impinged directly with the force of the actuators holds the so-called passive brake linings here. It is preferably not rigid, but mounted in the brake calliper 24 (more than just irrelevantly) flexibly with the help of another spring element which has the form of plate spring packages 36. The auxiliary spring unit is dimensioned in such a way that the spring force developed by it keeps the balance with the spring force applied by the main spring unit in a certain position.

[0270] The reason for the installation of the auxiliary spring unit is that a rigid mounting of this brake lining carrier would cause the brake to response in such a strong manner that no delayed application ("brake force increasing over a certain, elongated period until reaching the maximum brake force") of the brake force, and certainly no close loop control of the brake force would be possible. In the case of a rigid mounting of the opposite brake lining carrier to the calliper, it would be the case that the volume of the working chamber 14 would practically no longer change from the moment when the brake linings start to touch the rail so that each further increase or reduction of pressure in the working chamber 14 would immediately lead to an external change of the brake force which is not sensibly controllable.

[0271] In order to ensure the flexibility of the second brake lining carrier 25, several guide pins are anchored and/or adjustment screws 35 are screwed in its rear side, which reach through the brake calliper 24 and/or its above mentioned boundary element with the side not facing the brake lining carrier. In between there are further pressure spring elements, here in the form of a plate spring package 36 which is slipped onto the adjustment screw 35 allocated to it. Like this the second brake lining carrier can evade against (by overcoming) the increasing tension of the auxiliary spring unit which is preferably created by plate spring packages here. That makes the characteristic line much softer, since little changes in pressure do not longer result in extremely big changes of the brake force.

[0272] However, it is remarkable that also the second brake lining carrier 25 is basically attached to a leaf spring package 27, and the forces occurring while braking are transferred completely or at least basically via the leaf spring package 27 to the brake calliper 24, not via the adjustment screws 35. These preferably run with generous play in the brake calliper 24 in order not to interfere with the flexibility of the second brake lining carrier, or to distort it with friction forces. The function of the adjustment screws 35 is basically limited to the fact of keeping the plate spring packages 36 in place and of avoiding with its heads protruding from the brake calliper on the side not facing the brake lining carrier and/or the underlying lock nuts 37 that the brake lining carrier shifts too far with regard to the brake calliper in the direction of the rail and/or guide rail 2 under the influence of the plate spring packages and possibly lugs. Especially the provision of the mentioned lock nuts 37 is convenient, since the position can be set like this.

[0273] For sake of completeness, reference is made to the preferably provided adjustable stops 38 which are designed here as stop screws which are preferably to be tightened by means of locking. Like this the distance can be limited by which the second brake lining carrier can evade. Like this it can be ensured, if necessary, that the brake unit shows a sharply rising characteristic line from a certain point on, thus creates a sharply rising brake force with each further pressure increase on the side of the actuators, if applicable.

[0274] It has to be pointed out again that the brake which has just been described by means of the figures can also be used as service brake. Then the motor brake which has been necessary so far, mostly in the form of a disc or drum brake which brakes the motor or the drive sheave shaft, is no longer necessary - which at least compensates for a good part of the costs due for the brake provided according to the invention.

Reference signs list

[0275]

1	Elevator drive
2	Elevator car guide rails
3	Guidance devices
4	Elevator car
5	Route reference
6	Displacement sensor
7a	First elevator car brake unit of the safety brake
7b	Further elevator car brake unit of the safety brake
7'a	First elevator car brake unit of another form of the brake
7'b	Second elevator car brake unit of another form of the brake
8a	First additional brake unit of the additional brake
8b	Further additional brake unit of the additional brake
9	Further central elevator control
10	Control of the elevator car
10a	Acceleration sensor
10b	Acceleration sensor
10c	Signal line
11	Hydraulic actuator (individualized as 11.1.1 to 11.1.x and/or 11.2.1 to 11.2.x and/or 11.1, 11.2 and 11.3)
12	Cylinder
13	Piston
14	First working chamber of the cylinder
15	Second working chamber of the cylinder
16	Brake linings
17	Spring element, part of the main spring unit
18	Electric motor
19	Hydraulic pump
20	Pressure equalizing vessel
21	Throttle
22	Control block
23	Fixing bracket
24	Brake calliper
25	Brake lining carrier
26	Passage with brake calliper
27	Leaf spring package
28	Eye of a leaf spring package
29	Retaining screw leaf spring package
30	Spring anchoring screws
31	Piston rod
32	(not allocated)
33	Pressure spring
34	Spring plate
35	Adjustment screws
36	Plate spring package
37	Lock nut of an adjustment screw
38	Adjustable stops
39	Control line
40	Short-circuit line
41	Throttled line
42	Brake release line
111	pressure accumulator
114	loop interconnecting first working chambers
115	loop interconnecting second working chambers
116	common loop for a plurality of valves
117	interconnection loop
118	interconnection loop
119	interconnection loop

U	Overlap of the brake calliper across the front side of a brake lining holder
R	Boundary element of the brake calliper
ESB	Safety brake
ESG	Additional brake
ISB	Intelligent safety brake

D	Pressure side of the hydraulic pump
S	Suction side of the hydraulic pump
SE1	Pressure sensor
SE2	Pressure sensor
V1	Valve 1
V2	Valve 2
V3	Valve 3
V4	Valve 4
V5	Valve 5
V23	Valve 23
V34	Valve 34
CV	Check valve (individualized as CV1, CV2, CV3)
BP	Hydraulic duct forming a bypass allowing pressure control
HS1	First hydraulic duct
HS2	Second hydraulic duct

Claims

1. Elevator with an elevator car (4) moving along guide rails(2) up and down comprising an open or close loop controlled hydraulic brake for decelerating the elevator car (4), whereas the brake comprises a hydraulic actuator (11) for pressing a set of brake linings (16) in closing direction against a brake member,

   the hydraulic actuator (11) is pre-stressed by a main spring unit in closing direction with a force for generating a brake friction, whereas the hydraulic actuator (11) comprises a hydraulic cylinder (12) and a piston (13) dividing the cylinder (12) into a first working chamber (14) and a second working chamber (15),whereas the piston (13) depending on the hydraulic pressure prevalent in the first working chamber (14) completely or partly compensates the force of the main spring unit, **characterized in that** the speed with which the brake applies, and/or the resulting force with which the brake linings (16) operated by the hydraulic actuator (11) is pressed against the rail(2) is open or close loop controlled by means of a hydraulic pressure source whose pressure side (D) charges aforementioned first working chamber (14) of the at least one piston (13) with hydraulic fluid, and whose suction side (S) is capable to suck hydraulic fluid from a second working chamber (15) of the at least one piston (13), whereas an additional pressure control line (39) interconnects the first working chamber (14) and the second working chamber (15), and whereas the actual flow rate of hydraulic fluid through the pressure control line (39) is determined by a control valve.

2. Elevator according to claim 1, **characterized in that** the control valve (V2; V23) is a valve for exclusive on-off-service having only two stable positions, namely "valve fully closed" or "valve fully opened".

3. Elevator according to claim 2, **characterized in that** the control valve (V2; V23)is a valve with a valve body for blocking or opening the passage through the valve (V2; V23), whereas the valve (V2; V23) is designed in such a way that the amount of flow through the valve (V2; V23) can be determined by switching the valve (V2; V23) each second repeatedly back and forth between the states "move valve body in closing direction" and "move valve body in opening direction".

4. Elevator according to one of the previous claims, **characterized in that** the hydraulic system comprises in addition to the pressure control line (39) with the control valve (V2) a throttled line (41) with a throttle control valve (V3) for noise reduced application of the hydraulic brake during or after landing of the elevator car (4), and/or a short-circuit line (40) with a short-circuit valve (V1) for quick brake application in case of emergency, and/or a brake release line (42) with a brake release valve (V4) for releasing the brake without activation of a hydraulic pump (19) to such an extent that a new ride can start.

5. Elevator according to one of the previous claims with a hydraulic pump (19) feeding the hydraulic actuator (11), whereas the pump (19) is - during braking the elevator car (4) down in case of abnormal running conditions to normal running conditions or to standstill - continuously operated, without itself being speed-, torque-, frequency- or power consumption controlled.

6. Elevator according to one of the previous claims, **characterized in that** the hydraulic cylinder (12) being part of the hydraulic actuator (11) is a "double stroke", "double rod" cylinder (12) with the piston (13) therein forming a first working chamber (14) and a second working chamber (15), whereas the cylinder (12) is designed that way that the equal amount of hydraulic fluid displaced from the first working chamber (14) is taken up by the second working chamber (15) when the piston (13) moves.

7. Elevator according to one of the previous claims, **characterized in that** the hydraulic actuator (11) comprises one or preferably more cylinders (12), whereas at least the first working chambers (14) of these cylinders (12) or the second working chambers (15) of theses cylinders (12) have a direct fluidal interconnection in the shape of a common rail.

8. Elevator according to one of the previous claims, **characterized in that** the elevator car brake and the control governing the elevator car brake are de-

signed that way that in the beginning of a departure the elevator car brake is opened by means of the pressure stored in a pressure accumulator (111) while the hydraulic pump (19) starts with a delay and is preferably not started before the elevator car (4) has reached at least 30 %, and better at least 50 % of its regular travel speed.

9. Elevator according to claim 8, **characterized in that** the brake comprises at least two of said hydraulic actuators (11), both designed to act on a brake pad, whereas at least one of these hydraulic actuators (11) is used under regular operation as a hydraulic pressure accumulator (111) delivering the pressure required for opening the elevator car brake in the beginning of a departure without operating the hydraulic pump (19), or at least one of said hydraulic actuators (11) and an additional pressure accumulator (111) delivering the pressure required for opening the elevator car brake in the beginning of a departure without operating the hydraulic pump (19).

10. Elevator according to one of the previous claims, **characterized in that** the hydraulic elevator car brake itself comprises, preferably integrated into the brake unit, an acceleration sensor (10a, 10b), the signal of which is used in order to control the brake force, preferably in such a way that it results in 1 g.

11. Method for open or close loop control of an elevator according to claim 1, comprising a hydraulic elevator car brake with a hydraulic actuator (11) which has at least one piston rod (31) that is pre-stressed by a main spring unit in closing direction with a force necessary for generating the required brake force, whereas the piston rod (31) is connected to a piston (13) which, depending on the hydraulic pressure applied to it, completely or partly compensates the force of the main spring unit, **characterized in that** the resulting force with which the brake lining (16) operated by the piston rod (31) is pressed against the rail is open or close loop controlled by means of a multi-quadrant-operated motor which as first alternative, depending on the actual needs, either drives a hydraulic pump (19) in such a way that the hydraulic pump (19) conveys hydraulic fluid and thus reduces the resulting force acting on the brake lining (16), or which acts as a generator or a braking motor braking a hydraulic pump (19) in such a way that a - preferably close or open loop controlled - stream of the hydraulic fluid flows back via the hydraulic pump (19) driven by the hydraulic fluid in the opposite direction of its actual conveying direction and thus increases the resulting force acting on the brake lining (16), and which as second alternative, depending on the actual needs, drives a hydraulic pump (19) in such a way that the hydraulic pump (19) either conveys hydraulic fluid and thus reduces the resulting force acting on the brake lining (16), or that a leakage flow flows back via the hydraulic pump (19) in the opposite direction of the conveying direction and thus increases the resulting force acting on the brake lining (16).

12. Method according to claim 11, **characterized in that** the hydraulic pump (19) is driven with a rotation speed which is preferably variable depending on need.

13. Method according to claim 11, **characterized in that** the hydraulic pump (19) is driven with a torque which is preferably variable depending on need.

14. Method according to claim 11, 12 or 13, **characterized in that** for carrying out an emergency braking the hydraulic pressure completely or partly compensating the force of the spring element (17) is eliminated by bypassing the hydraulic pump (19) by means of a short-circuit line which can be fully or partly released with the help of an electric valve (V1).

15. Method according to one of the claims 11 to 14, **characterized in that** the elevator car brake comprises several hydraulic actuators (11) for direct effect on at least one brake lining (16) and, depending on the size of the currently needed brake force, all or a predefined number of actuators (11) of one elevator car brake unit are activated.

Patentansprüche

1. Aufzug mit einem Fahrkorb (4), der sich entlang Führungsschienen (2) auf und ab bewegt und eine gesteuerte oder geregelte hydraulische Bremse zum Abbremsen des Fahrkorbs (4) aufweist, wobei die Bremse einen hydraulischen Aktuator (11) umfasst, um einen Satz Bremsbeläge (16) in Schließrichtung gegen ein Bremsglied zu drücken, der hydraulische Aktuator (11) ist durch eine Hauptfedereinheit in Schließrichtung mit einer Kraft zur Aufbringung einer Bremsreibung vorgespannt, wobei der hydraulische Aktuator (11) einen Hydraulikzylinder (12) und einen Kolben (13) umfasst, der den Zylinder (12) in eine erste Arbeitskammer (14) und eine zweite Arbeitskammer (15) teilt, wobei der Kolben (13) in Abhängigkeit von dem in der ersten Arbeitskammer (14) herrschenden hydraulischen Druck die Kraft der Hauptfedereinheit ganz oder teilweise kompensiert, **dadurch gekennzeichnet, dass** die Bremsgeschwindigkeit und/oder die resultierende Kraft, mit der die durch den hydraulischen Aktuator (11) betätigten Bremsbeläge (16) gegen die Schiene (2) gedrückt werden, durch eine hydraulische Druckquelle gesteuert oder geregelt wird, deren Druckseite (D) die vorgenannte erste Arbeitskammer (14) des mindestens einen Kolbens (13) mit Hydraulikflüssigkeit beaufschlagt, und deren Saugseite (S) Hydraulikflüssigkeit aus einer zweiten Arbeitskammer (15) des mindestens einen Kolbens (13) ansaugen kann, wobei eine zusätzliche Drucksteuerleitung (39) die erste Arbeitskammer (14) mit der zweiten Arbeitskammer (15) verbindet, und wobei die tatsächliche Durchflussmenge an Hydraulikflüssigkeit durch die Drucksteuerleitung (39) von einem Steuerventil bestimmt wird.

2. Aufzug nach Anspruch 1, **dadurch gekennzeichnet, dass** das Steuerventil (V2; V23) ein Ventil für den ausschließlichen Auf-Zu-Betrieb mit nur zwei stabilen Positionen ist, nämlich "Ventil vollständig geschlossen" oder "Ventil vollständig geöffnet".

3. Aufzug nach Anspruch 2, **dadurch gekennzeichnet, dass** das Steuerventil (V2; V23) ein Ventil mit einem Ventilkörper zum Sperren oder Öffnen des Durchgangs durch das Ventil (V2; V23) ist, wobei das Ventil (V2; V23) so ausgelegt ist, dass die Durchflussmenge durch das Ventil (V2; V23) bestimmt werden kann, indem das Ventil (V2; V23) jede Sekunde wiederholt zwischen den Zuständen "Ventilkörper in Schließrichtung bewegen" und "Ventilkörper in Öffnungsrichtung bewegen" wechselt.

4. Aufzug nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Hydrauliksystem zusätzlich zur Drucksteuerleitung (39) mit dem Steuerventil (V2) eine gedrosselte Leitung (41) mit einer Drosselklappensteuerung (V3) zum geräuschreduzierten Betätigen der hydraulischen Bremse während oder nach der Landung des Fahrkorbs (4) umfasst, und/oder eine Kurzschlussleitung (40) mit einem Kurzschlussventil (V1) zum schnellen Bremsen im Notfall und/oder eine Bremslöseleitung (42) mit einem Bremslöseventil (V4) zum Lösen der Bremse ohne Aktivierung einer Hydraulikpumpe (19) dergestalt, dass eine neue Fahrt beginnen kann.

5. Aufzug nach einem der vorhergehenden Ansprüche mit einer Hydraulikpumpe (19), die den hydraulischen Aktuator (11) speist, wobei die Pumpe (19) - während des Abbremsens des Fahrkorbs (4) bei abnormalen Fahrbedingungen auf normale Fahrbedingungen oder bis zum Stillstand - kontinuierlich betrieben wird, ohne selbst drehzahl-, drehmoment-, frequenz- oder stromverbrauchsgesteuert zu sein.

6. Aufzug nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Hydraulikzylinder (12), der Teil des hydraulischen Aktuators (11) ist, ein "Doppelhub"-, "Doppelstangen"-Zylinder (12) ist, wobei der Kolben (13) darin eine erste Arbeitskammer (14) und eine zweite Arbeitskammer (15) bildet, wobei der Zylinder (12) so ausgelegt ist, dass die gleiche Menge an aus der ersten Arbeitskammer (14) verdrängter Hydraulikflüssigkeit von der zweiten Arbeitskammer (15) aufgenommen wird, wenn der Kolben (13) sich bewegt.

7. Aufzug nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der hydraulische Aktuator (11) einen oder vorzugsweise mehrere Zylinder (12) umfasst, wobei zumindest die ersten Arbeitskammern (14) dieser Zylinder (12) oder die zweiten Arbeitskammern (15) dieser Zylinder (12) eine direkte fluidische Verbindung in Form einer Common-Rail aufweisen.

8. Aufzug nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Aufzugskabinenbremse und die die Aufzugskabinenbremse regelnde Steuerung so ausgelegt sind, dass zu Beginn einer Abfahrt die Fahrkorbbremse mittels des in einem Druckspeicher (111) gespeicherten Drucks geöffnet wird, während die Hydraulikpumpe (19) verzögert startet und vorzugsweise nicht gestartet wird, bevor der Fahrkorb (4) mindestens 30 %, besser mindestens 50 % seiner regulären Fahrgeschwindigkeit erreicht hat.

9. Aufzug nach Anspruch 8, **dadurch gekennzeichnet, dass** die Bremse mindestens zwei dieser hydraulischen Aktuatoren (11) umfasst, die beide dazu ausgelegt sind, auf einen Bremsbelag einzuwirken, wobei mindestens einer dieser hydraulischen Aktuatoren (11) im regulären Betrieb als hydraulischer Druckspeicher (111) verwendet wird, der den zum Öffnen der Fahrkorbbremse erforderlichen Druck zu Beginn einer Abfahrt ohne Betätigung der Hydraulikpumpe (19) bereitstellt, oder mindestens einer dieser hydraulischen Aktuatoren (11) und ein zusätzlicher Druckspeicher (111), die den zum Öffnen der Fahrkorbbremse erforderlichen Druck zu Beginn einer Abfahrt ohne Betätigung der Hydraulikpumpe (19) bereitstellen.

10. Aufzug nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die hydraulische Fahrkorbbremse selbst, vorzugsweise in die Bremseinheit integriert, einen Beschleunigungssensor (10a, 10b) umfasst, dessen Signal zur Steuerung der Bremskraft verwendet wird, vorzugsweise so, dass sie 1 g beträgt.

11. Verfahren zur Steuerung oder Regelung eines Aufzugs nach Anspruch 1 mit einer hydraulischen Fahrkorbbremse mit einem hydraulischen Aktuator (11), der mindestens eine Kolbenstange (31) aufweist, die von einer Hauptfedereinheit in Schließrichtung mit einer zur Aufbringung der notwendigen Bremskraft erforderlichen Kraft vorgespannt ist, wobei die Kolbenstange (31) mit einem Kolben (13) verbunden ist, der je nachdem, welcher hydraulische Druck an ihm anliegt, die Kraft der Hauptfedereinheit ganz oder teilweise kompensiert, **dadurch gekennzeichnet, dass** die resultierende Kraft, mit der der von der Kolbenstange (31) betätigte Bremsbelag (16) gegen die Schiene gedrückt wird, mit Hilfe eines im Mehrquadrantenbetrieb gefahrenen Motors geregelt oder gesteuert wird, der in erster Alternative, je nach aktueller Notwendigkeit, entweder eine Hydraulikpumpe (19) so antreibt, dass die Hydraulikpumpe (19) Hydraulikflüssigkeit fördert und damit die auf den Bremsbelag (16) einwirkende resultierende Kraft verringert, oder der als Generator oder ein Bremsmotor wirkt, der eine Hydraulikpumpe (19) derart bremst, dass über die entgegen ihrer eigentlichen Förderrichtung von der Hydraulikflüssigkeit angetriebene Hydraulikpumpe (19) ein - vorzugsweise regel- oder steuerbarer - Strom der Hydraulikflüssigkeit zurückfließt und damit die resultierende Kraft, die auf den Bremsbelag (16) wirkt, vergrößert wird und der in zweiter Alternative, je nach aktueller Notwendigkeit, eine Hydraulikpumpe (19) so antreibt, dass die Hydraulikpumpe (19) entweder Hydraulikflüssigkeit fördert und damit die resultierende Kraftwirkung auf den Bremsbelag (16) verringert, oder dass ein Leckagestrom über die Hydraulikpumpe (19) entgegen ihrer Förderrichtung zurückfließt und dadurch die resultierende Kraft, die auf den Bremsbelag (16) wirkt, vergrößert wird.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** die Hydraulikpumpe (19) mit einer vorzugsweise bedarfsabhängig variablen Drehzahl angetrieben wird.

13. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** die Hydraulikpumpe (19) mit einem vorzugsweise bedarfsabhängig variablen Drehmoment angetrieben wird.

14. Verfahren nach Anspruch 11, 12 oder 13, **dadurch gekennzeichnet, dass** zur Durchführung einer Notbremsung der hydraulische Druck, der die Kraft des Federelements (17) ganz oder teilweise kompensiert, unter Umgehung der Hydraulikpumpe (19) durch eine mit Hilfe eines elektrisches Ventils (V1) vollständig oder teilweise freigebbare Kurzschlussleitung, eliminiert wird.

15. Verfahren nach einem der Ansprüche 11 bis 14, **dadurch gekennzeichnet, dass** die Fahrkorbbremse mehrere hydraulische Aktuatoren (11) zur direkten Einwirkung auf mindestens einen Bremsbelag (16) aufweist und je nachdem, wie groß die aktuell benötigte Bremskraft ist, alle oder eine vorgegebene Anzahl von Aktuatoren (11) einer Fahrkorbbremseinheit aktiviert werden.

Revendications

1. Ascenseur avec une cabine d'ascenseur (4) se déplaçant le long de rails de guidage (2) de haut en bas et comprenant un frein hydraulique commandé en boucle ouverte ou fermée pour décélérer la cabine d'ascenseur (4), le frein comprenant un actionneur hydraulique (11) pour presser un ensemble de garnitures de frein (16) dans la direction de fermeture contre un élément de frein,
l'actionneur hydraulique (11) est précontraint par une unité de ressort principal dans la direction de fermeture avec une force pour générer une friction de freinage, l'actionneur hydraulique (11) comprenant un cylindre hydraulique (12) et un piston (13) divisant le cylindre (12) en une première chambre de travail (14) et une seconde chambre de travail (15), et, en fonction de la pression hydraulique régnant dans la première chambre de travail (14), le piston (13) compense totalement ou partiellement la force de l'unité de ressort principal, **caractérisé en ce que** la vitesse à laquelle le frein s'applique, et/ou la force résultante avec laquelle la garniture de frein (16) actionnée par l'actionneur hydraulique (11) est pressée contre le rail (2) est commandée en boucle ouverte ou fermée au moyen d'une source de pression hydraulique dont le côté de pression (D) charge la première chambre de travail (14) susmentionnée du au moins un piston (13) avec du fluide hydraulique, et dont le côté d'aspiration (S) est capable d'aspirer du fluide hydraulique d'une seconde chambre de travail (15) du au moins un piston (13), une ligne supplémentaire de commande de pression (39) reliant la première chambre de travail (14) à la seconde chambre de travail (15), et le débit réel de fluide hydraulique à travers la ligne de commande de pression (39) étant déterminé par une vanne de commande.

2. Ascenseur selon la revendication 1, **caractérisé en ce que** la soupape de réglage (V2; V23) est une soupape destinée au fonctionnement exclusif ouvert/fermé et n'ayant que deux positions stables, à savoir "soupape complètement fermée" ou "soupape complètement ouverte".

3. Ascenseur selon la revendication 2, **caractérisé en ce que** la soupape de réglage (V2; V23) est une soupape avec un corps de soupape pour bloquer ou ouvrir le passage à travers la soupape (V2; V23), la soupape (V2; V23) étant conçue de telle manière que la quantité de débit à travers la soupape (V2; V23) peut être déterminée en commutant la soupape (V2; V23) chaque seconde à plusieurs reprises dans les deux sens entre les états "déplacer le corps de soupape dans la direction de la fermeture" et "déplacer le corps de la soupape dans la direction de l'ouverture".

4. Ascenseur selon l'une des revendications précédentes, **caractérisé en ce que** le système hydraulique comprend en plus de la ligne de régulation de pression (39) avec la soupape de réglage (V2) une ligne étranglée (41) avec une vanne papillon (V3) pour une application à bruit réduit du frein hydraulique pendant ou après l'atterrissage de la cabine d'ascenseur (4), et/ou une ligne de court-circuit (40) avec une vanne de court-circuit (VI) pour un freinage rapide en cas d'urgence, et/ou une conduite de desserrage des freins (42) avec un frein soupape de desserrage (V4) pour desserrer le frein sans actionner une pompe hydraulique (19) à un point tel qu'un nouveau trajet puisse démarrer.

5. Ascenseur selon l'une des revendications précédentes avec une pompe hydraulique (19) alimentant l'actionneur hydraulique (11), la pompe (19) étant actionnée en continu - pendant le freinage de la cabine d'ascenseur (4) en cas de conditions de fonctionnement anormales pour l'amener à des conditions de fonctionnement normales ou à l'arrêt -, sans être lui-même contrôlée en vitesse, en couple, en fréquence ou en consommation d'énergie.

6. Ascenseur selon l'une des revendications précédentes, **caractérisé en ce que** le cylindre hydraulique (12) faisant partie de l'actionneur hydraulique (11) est un cylindre (12) "à double effet", "à double tige" dans lequel le piston (13) forme une première chambre de travail (14) et une seconde chambre de travail (15), le cylindre (12) étant conçu de telle sorte que la même quantité de fluide hydraulique déplacée de la première chambre de travail (14) soit absorbée par la seconde chambre de travail (15) lorsque le piston (13) se déplace.

7. Ascenseur selon l'une des revendications précédentes, **caractérisé en ce que** l'actionneur hydraulique (11) comprend un ou de préférence plusieurs cylindres (12), au moins les premières chambres de travail (14) de ces cylindres (12) ou les deuxièmes chambres de travail (15) de ces cylindres (12) ayant une interconnexion fluidique directe en forme de common rail.

8. Ascenseur selon l'une des revendications précédentes, **caractérisé en ce que** le frein de la cabine d'ascenseur et la commande régissant le frein de la cabine d'ascenseur sont conçus de telle sorte qu'au début d'un départ le frein de la cabine d'ascenseur est ouvert au moyen de la pression stockée dans un accumulateur de pression (111) tandis que la pompe hydraulique (19) démarre avec un retard et n'est de préférence pas démarré avant que la cabine d'ascenseur (4) ait atteint au moins 30 %, et mieux au moins 50 % de sa vitesse de déplacement normale.

9. Ascenseur selon la revendication 8, **caractérisé en ce que** le frein comprend au moins deux desdits actionneurs hydrauliques (11), tous les deux destinés à agir sur une plaquette de frein, au moins un de ces actionneurs hydrauliques (11) étant utilisé en fonctionnement normal comme un accumulateur de pression hydraulique (111) délivrant la pression nécessaire pour ouvrir le frein de la cabine d'ascenseur au début d'un départ sans actionner la pompe hydraulique (19), ou au moins l'un desdits actionneurs hydrauliques (11) et un accumulateur de pression supplémentaire (111) délivrant la pression nécessaire pour ouvrir le frein de la cabine d'ascenseur au début d'un départ sans actionner la pompe hydraulique (19).

10. Ascenseur selon l'une des revendications précédentes, **caractérisé en ce que** le frein hydraulique de cabine d'ascenseur comprend lui-même un capteur d'accélération (10a, 10b) qui de préférence est intégré à l'unité de freinage et dont le signal est utilisé pour contrôler la force de freinage, de préférence de telle manière qu'il en résulte 1 g.

11. Procédé de commande en boucle ouverte ou fermée d'un ascenseur selon la revendication 1, comprenant un frein hydraulique de cabine d'ascenseur avec un actionneur hydraulique (11) qui a au moins une tige de piston (31) qui est précontrainte par une unité de ressort principal dans la direction de fermeture avec une force nécessaire pour générer la force de freinage requise, la tige de piston (31) étant reliée à un piston (13) qui, en fonction de la pression hydraulique qui lui est appliquée, compense totalement ou partiellement la force de l'unité de ressort principal, **caractérisé en ce que** la force résultante avec laquelle la garniture de frein (16) actionnée par la tige de piston (31) est pressée contre le rail est commandée en boucle ouverte ou fermée au moyen d'un moteur à plusieurs quadrants qui, en première alternative, en fonction des besoins réels, entraîne une pompe hydraulique (19) de telle sorte que la pompe hydraulique (19) transporte du fluide hydraulique et réduit ainsi la force résultante agissant sur la garniture de frein (16), ou qui agit comme un générateur ou un moteur de freinage freinant une pompe hydraulique (19) de telle manière qu'un flux de fluide hydraulique - de préférence contrôlé en boucle fermée ou ouverte - reflue via la pompe hydraulique (19) entraînée par le fluide hydraulique dans le sens opposé à son sens de transport réel et augmente ainsi la force résultante qui agit sur la garniture de frein (16), et qui en deuxième alternative, en fonction des besoins réels, entraîne une pompe hydraulique (19) de telle sorte que la pompe hydraulique (19) transporte le fluide hydraulique et réduit ainsi la force résultante agissant sur la garniture de frein (16), ou qu'un courant de fuite reflue via la pompe hydraulique (19) dans le sens opposé au sens de transport et augmente ainsi la force résultante qui agit sur la garniture de frein (16) .

12. Procédé selon la revendication 11, **caractérisé en ce que** la pompe hydraulique (19) est entraînée à une vitesse de rotation qui est de préférence variable en fonction des besoins.

13. Procédé selon la revendication 11, **caractérisé en ce que** la pompe hydraulique (19) est entraînée à un couple qui est de préférence variable en fonction des besoins.

14. Procédé selon l'une des revendications 11, 12 ou 13, **caractérisé en ce que**, pour effectuer un freinage d'urgence, la pression hydraulique compensant totalement ou partiellement la force de l'élément à ressort (17) est éliminée en contournant la pompe hydraulique (19) au moyen d'une ligne de court-circuit qui peut être libérée entièrement ou partiellement à l'aide d'une valve électrique (V1) .

15. Procédé selon l'une des revendications 11 à 14, **caractérisé en ce que** le frein de la cabine d'ascenseur comprend plusieurs actionneurs hydrauliques (11) pour l'effet direct sur au moins une garniture de frein (16) et, en fonction de l'importance de la force de freinage actuellement nécessaire, tous ou un nombre prédéfini d'actionneurs (11) d'une unité de freinage de cabine d'ascenseur sont activés.

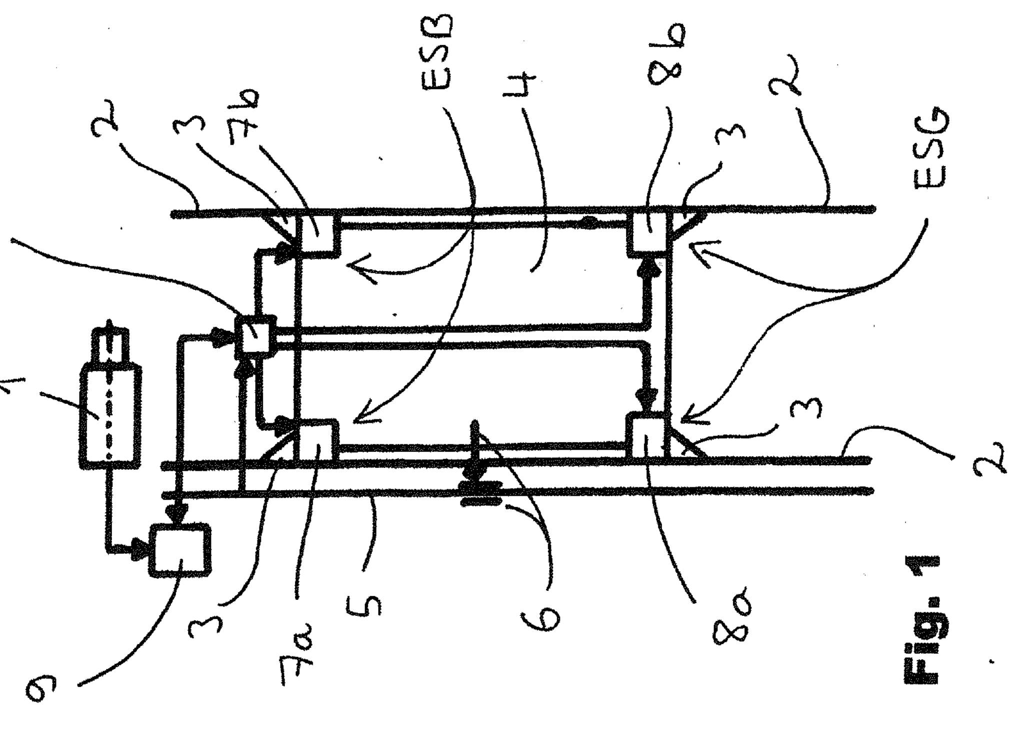


Fig. 1

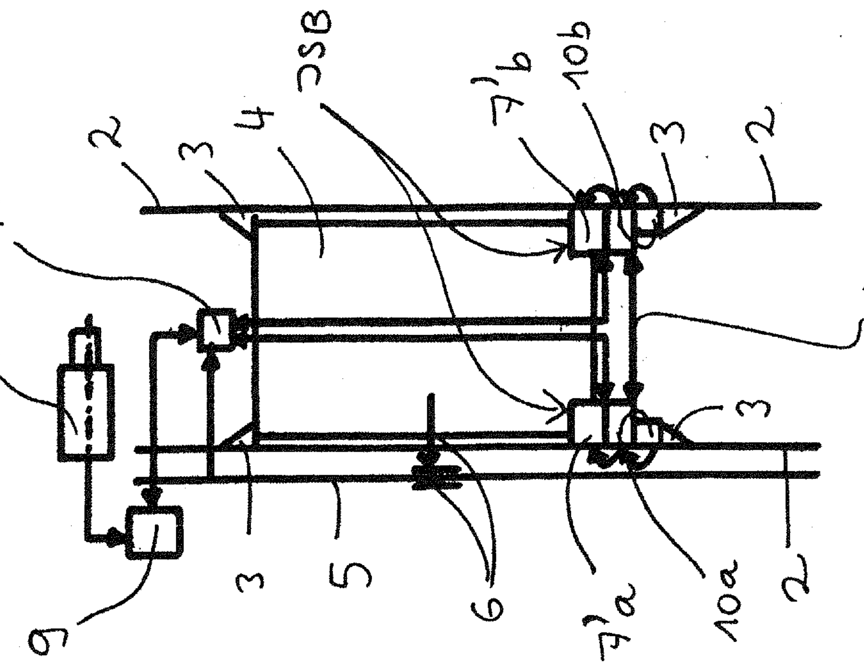


Fig. 2

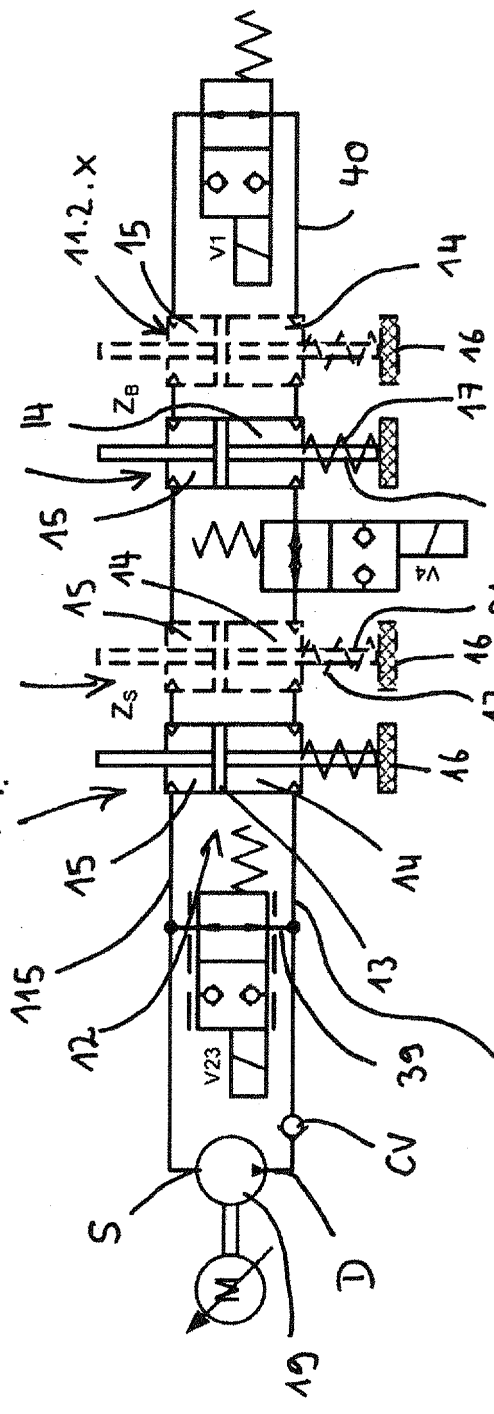


Fig. 3a

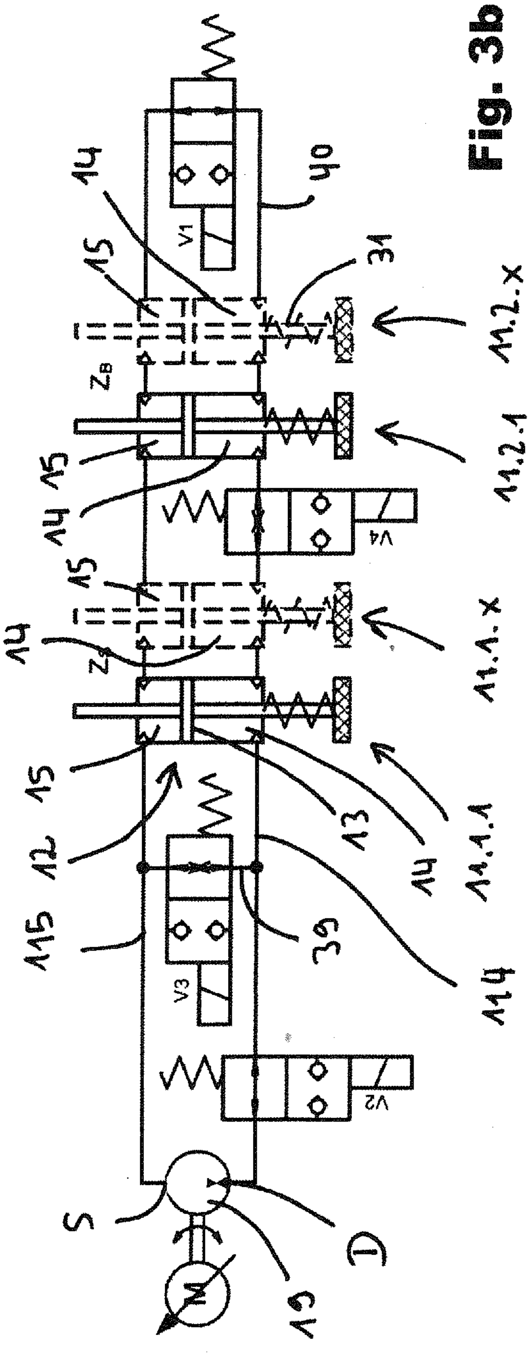


Fig. 3b

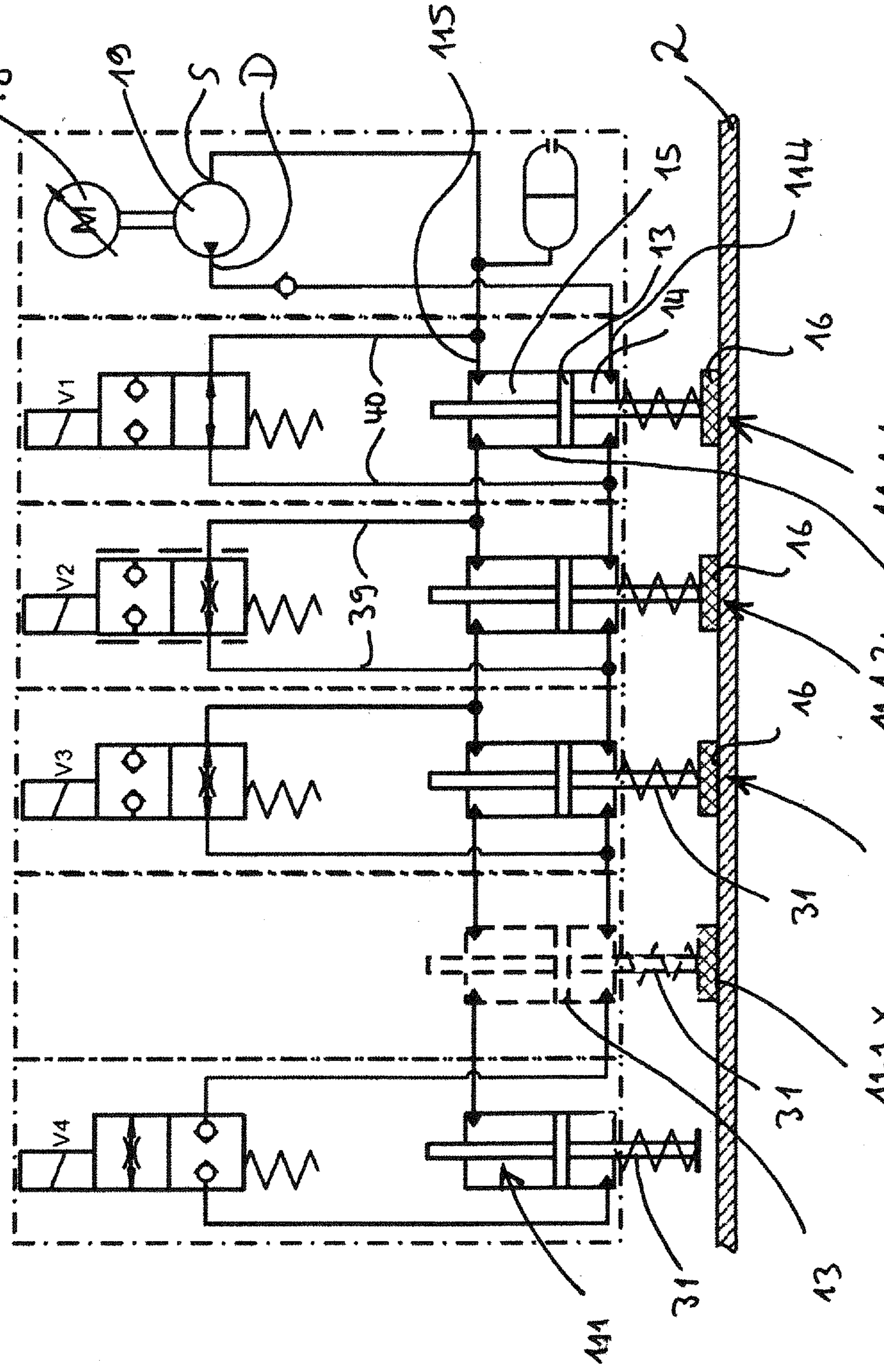

18
19
S
D
M
115
15
13
14
114
2
16
40
39
V1
V2
V3
V4
12
11.1.1
11.1.2
11.1.3
11.1.X
31
13
111

Fig. 3c

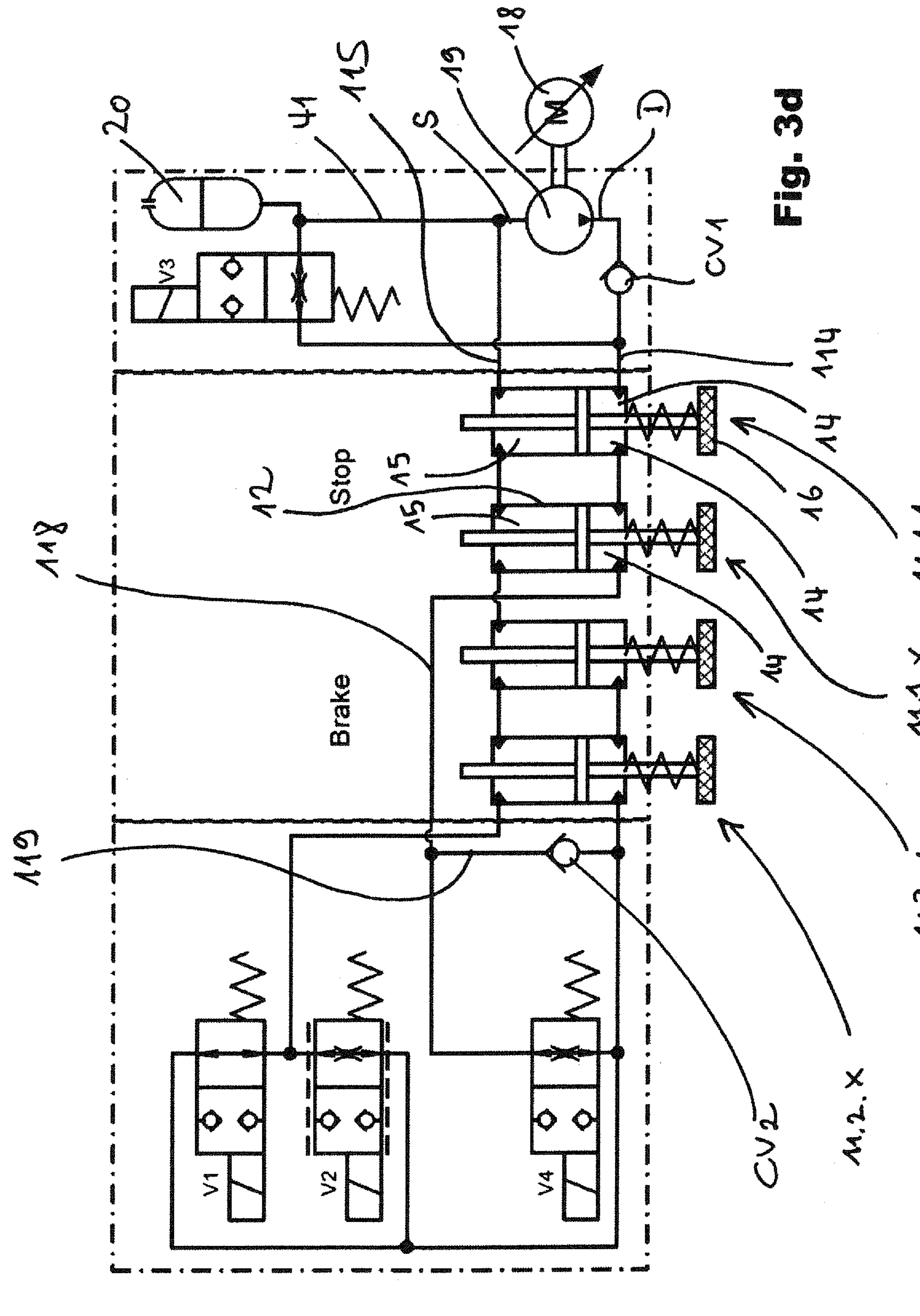
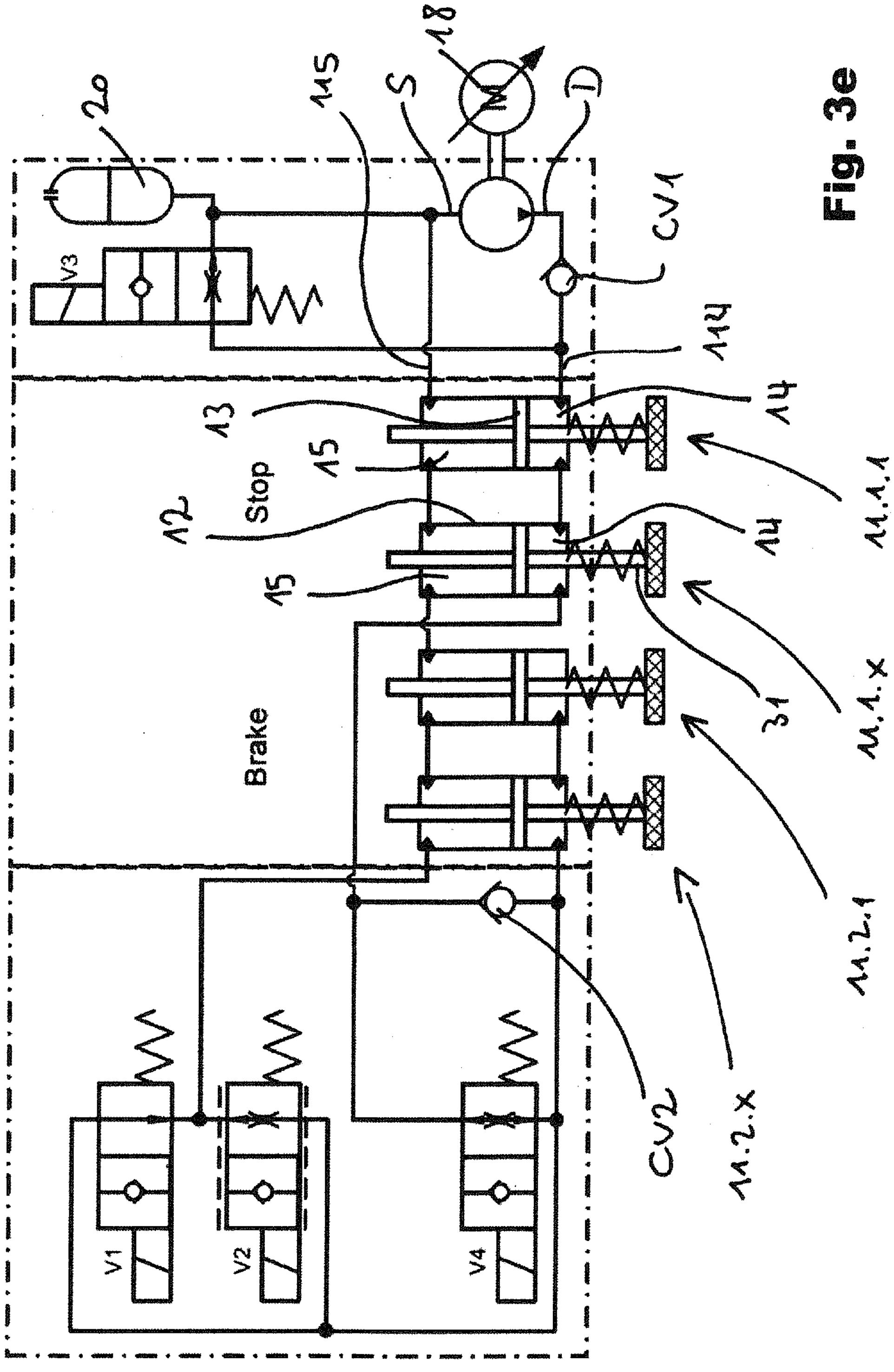

V1
V2
V3
V4
M
Brake
Stop
CV1
CV2
20
41
115
S
19
18
114
14
15
16
12
118
119
11.1.1
11.1.x
11.2.1
11.2.x

Fig. 3d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V3
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S
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M
D
CV1
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13
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15
Stop
12
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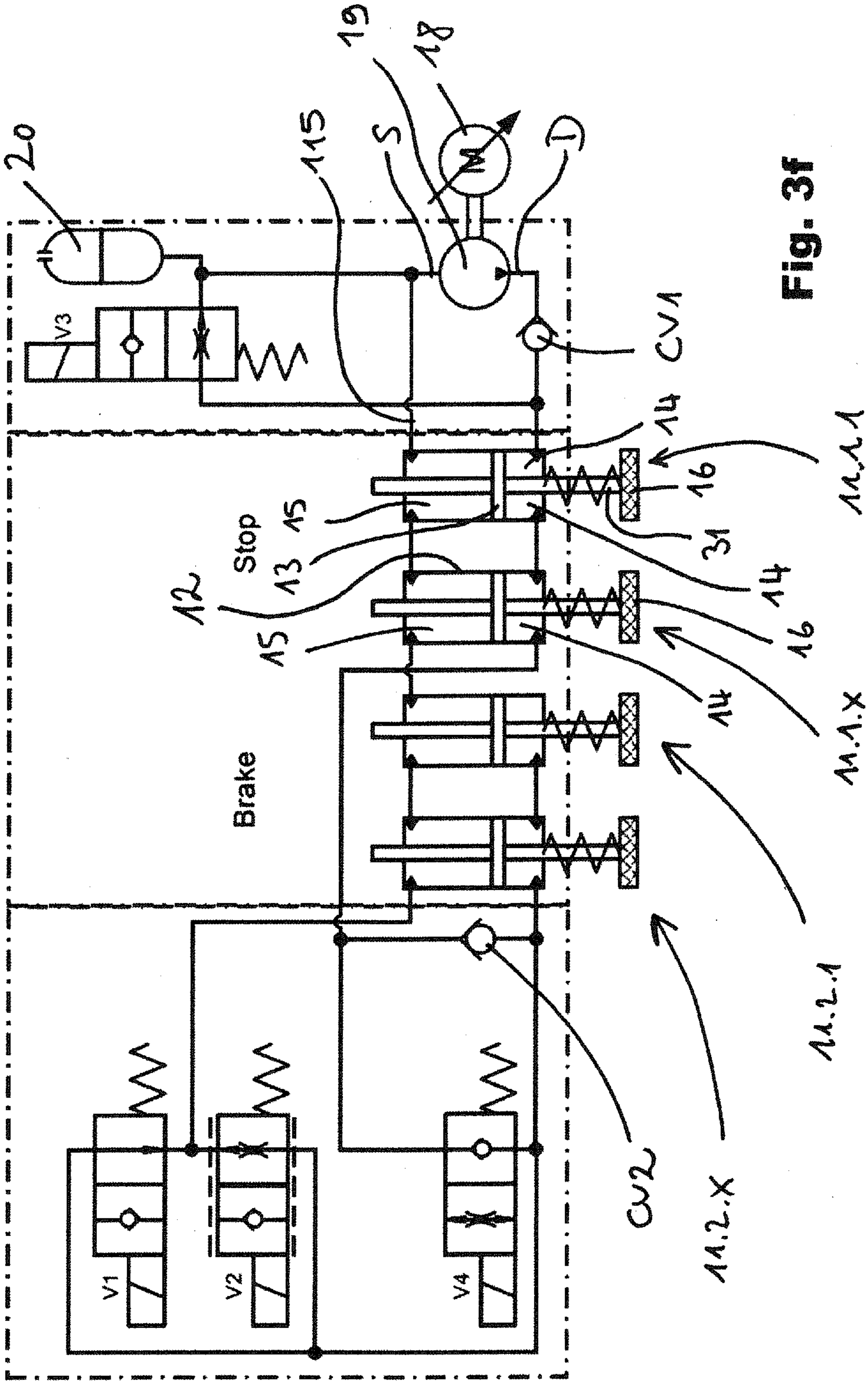
11.2.1
11.2.x
CV2
V1
V2
V4

Fig. 3e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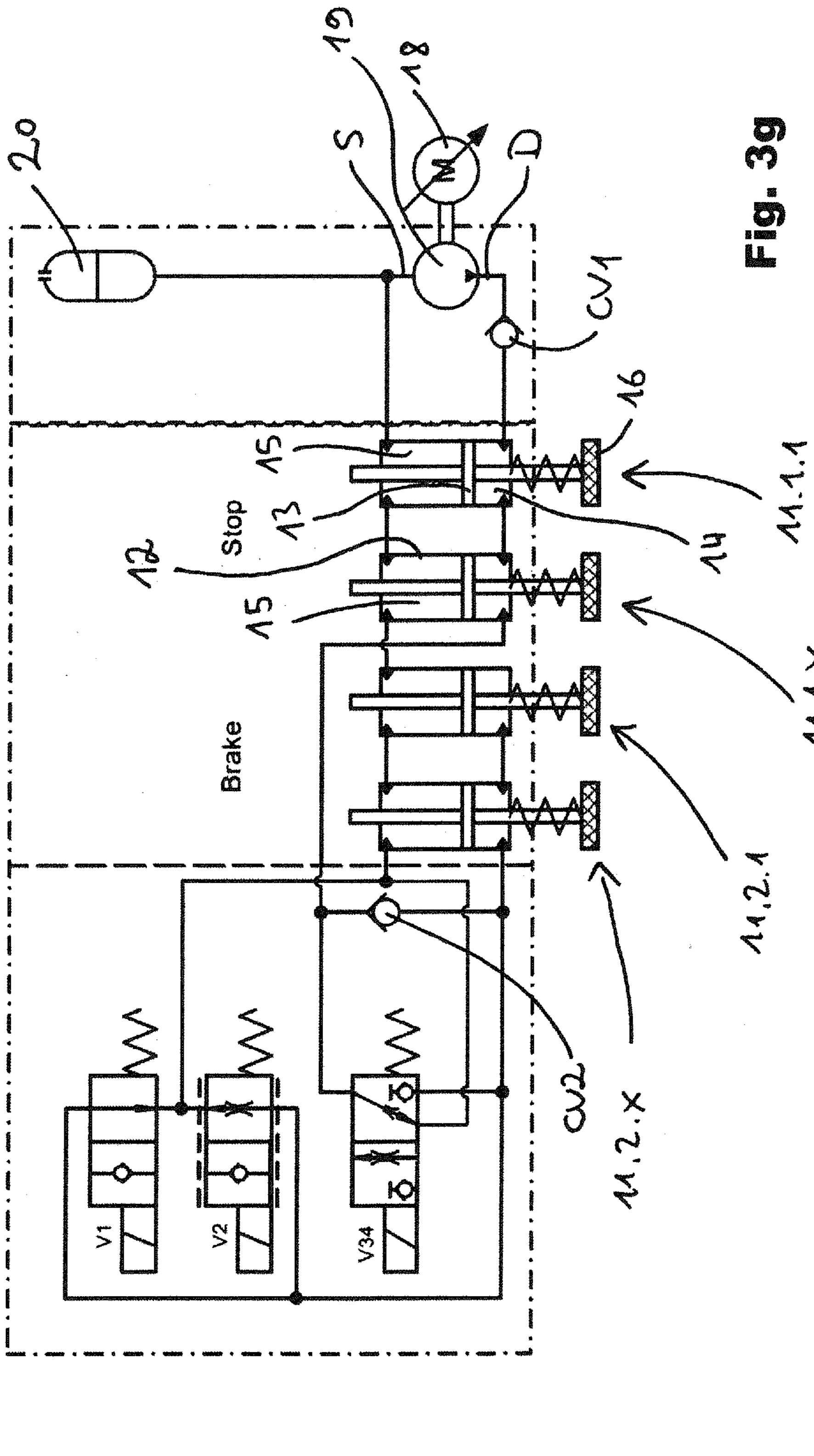
Brake
11.2.1
CV2
11.2.x
V1
V2
V4

Fig. 3f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D
CV1
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Stop
13
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14
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11.2.1
CV2
11.2.x
V1
V2
V34

Fig. 3g

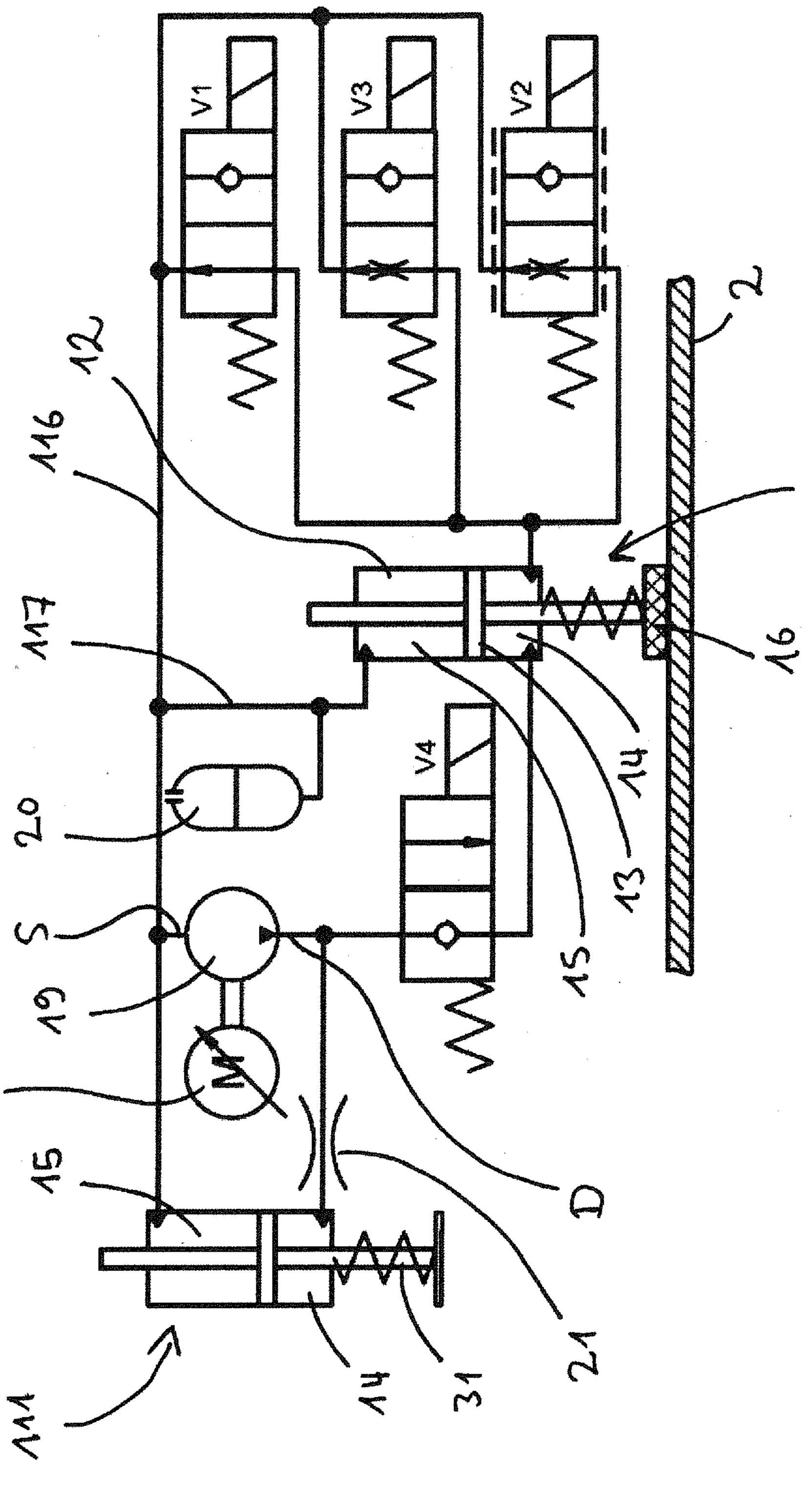


Fig. 3h

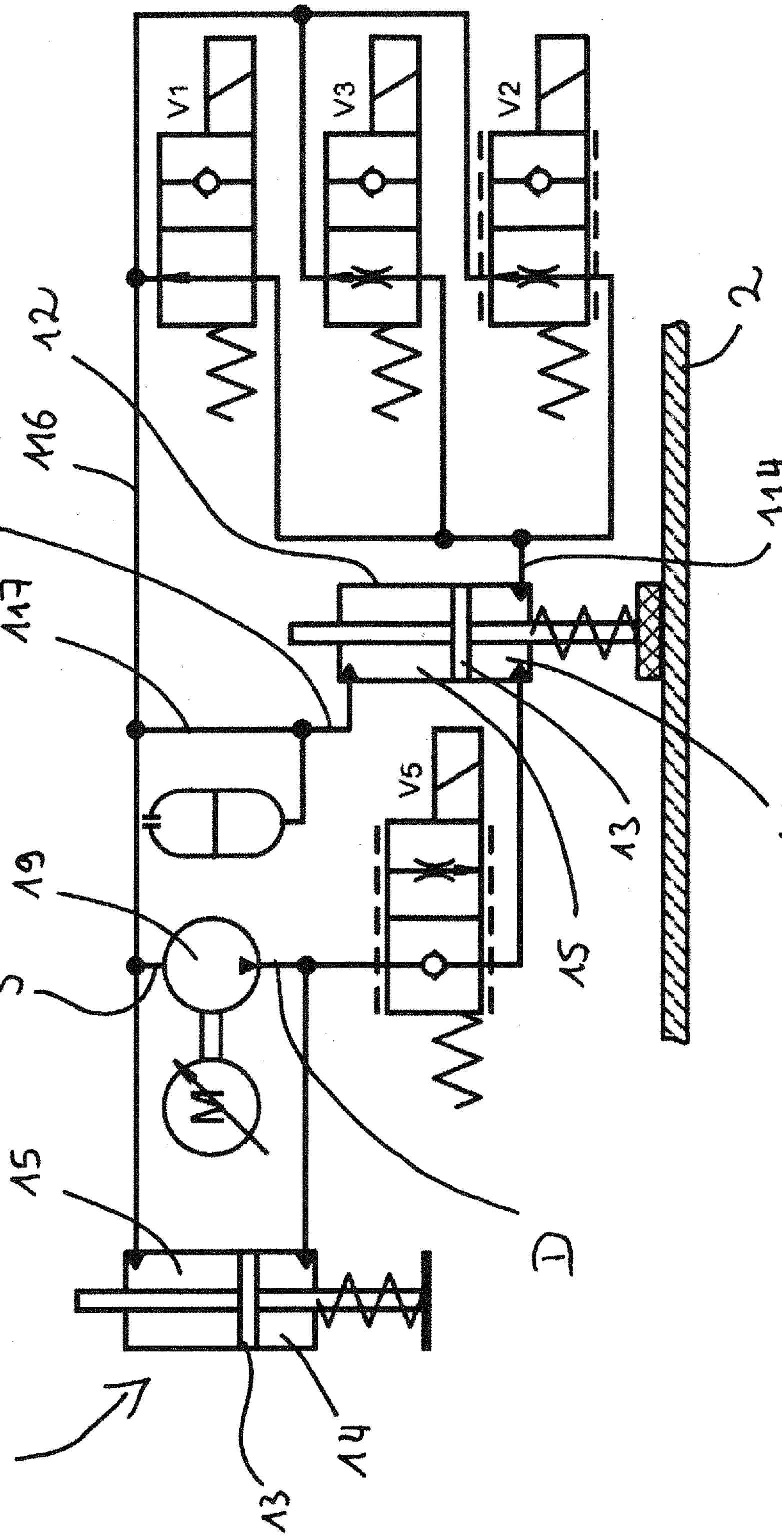
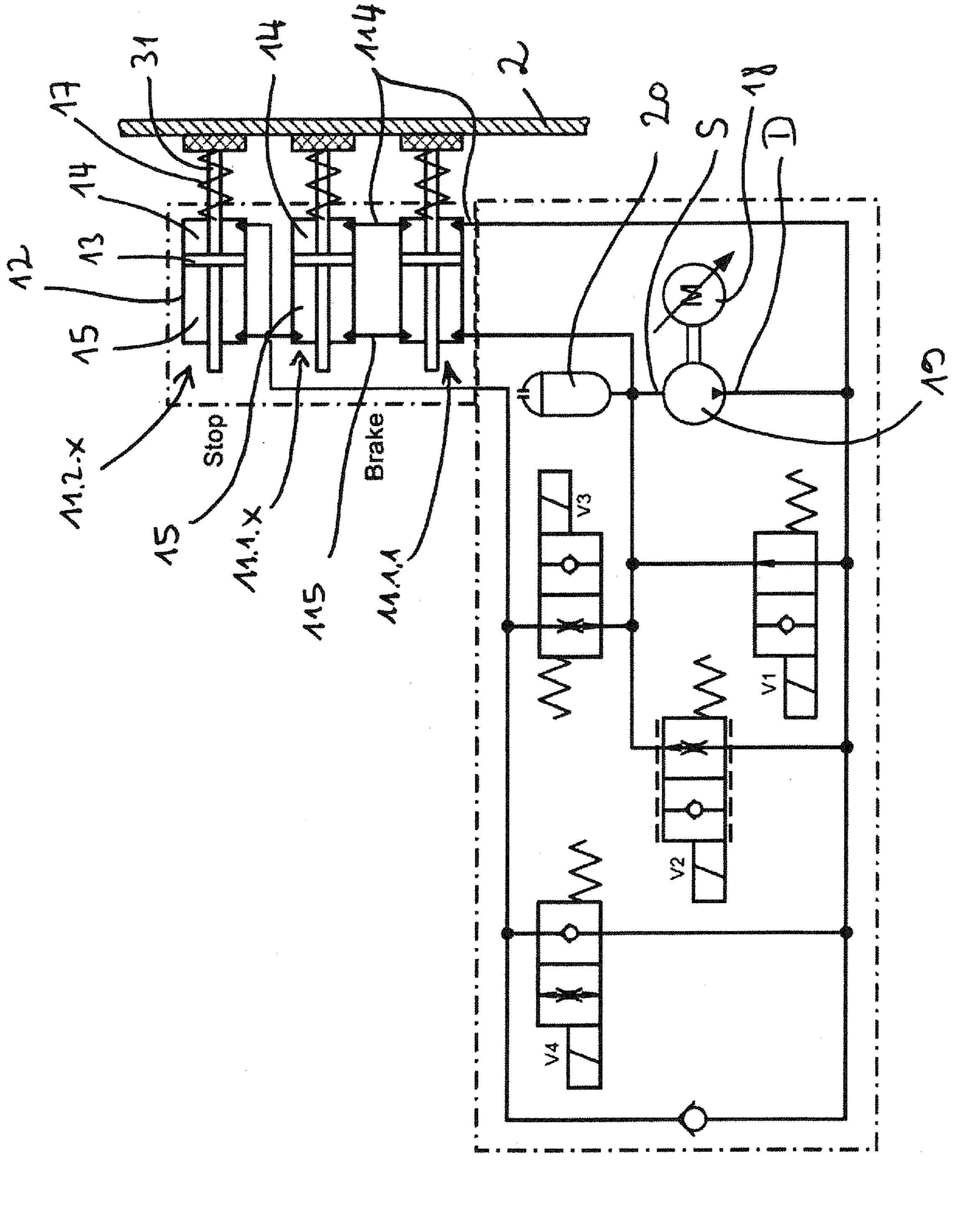


Fig. 3i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D
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115
Brake
11.1.1
V3
V1
V2
V4

Fig. 3j

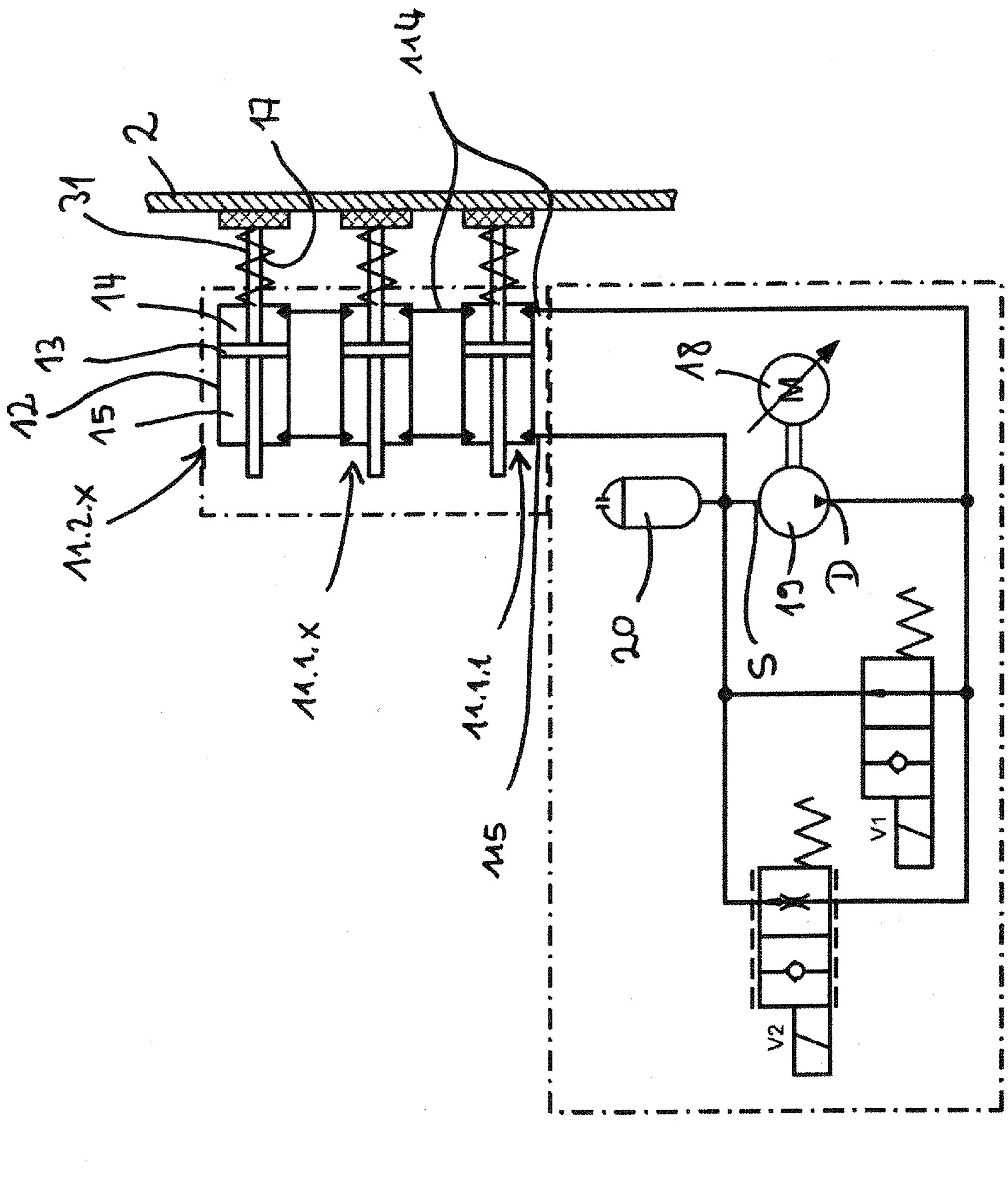

Fig. 3k

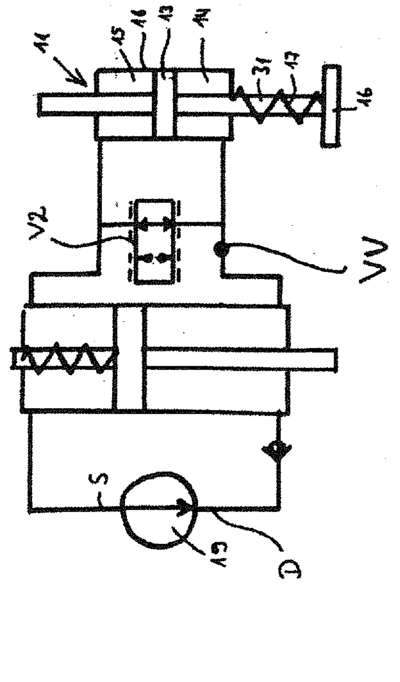

Fig. 3L

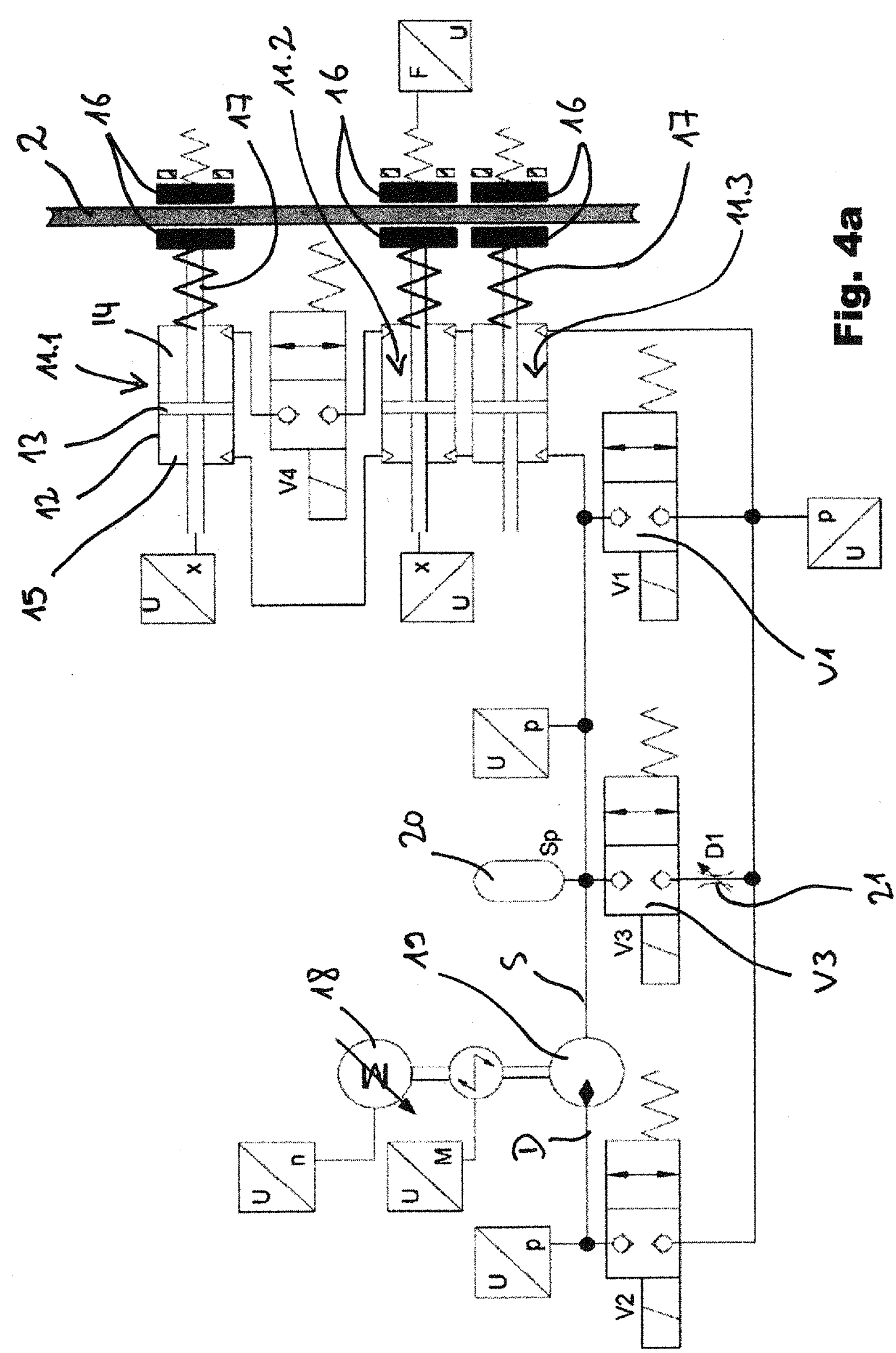
2
16
17
11.2
16
16
17
11.3
11.1
14
13
12
15
V4
V1
V2
V3
Sp
D1
20
21
S
18
19
D
F
U
x
p
n
M

Fig. 4a

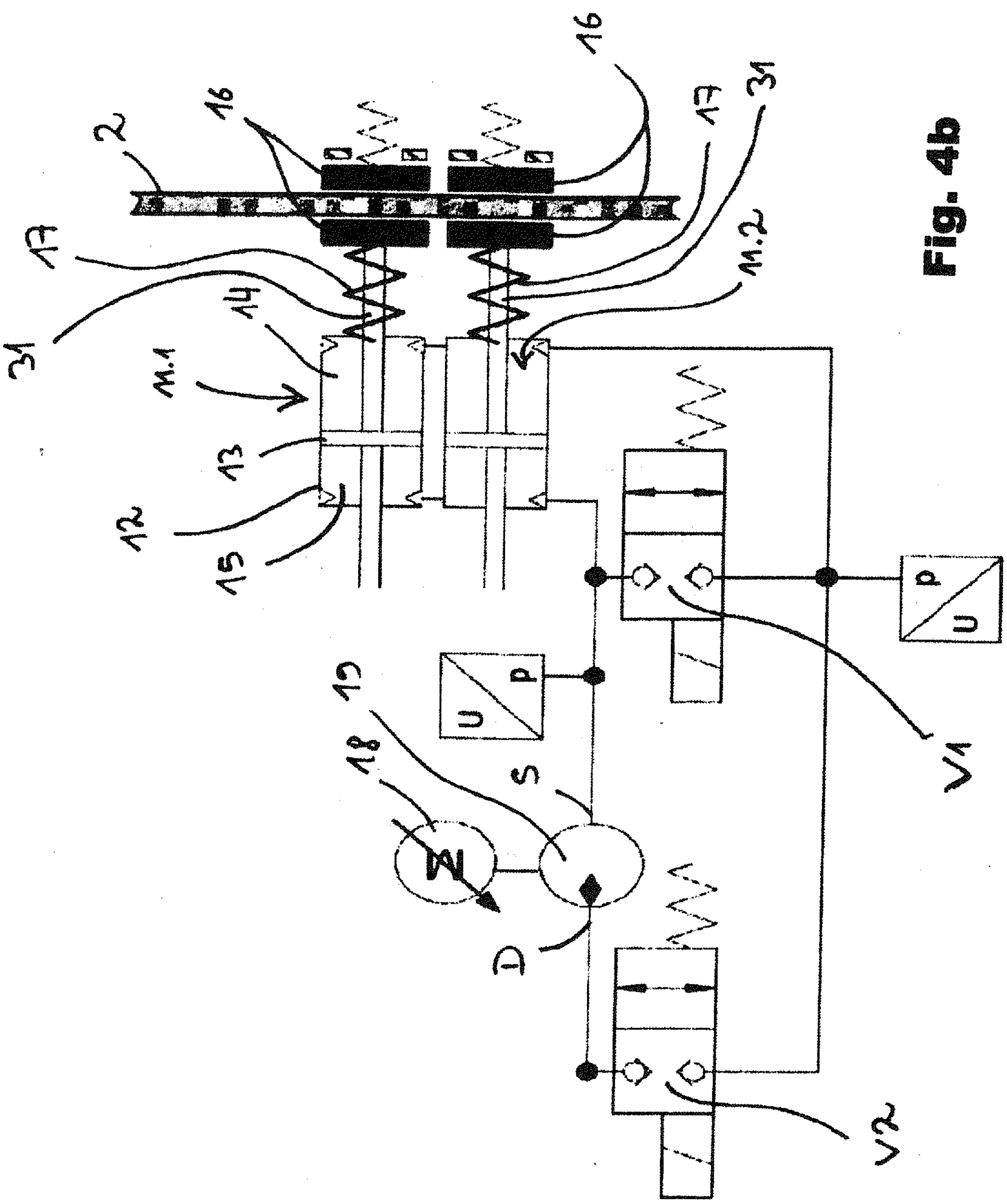

Fig. 4b

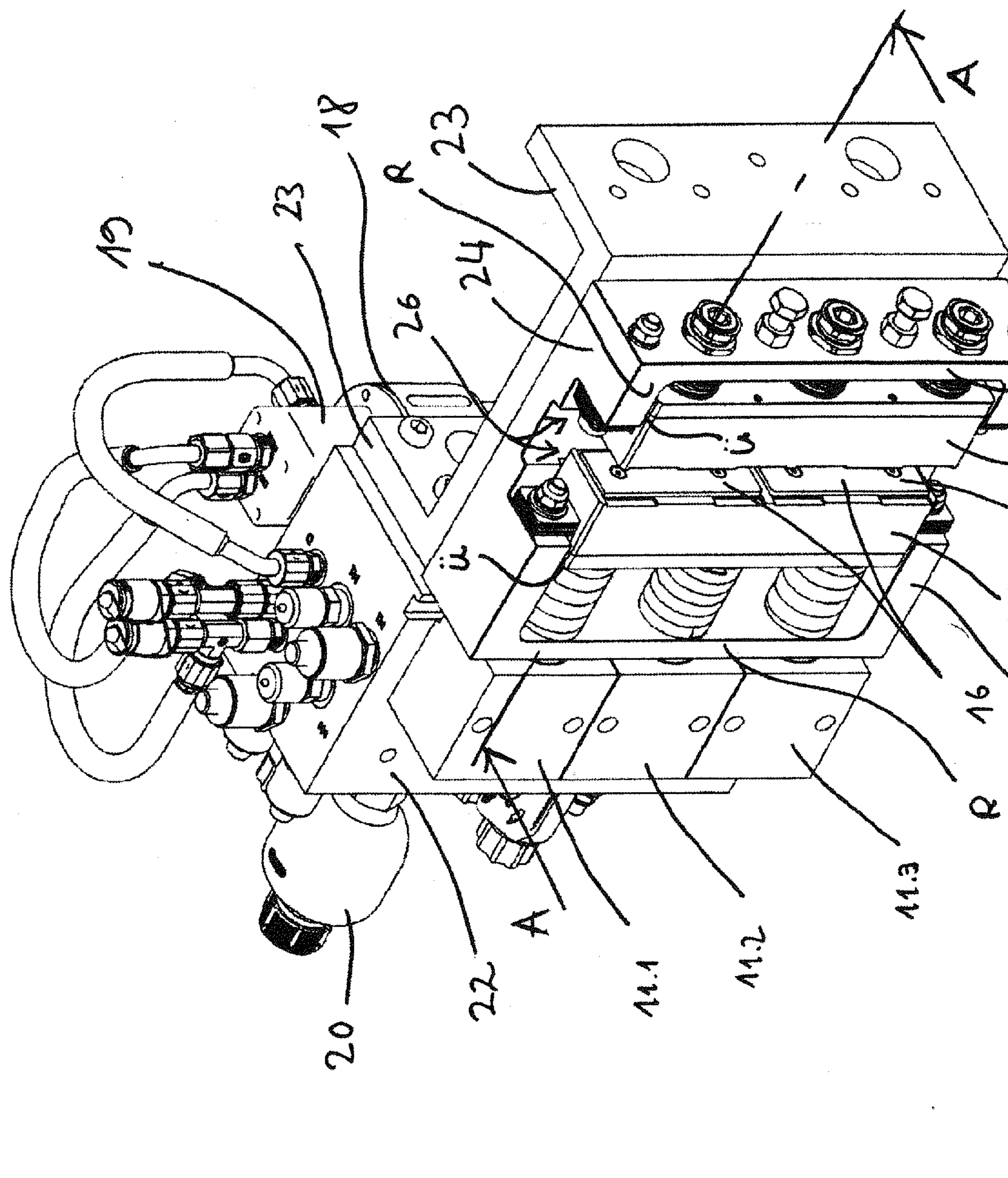

Fig. 5

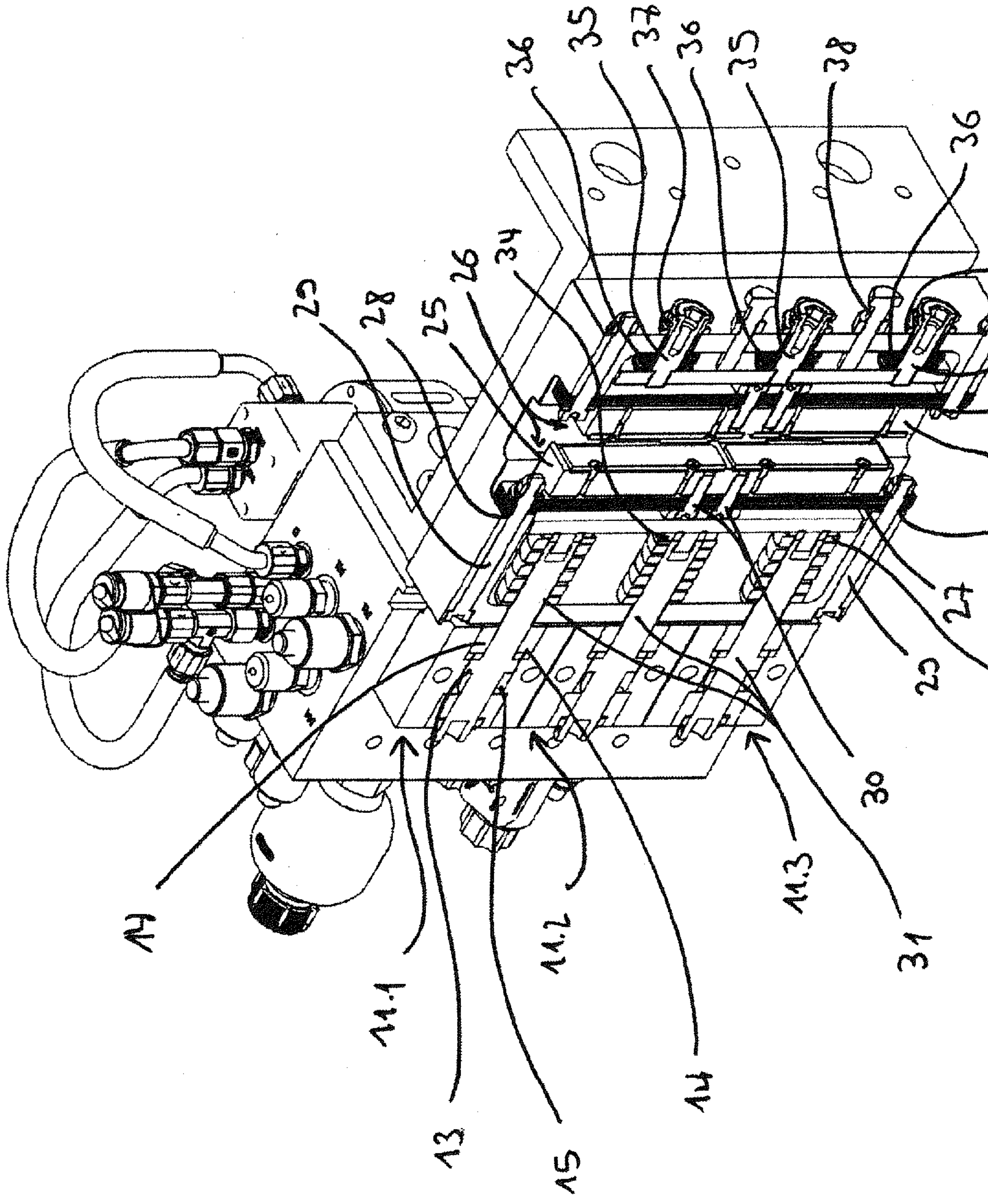

Fig. 6

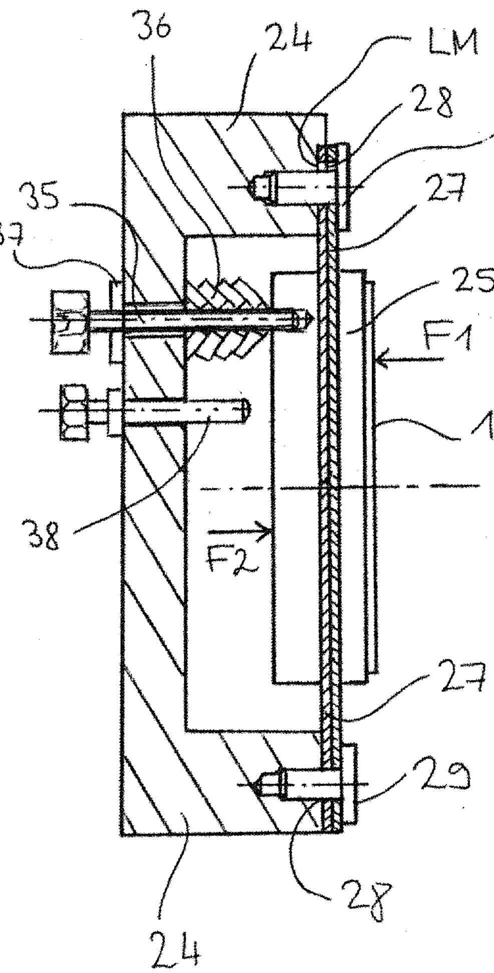

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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- DE 202004017587 U1 **[0003]**