Past, present and future of hydraulic valves

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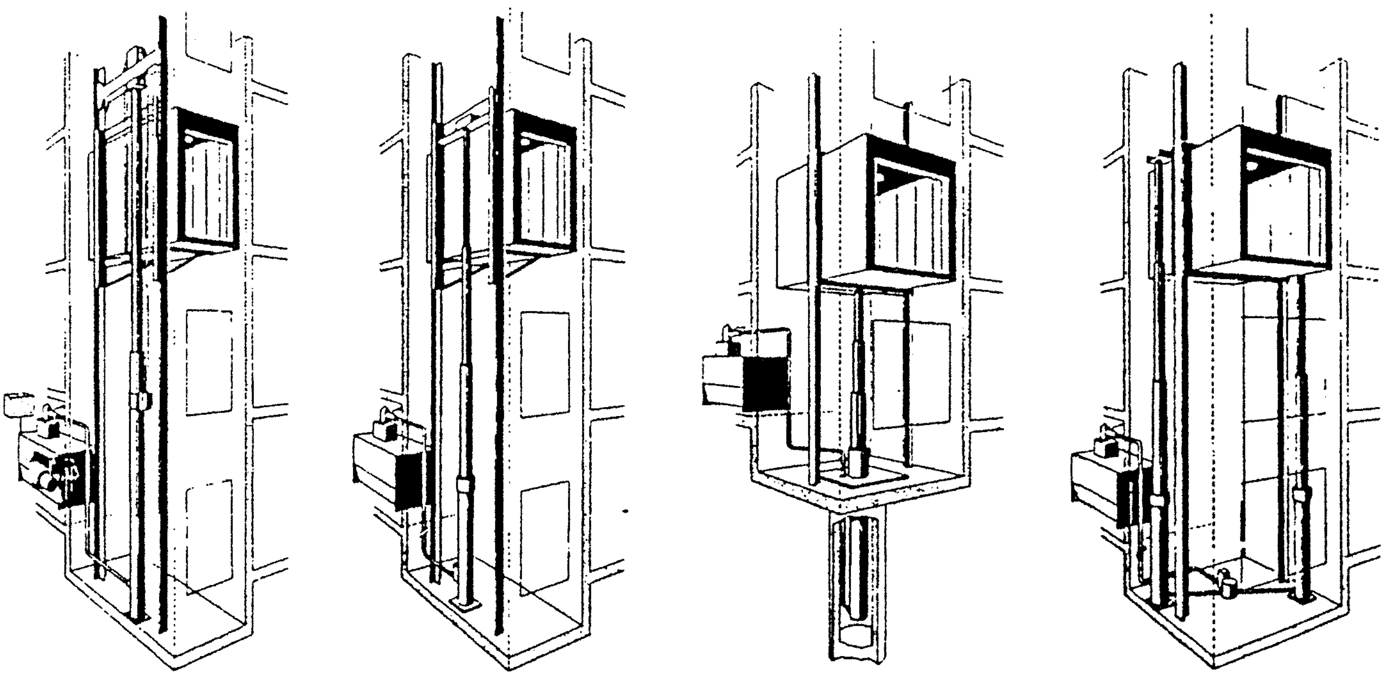
ABSTRACT:

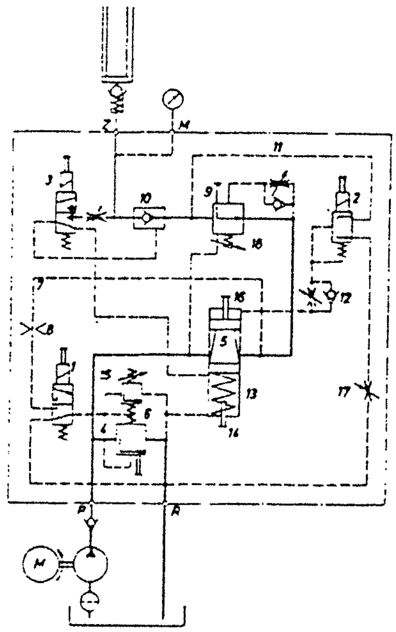
The number of hydraulic lifts in operation has been ever increasing during the course of the past years. Although originally concieved as goods lifts, hydraulic lifts today are used more and more as passenger lifts with travel speeds up to 1m/s (EN81-2) and more.
Hydraulically operated passenger lifts are installed not only in residential buildings and industrial premises, but also in public buildings and centres, where they often take the shape of panoramic glass lifts. More and more lifts are installed in self-supporting and fashionably lined shaft frameworks subsequently added to buildings. Architects and lift manufacturers can give full play to their creativity regarding the design of lifts, including them in their architectural concept.Along with the increasing demand for hydraulic passenger lifts, greater stress has been put on travel comfort. Hydraulic lifts are required to offer a travel comfort that can be compared to the travel comfort of rope-traction lifts with speed-controlled direct current drives. Clients expect hydraulic lifts to offer a constantly high travel comfort unimpaired by load and temperature changes.

HYDRAULIC SYSTEMS:



PAST:

Controlled lift valves work today still by the same functional principles as about 30 years ago. In up direction mode the volume flow is being increased continuously by means of a 3 port valve. The lift valve is designed in such a way that for up it requires 3-way volume control, for down direction 2-way volume control. Since all volume control functions must be implemented by hydraulic mechanical design, the lift valve contains many hydraulic actuator elements and a number of externally accessible adjustment screws. Due to the complexity of such a lift control valve its setting or optimizing is possible for trained personnel only.



Upwards

Up direction command both the motor and the solenoid valves 1 and 2 will be switched on. Oil flows through a reflux valve to the over-pressure bypass valve 4 and on to the throttle slide 5. The lower face of the piston is connected to the pump pressure, while a compression coil 6 applies a counter pressure equivalent to 2.5 bar to the piston's upper end. When the pump pressure exceeds this value the piston will move and open up flow to the tank. Pressure of the main line is applied through the control bore 7 of the throttle slide to the upper face of the piston in the over-pressure valve, which due to orifice 8 will start for a delayed close up. The resulting pressure initiates movement of the lift. For this flow direction the pressure limiting valve 9 is ineffective. The control bore 11 conducts the adjustable oil flow through throttle screw 12 to the upper face of throttle slide 5. By this action the throttle slide 5 is pushed downwards against the compression spring 13, which results in continuous acceleration of the lifting cylinder up to the maximum speed limited by the stop screw 14. When the cabin reaches the the delay switch in the lift shaft, the solenoid valve 2 will be without power, upon which the throttle piston 5 will close according to the setting of throttle screw 17, which results in continuous deceleration. Slow speed is set by throttle screw 16. After reaching the level switch the solenoid valve 1 switched off. The pump motor is switched off, and due to reflux valve10 the cabin will hold its position.

Downwards

Upon downwards command solenoid valves 2 and 3 are switched on simultaneously. Via solenoid valve 3 the reflux valve 10 will be opened. Oil flows to the pressure limiting valve 9 which together with the throttle slide 5 represents a 2-way volume control. At compression spring 18 the speed ca be set. The continuous acceleration and deceleration of the lift is effected by the solenoid valve 2 in the same way as in upwards. Upon stopping solenoid valve 3 will be without power which results in immediate closing of the reflux valve.

PRESENT:

Requirments for a modern hydraulic lift / valve block

- Ride comfort:

Independent of load / pressure: The speed, stopping accuracy, acceleration and deceleration as well as the constancy of travel time must remain uniform over the complete load range of the lift.

Independent of temperature / viscosity: The speed, stopping accuracy, acceleration and deceleration as well as the travel time constancy must always remain the same over the complete operating temperature range of the lift.

Speed: Higher speeds up to 1m/s and above are increasingly demanded for modern hydraulic lifts. Ability to set different speeds for ascending and descending is taken for granted today.

Energy requirement: Constant travel times, almost direct floor arrival as well as faster down speed enable a very high carrying capacity to be achieved with minimum energy requirement.

Safety, adjustable inspection speed: Facility for speed monitoring in the door areas as well as a set / actual speed monitoring offer the maximum safety for a hydraulic lift.

Operation: The operation of a valve block should be simple, practical and service-friendly.

Environment: In future it will have to be possible to operate hydraulic lifts using a medium which is to water protection class 0.

Functional description of electronically controlled lift valve

General description

Electronically controlled lift valve systems consists of the control valve with integral flow measurement (actaul value detection), the electronic card and the associated power supply module. Pressure changes and also changes in viscosity in the 20 to 500 cSt range have an insignificant effect on the travel time and almost direct arrival at the stopping point is possible. Travelling speeds of over 1m/s are achieved, whilst still maintaining the high level of ride comfort.

Up direction

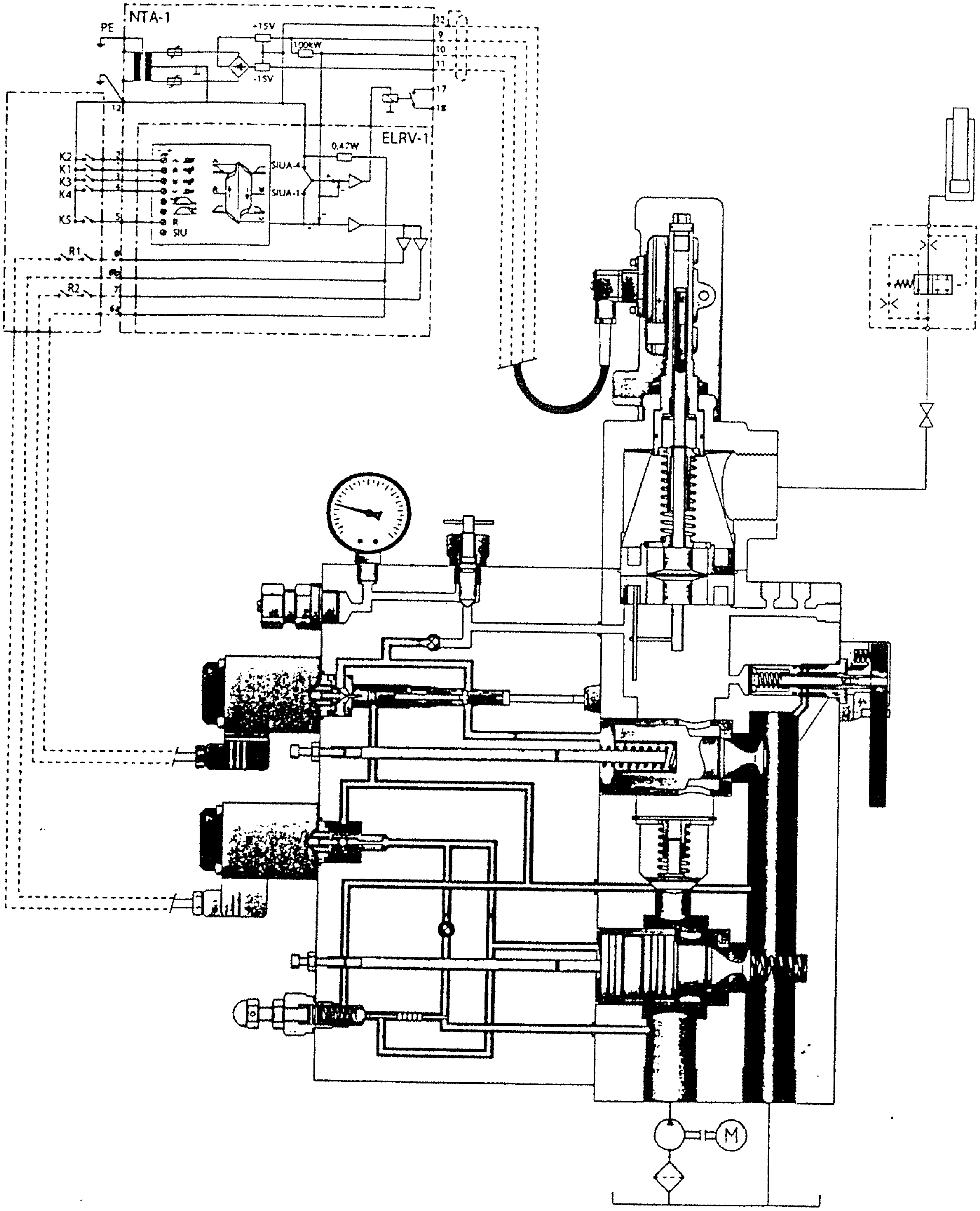
During up travel this bypass valve is held closed against spring pressure ba an electro-proportional pressure valve and therefore produces a stepless acceleration of the lift. Deceleration is achieved by reducing energy at the electro proportional solenoids.

Down travel

Construction of the downwards travel part is similar to the upward travel part. In the at-rest position the lowering valve is held completely closed both by spring pressure and load pressure. This lowering valve is opened by an electro-proportional pressure valve which is designed as a seat valve.

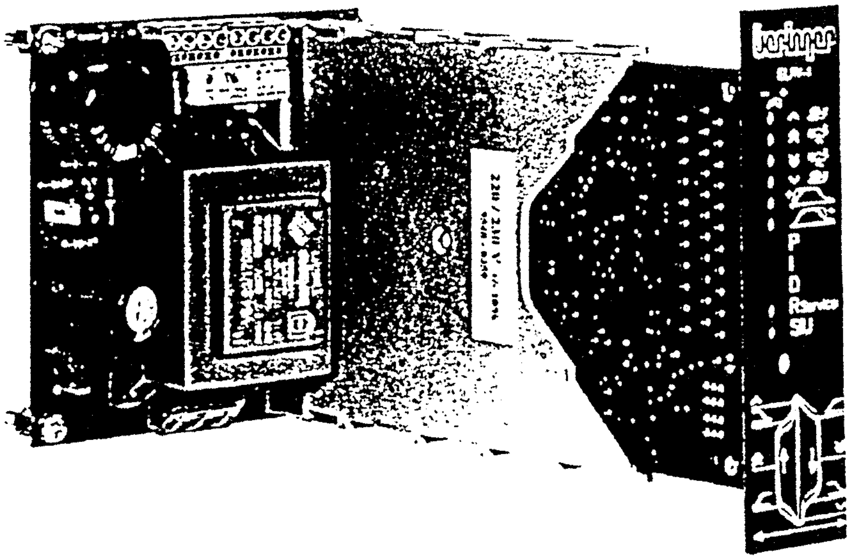
Flow measuring system

The oil flow to the cylinder during upward travel and the cylinder during downward travel passes through an integral flowmeter in the valve. A pressure drop which occurs at a specific flow causes a pressure disc to be axially displaced. This movement is converted by a contactless displacement transducer.



Electronic control board

The electronic card is the brain of the Lift valve system and recieves the information signals for control of the lift via 4 floating relay contacts or semi-conductors.The complete travel curve in the up and down direction is "programmed" via the set value selector by means of six potentiometers. The fast up and down speed, the leveling up and down speed and the acceleration as well the deceleration can be set independently of each other. The optimum set travel curve, which is set once, is continuously compared with the actual value throughout the complete travel time. If a deviation occurs, the proportional solenoids are influenced via an amplifier and these adjust the up or down valve as necessary until the actual value coincides with the set value.



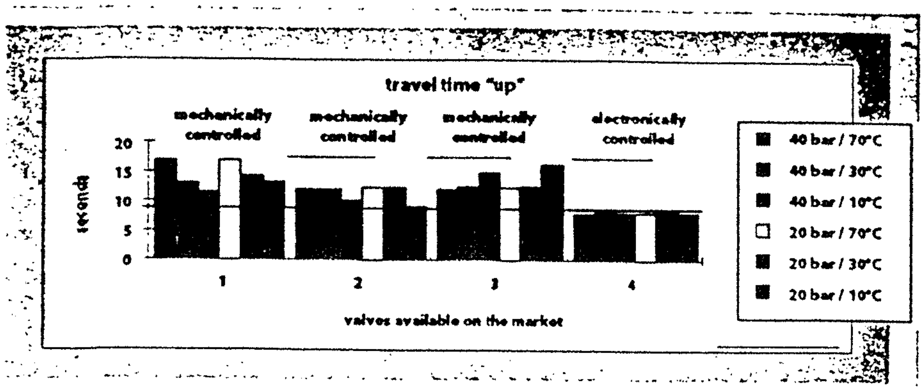
Comparison: Electronically controlled valve vs. mechanically controlled lift valves!

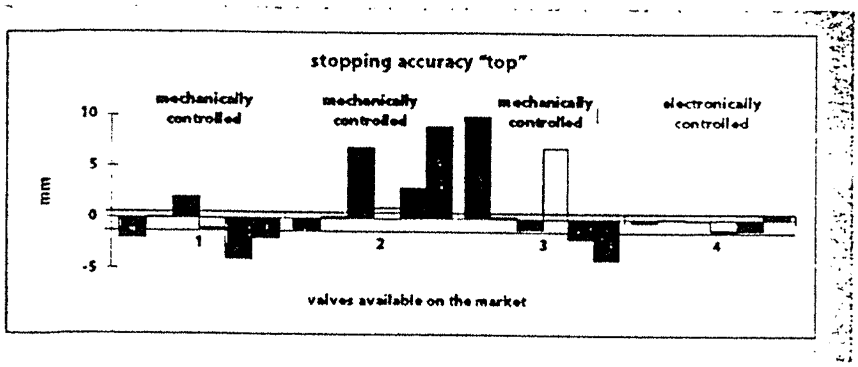
The electronically controlled lift valve system was compared on a trials lift with various mechanically controlled valve, under the same operating conditions.

Lift data for comparison measurements:

Lift system:	Rucksack 2:1
Travel of car:	3800 mm
Speed UP/DOWN:	0.63m/s
Oil:	HLP 46

UP travel time:	The constant travel time with an electronically controlled valve over the 10 to 70°C temperature range and under the different pressures of 20 and 40 bar is worthy of note. (Fig.1)
Stopping accuracy:	Stopping accuracy of +/- 1mm was achieved without difficulty. (Fig.2)


travel time "up"
mechanically controlled
mechanically controlled
mechanically controlled
electronically controlled
seconds
20
15
10
5
0
1
2
3
4
valves available on the market
40 bar / 70°C
40 bar / 30°C
40 bar / 10°C
20 bar / 70°C
20 bar / 30°C
20 bar / 10°C


stopping accuracy "top"
mechanically controlled
mechanically controlled
mechanically controlled
electronically controlled
mm
10
5
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-5
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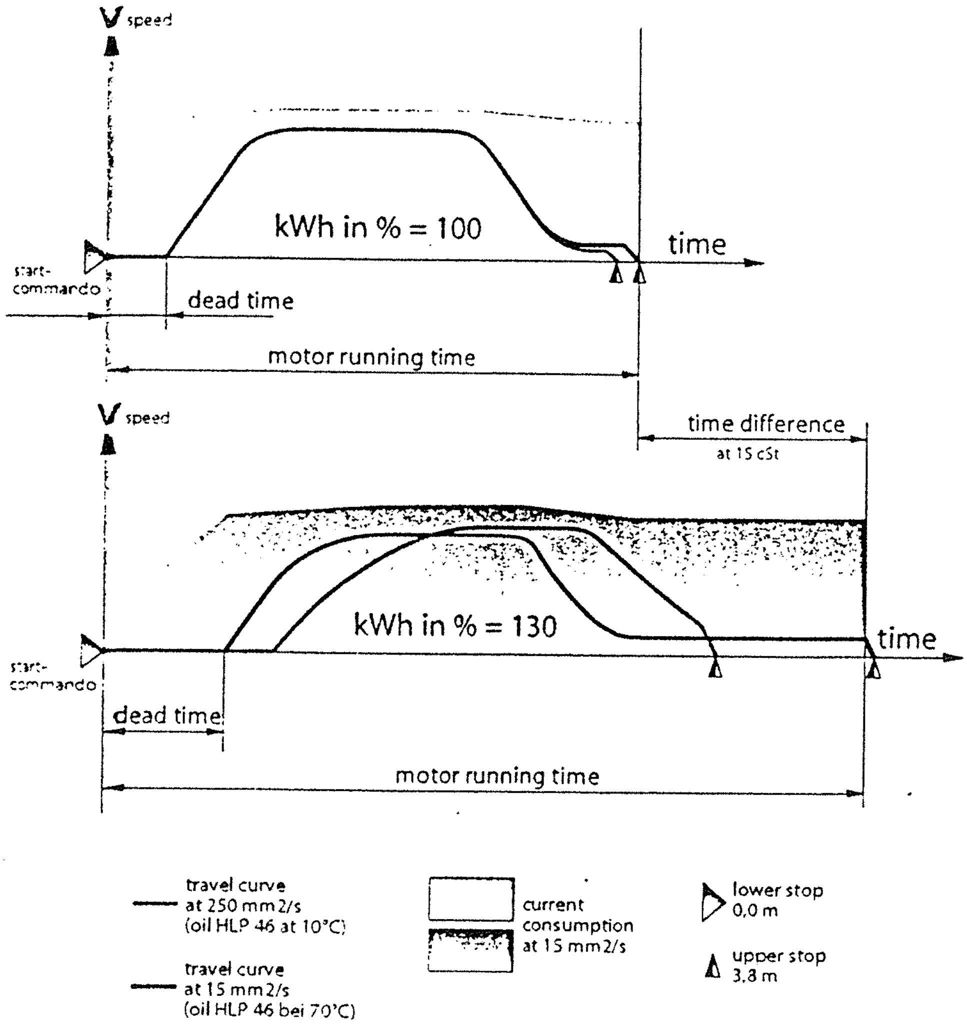
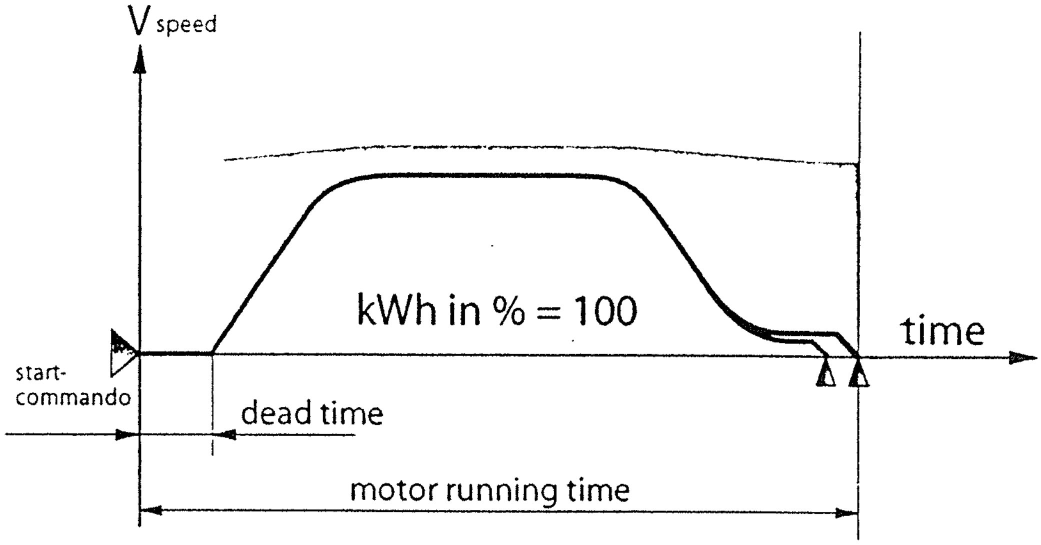
valves available on the market


V speed
kWh in % = 100
time
start-commando
dead time
motor running time
V speed
time difference
at 15 cSt
kWh in % = 130
time
start-commando
dead time
motor running time
travel curve at 250 mm2/s (oil HLP 46 at 10°C)
travel curve at 15 mm2/s (oil HLP 46 bei 70°C)
current consumption at 15 mm2/s
lower stop 0,0 m
upper stop 3,8 m

Carrying capacity and energy requirement!

For some considerable time the hydraulic lift has had a bad reputation as an energy waster. For this reason it is important that the possibilitie, already mentioned, offered by a modern valve block be fully exploited and suitably used. The speed/time diagram below shows the pattern of movement and energy requirement. The dotted surface shows the energy required to move the car from one to the next floor. It can be seen at a glance that a large part of the energy is wasted, i.e. converted to heat.



The energy loss depends on the followings factors!

- Valve response time frome command to start of movement
- Acceleration constancy under different operating conditions
- Speed constancy under different operating conditions
- Change in reaction time from the input to the deceleration switch in the shaft until the deceleration becomes noticeable in the car
- Deceleration constancy under different operating conditions
- Constancy of slow speed under different operating conditions

The more these factors change under all operating conditions the greater and more various is the energy loss and the travel time also changes considerably. Because the deceleration switch in the shaft is mainly set at lower oil temperature, the travel times changes and the electrical energy required also changes proportionally.
The figure shows the different behaviour of the valve compared with an electronically controlled valve system during changes in temperature and viscosity. In the case of the electronically controlled the motor running time only changes by 4.3% compared with the mechanically controlled valve where a difference of 25.8% can be measured. A further interesting comparison can be made at a viscosity of 250 cSt. The travel time with a electronically controlled system is about 21% shorter than with an mechanically controllled valve. It can be seen that a hydraulic lift fitted with an electronically controlled and epuipped with the same drive elements (pump/motor) has on average 33.9% shorter travel times when ascending. The average energy saving is therefore also approximately 30%. The design for a hydraulic lift is always based on the maximum achieveable speed, whereas this comparison shows that it is more important to define the travel cycle.

FUTURE:

The current market share held by hydraulic lift system is known to be between 30 and 70% depending on the country. Irrespective of the current development of cable lifts, hydraulic lifts will in the future continue to maintain their hold on the market thanks to their considerable advantages.
The manufacturers of hydraulic lift components are faced with a real challenge when it comes to continuing the development of the concept of hydraulic lifts as a whole. Above all, all resources must be deployed in an attempt to bring what is in some respects outdated technology up to the current state of the art with the aid of modern means and components. This, of course, must always be conducted with one eye on the economic aspect. The following topics are already of enormous importance and will determine the systems engineering of a future hydraulic lift.

Spatial requirements / Machine room

The development of the electric lift without a machine room necessitates delibrations with respect to the hydraulic lift, too, that will enable us to offer a self-contained hydraulic system that does not require a machine room. These deliberations must pay particular attention to the topics of heat, noise, smell and energy consumption, but also to ease of assembly and servicing. Today's hydraulic lift systems do not offer the suitable solution being striven for. New possibilities and solutions must be searched for. Systematic thinking is what is called for.

Connected load / Energy

The connected load of the hydraulic lift must be reduced by a large amount and should roughly achieve the level consumed by an electric lift. Systems on the basis of pulling piston units with a corresponding counterweight may offer an approach to finding a solution to this problem, but they still, without doubt, require further optimization.

Digital electronics

Mechanically controlled lift valve systems will no longer be of any significance in the future. Digitally controlled valves that incorporate interfaces that allow remote diagnosis and improvements in the safety aspects, too, and intelligent, "self learning" systems and control systems will be standard features in the future. The rapid development made in the area of microelectronics already enables such a lift valve concept to be put into practice today. It makes absolutely no sense when valve systems whose technology dates back 30 years or more are connected up to the latest in control technology.

Hydraulic / mechanical section

The use of new materials, such as plastic and special alloys, must lead to a reduction in production costs. The use of biodegradable fluids that pose only a very slight threat to mankind and the environment is an absolute must.

Frequency-controlled, hydraulic lift

Thanks to the rapid development of power semiconductors, nothing stands in the way of a frequency-controlled, hydraulic lift any more. And thanks to the use of frequency converters, it is now possible to put hydraulic lift systems to use in a more optimum way with regard to heat generation, starting currents, energy costs etc. Existing frequency-controlled, hydraulic lift systems are heavily equipped with measuring sensors that are necessary in order to guarantee the same quality of travel as offered by electric lifts. These concepts are very complex and very difficult for the user to master. New design concepts should make use of as many familiar elements, such as pumps and electric motors, as possible, the number of sensors used being reduced to an absolute minimum.