VVVF CONTROLLED HYDRAULIK ELEVATOR

with the

BERINGER INVERTER VALVE SYSTEM

SATURN - ALPHA

Ever since its introduction 30 years ago, the hydraulic elevator has been known for a considerably higher power consumption compared to a traction elevator. Introduced will be a frequency controlled hydraulic drive system of which the power consumption is similar to that of a traction elevator and which does not need a machine room.

1. General

The new frequency-controlled hydraulic drive differs from a conventional hydraulic drive in so far as both the motor and the pump are run at a variable speed.

With regard to lifting travel, this means that only the amount of oil required to achieve the instantaneous travelling speed has to be supplied. With a conventional hydraulic drive, however, a constant quantity of oil is always required. In the case of the frequency-controlled drive, this smaller flow of oil means that less electrical energy is consumed, which at the same time also leads to the oil being heated up to a lesser degree by motor and pump losses.

When lowering the lift, this makes it possible to drive the motor by means of the pump and therefore to use the motor as a generator. In this way, part of the potential energy that is stored in the lift car can be converted back to electrical energy. The size of this share of potential energy depends on the efficiency of the motor and the pump. The hydraulic oil is heated up to a lesser extent than with a conventional drive while the lift is being lowered too. The electrical energy generated can either be converted into heat by means of resistors or fed back into the mains. Let's summarise the main points here.

- thanks to the oil being heated up by a lesser degree, an oil cooler is only necessary in special cases; this means that the oil tank and quantity of oil required is smaller
- lower starting currents
- lower energy consumption
- greater ride comfort irrespective of lead and viscosity
- jerk-free acceleration and deceleration
- constant travel times

2. Advantages of the Beringer VVVF Power unit

+ Any type of Inverter can be used (elevator manufacturers' own type)
  with interface - Frequency demand input 4-20mA or 0 - 10VDC
  - Forward and reverse signal
  - Current vector control (close loop)

  with break unit and break resistor

+ Safety outputs signals of the inverter can be connected to the valve controller

+ Standard motors and pumps without any special requirements

+ Electronically controlled valve with digital electronic card

+ Interface to elevator controller, same as for hydraulic power units (Beringer LRV valve)

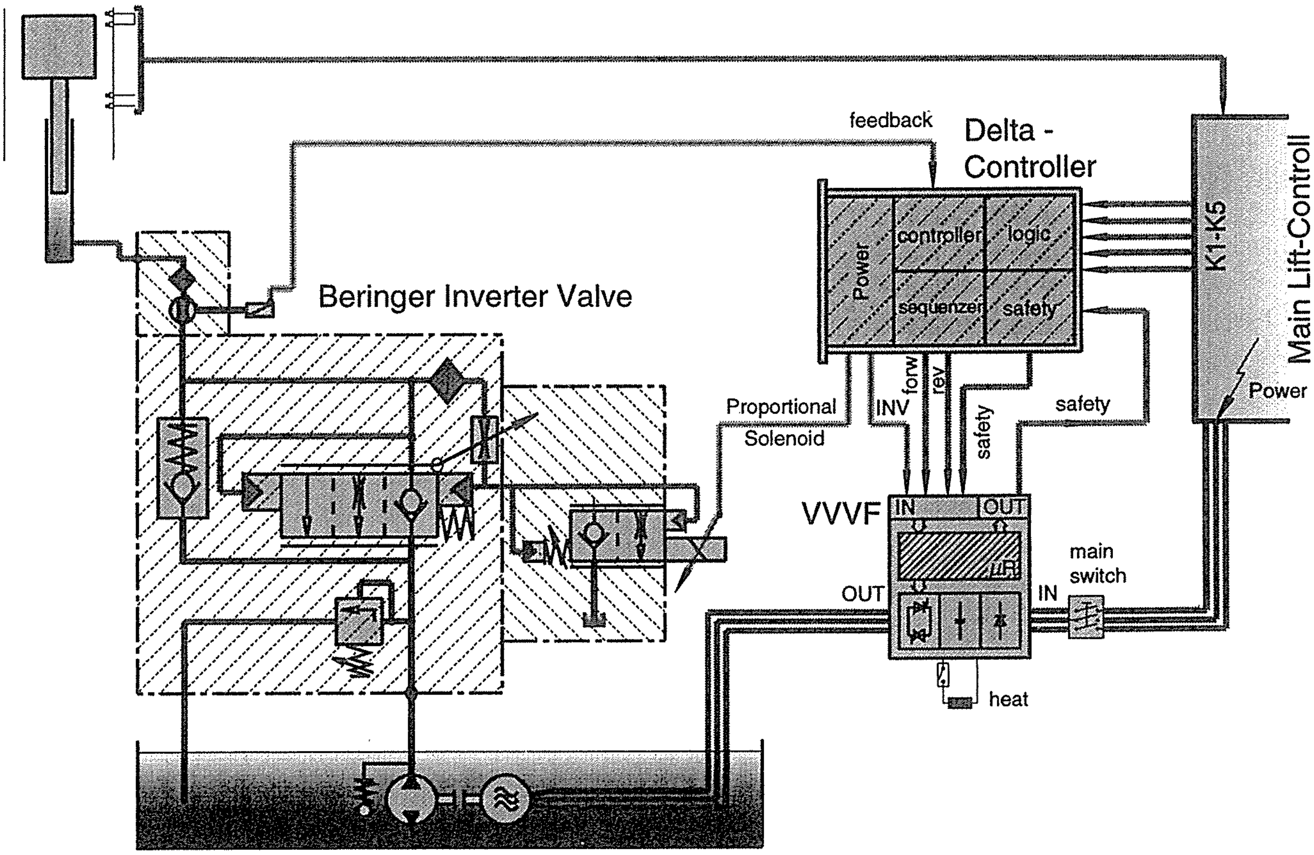
+ Lower energy consumption

+ Less heat development normally no coolers necessary
  smaller oil tanks with less oil

+ Reduced noise level compared to standard power units

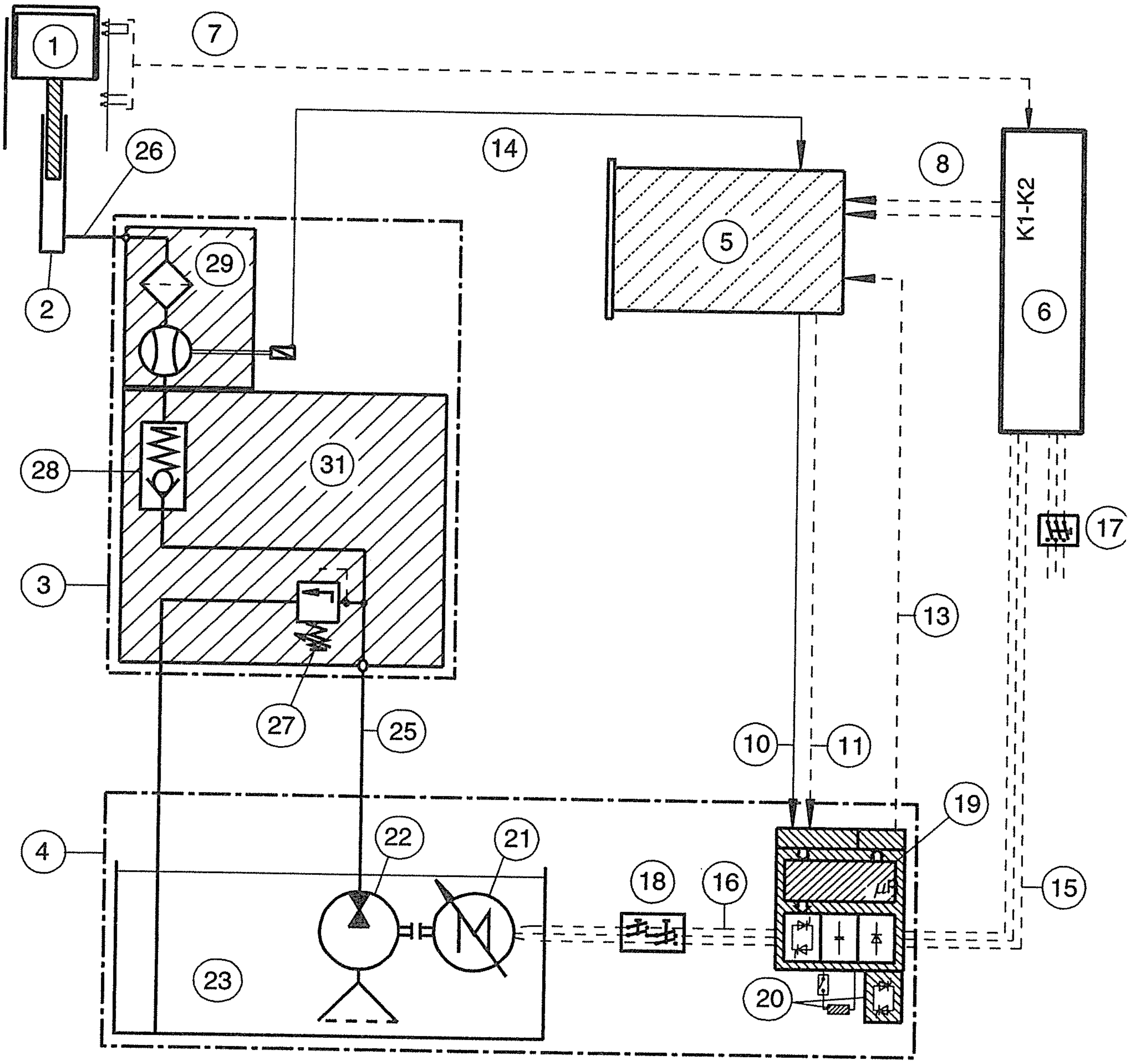
3. Functional description

3.1 System overview



The new frequency-controlled hydraulic drive that Beringer Hydraulik presented to the specialists from the world of lifts at Interlift '97 in Augsburg requires only a single sensor. Beringer's patented flow sensor, this being a Hall-effect sensor (see item 19 in the diagrams explaining lifting and lowering travel). This sensor makes it possible to always obtain the same travel speed irrespective of the load and viscosity. This means that the travel times between the individual floors of a building are constant and as good as identical. The travel speed is controlled by a new digital electronic card, which also controls the frequency converter (19) and valve (3).

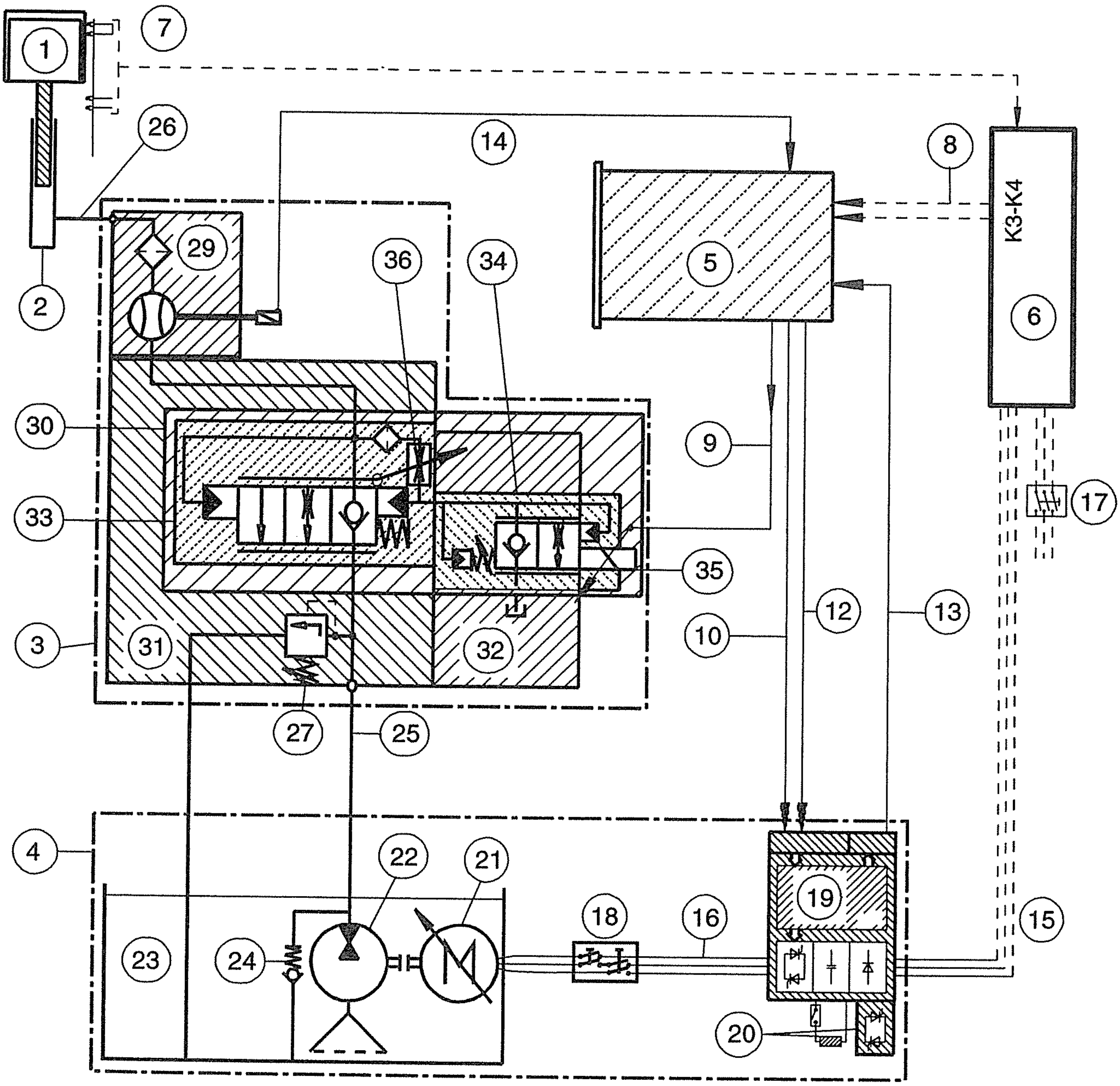
3.2 UP travel



1. Cabine
2. Cylinder
3. Valve
4. Power Unit
5. Electronic Card
6. Controller
7. Shaft switch
8. Controller signal
10. Inverter control-signal
11. Forward signal
13. Safety signal
14. Feedback
15. Power
16. Motorpower
17. Main switch
18. Motor switch
19. Inverter
20. Breaking unit
21. Motor
22. Pump
23. Oiltank
27. Relief valve
28. Check valve
29. Flow sensor

- The speed during lifting travel is controlled purely by controlling the speed of the motor and pump by means of the frequency converter (19) and digital electronic card (5) (see the system diagram and control concept for lifting travel).
- The digital electronic card can be programmed by means of either a parameter assignment box or parameterization software that runs under MS-Windows.
- The instantaneous travel speed is metered throughout the entire travel time by the flow sensor (29) and controlled in accordance with the specified travel curve by means of the electronic card (5).
- At the beginning of lifting travel, the motor (21) starts rotating slowly and builds up a slowly increasing pressure between the pump (22) and valve (3).
- The check valve (28) opens automatically when the pump pressure rises above the system pressure and closes again automatically when the pump pressure falls below the system pressure.

3.3 Down travel



1. Cabine
2. Cylinder
3. Valve
4. Power Unit
5. Electronic Card
6. Controller
7. Shaft switch
8. Controller signal
9. Magnet control-signal
10. Inverter control-signal
12. Reverse signal
13. Safety signal
14. Feedback
15. Power
16. Motorpower
17. Main switch
18. Motor switch
19. Inverter
20. Breaking unit
21. Motor
22. Pump
23. Oiltank
24. Anti-cavitation check valve
25. Pump line
26. Cylinder line
27. Relief valve
29. Flow sensor
30. Down valve
31. Valve block
32. Pilot plate
33. Main valve
34. Pilot valve
35. Proportional solenoid
36. Spec. jet

- During lowering travel, the speed during starting and stopping is controlled by the valve (3) and during the rest of the travel phase by means of controlling the motor and pump speeds.

- In the same way as during lifting, the instantaneous speed of the car is metered by the flow sensor (29) and controlled throughout the entire travel sequence by the digital electronic card (5) in accordance with the specified travel curve (see the system diagram and control concept for lowering travel).

- This is how it works: at the beginning of the lowering motion, the proportional solenoid (35) opens the pilot valve (34), which in turn opens the main control valve (33), and in this phase the motor (21) rotates backwards at a slow and constant speed.

- To protect the pump, a replenishing valve (24) is installed in which the pump (22) can draw in oil when travel has begun.

- When a specified speed is reached, the main control valve (33) is opened fully by the pilot valve (34) and the travel speed is then from this moment on controlled by means of the pump (22), the motor (21) and the frequency converter (19).

- The pump (22) then acts as a hydraulic motor and drives the motor (21) which is effectively acting as a generator.

- The electrical energy flows back to the frequency converter (19) where it is converted to heat by a braking unit (20) in a braking resistor.

- If greater power levels are involved, it is also conceivable that the energy be fed back into the mains by means of a recuperating unit (20).

- During deceleration, the pilot valve (34) closes the main control valve (33) continuously, the latter in this way reassuming control over the car's speed until it comes to a stop at the floor.

4. Energy and Heat Balance

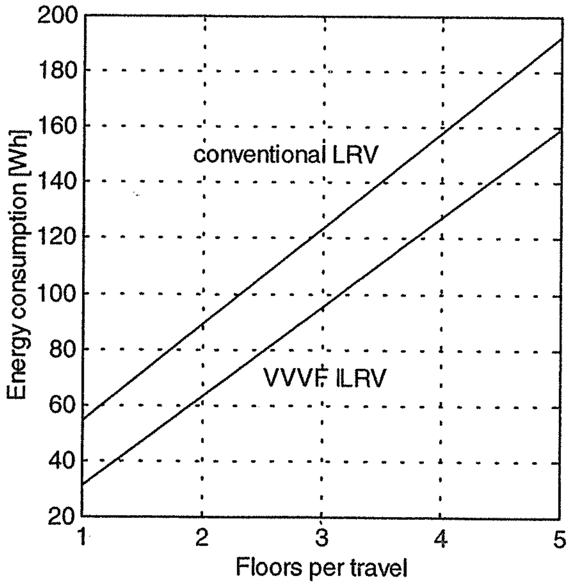
Energy and Power loss comparison between LRV-1 and ILRV

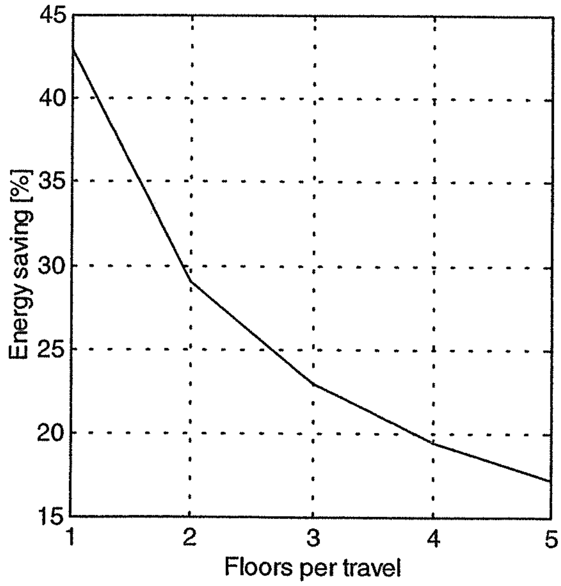
Basis:
- Travel time total 11.5 sec.
- Max. speed of cabin during 6.5 sec. (2 Stops)
- Travel time with max. speed 56% of total travel time.

Up-Travel:

	LRV-1	ILRV
Total energy input	100%	67%
Acceleration energy	30%	17%
Deceleration energy	30%	17%
Energy max. speed	40%	33%

The ratio (100% to 67% / 1 : 0,67) of the total input energy is reduced with extended travel time of the cabin. The energy reduction at max. speed between LRV-1 and ILRV amounts to 3% only.

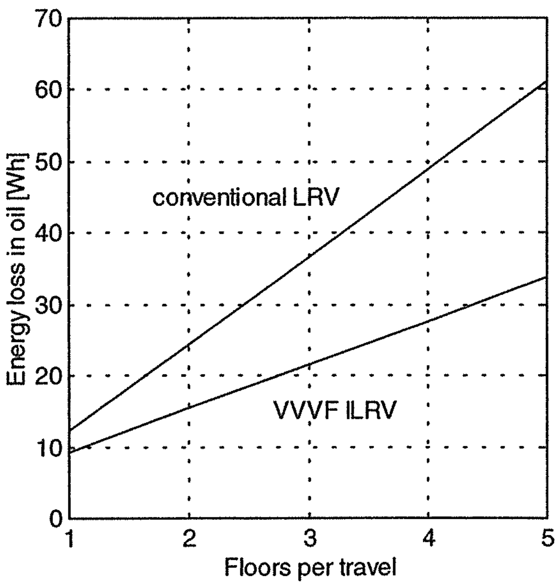


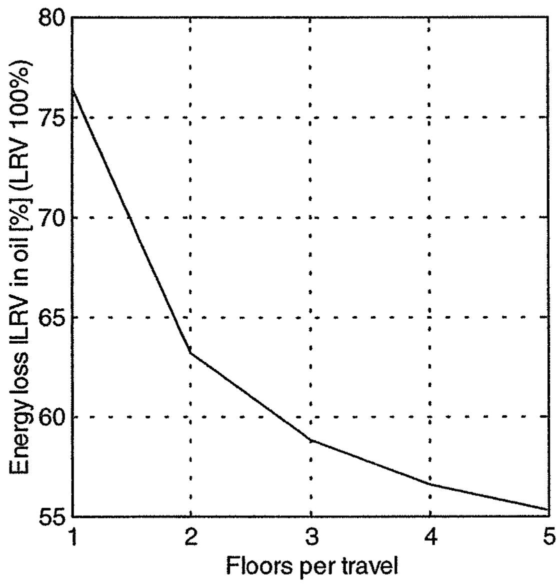


Down-Travel:

	LRV-1	ILRV
Down energy as loss in oil	100%	63%

The ratio (100% to 63% / 1 : 0,63) increased with longer travel time of the cabin, i.e. higher reduction of loss.





The above comparison is based on operation with normal screw spindle pumps and submerged motors as used today. To be observed is that the total efficiency of submerged pump combination is approx. 50%.

All other travel parameters like travel time constancy, levelling accuracy, slow speed time are about same as known from LRV-1 valve because the inverter valve system operates with same feedback device.

Summary:

A hydraulic elevator operating with VVVF system consumes approx. 30% less energy than the LRV-1 system. The heat balance of the complete hydraulic system improves about 35%. For most VVVF driven hydraulic elevators, an oil cooling system is no longer necessary.

5. External connection diagram