Mechatronics for elevator installers and technicians Part 6

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1 Safety during elevator installation

Passenger and freight elevators are extremely safe means of transport, this being due to careful planning and erection, many years of experience and extensive standardization. In addition, they are subject to regular maintenance and continuous monitoring, (e.g. by the TÜV Technical Inspectorate)
This superb degree of safety , however, applies essentially only to the car, which is accessible to users and in which passengers or goods are carried. The machine rooms and the hoistway are without exception hazardous workplaces, even for experienced technicians, where life and health are always threatened by the potential for electrical shock and mechanical injuries.

These hazards are heightened considerably during the erection and commissioning phases;

- Various safety circuits have not yet been installed, connected and/or activated.
- Safety circuitry is temporarily disabled to carry out construction work.
- The stability and functionality of mechanical systems have not yet been tested.
- Elevator control functions have not yet been adjusted and verified.
- The frequency inverter has not yet been adjusted and/or its functions have not been validated.
- One must always anticipate unexpected and undesirable responses in both the electrical and mechanical components in the system.
- Various switching and circuitry errors can be present or caused inadvertently by personnel.
- The documentation for the system is incomplete or even, under certain circumstances, faulty.
- Defective, improperly specified, improperly adjusted or improperly installed components are present.
- Persons who are not familiar with elevators and who have not been given instruction are near the elevator.
- You are stressed out, it is late at night, you are trying to meet deadlines etc.

An elevator system is in fact a lifting device. This means that, without active braking, the force of gravity alone will exert an effect in case of a malfunction. Consequently, depending on the loading situation, the car will be pulled upward into the overhead stops (if they have already been installed) or downward to seat on the buffers in the pit.
To ensure that you always have full control over the elevator and can switch it off immediately in case of danger, you must have a fully serviceable emergency stop switch near you at all times. This must positively carry out the following functions at all times And this shall have been tested and verified:

- Engaging the mechanical service brakes
- Isolating the motor from the power supply
- Switching off all voltage to protect against electrical shock.

The service brakes must, of course, be correctly adjusted and their functions may never be blocked or defeated by objects of any kind (e.g. pins, bolts, screws, tools or other equipment).
When the emergency Stop switch is actuated the motor should be separated from the power supply at least by the contactors so that it cannot continue to turn with the brakes engaged. When operating under frequency inverter or voltage splitter control it is possible to ensure, by providing a leading contact at the main contactors, that the main contacts will always disconnect power in the normal situation.
Notes on averting hazards:

- Always observe the regulations published by the workmen`s disability compensation insurance society for the industry or by other regulatory authorities and by your company.
- Always expect the unexpected, at all times.
- Familiarize yourself completely with the documentation and in case of doubt ask questions until you are absolutely sure that have understood everything.
- Avoid stress, tight scheduling anhd overly workdays (hazard due to fatigue).
- In spite of experience and routine, always maintain a healthy resepect for hidden dangers.

2 Commissioning „roomless" and/or gearless elevator systems

Taking a lift without a machine room – incorporating the so-called „ roomless technology" – as an example, a few typical sources of error are to be discussed here, with emphasis on the drive technology.

The ultimate quality of the lift system is determined right from the phase in which the hoistway and structural tower are erected, the guide rails are set and the cab and counterweight are installed in the system. When constructing the hoistway one cannot always count on the fact that the concrete walls will be straight and at right angles along the full height of the shaft. Always remember that the tolerances in masonry work are in the centimetre range but that you will have to achieve clearances between the guide rails at tolerances in the millimetre range. Thus some elevators ultimately travel across an inclined plane and will, under certain circumstances, not be suspended in the center, between the guide rails. It is for this reason that prefabricated, self-supporting hoistway towers are used which, set up in a modular system, ensure that the distancebetween guide rails is constant. "Back-Pack" designs with drive gear at the top or bottom are becoming ever more popular when constructing particularly compact roomless systems The disadvantage in these elevators is that the car guide rails are subjected to severe loading and that special starting and levelling algorithms are needed to achieve smooth, jerk-free travel; furthermore, selecting the location for the rope reversing sheaves and the counterweight csan be quite complicated. As a rule the ropes pass around the drive sheave and deflection sheaves with slight deviations in the run-in angle and this can result in offcenter wear at the edges of the traction sheave grooves. But even in more commonplace concepts one often observes, particularly when using the narrow gearless or compact gearboxes, that this drive equipment is not correctly installed. The result is that the ropes run across the drive sheave at an unnecessarily large angle.This skewed running places excess load on the bearings in the drive gear and abrades the groove flank and the rope itself. In addition, this is the first point at which vibration and noise can be induced in and at the car. The force with which the ropes pull on the drive sheave may not be underestimated. In the least favourable case a fully loaded car and the counterweight will together exert their loads on the driving gear.

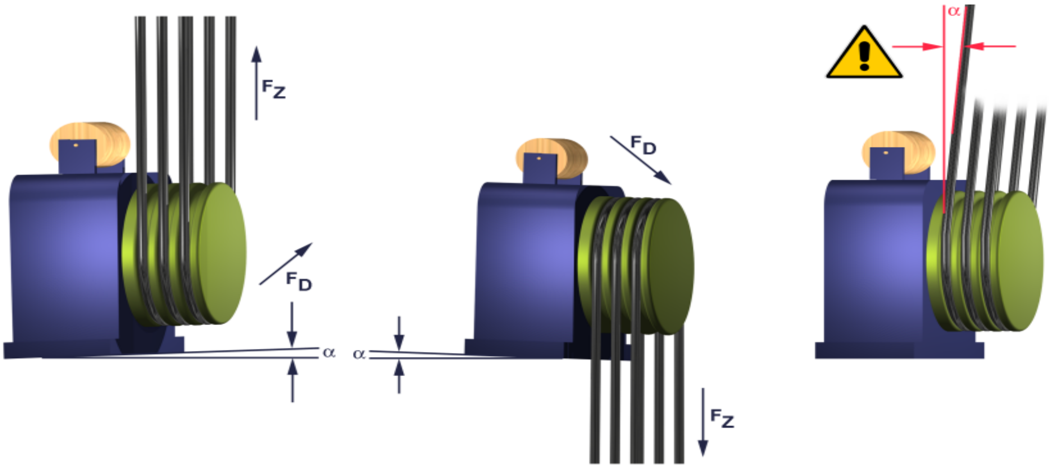

figure 21

We can see that the mounting frame or the oscillation damping elements twist through angle "α". Angle"α" thus asserts additional strain on the ropes (grooving at the drive sheave).
Thus you should attempt to employ appropriate strategies to align the power unit precisely while, however, avoiding acoustic coupling between the mounting frame and the drive unit`s housing.
Noise and vibration are frequent problems in roomles systems. Often the drive unit is located at the foot, in the pit, and in unfavorable situations may inject an unacceptable amount of noise into the hoistway, noise which can then readily be heard in adjoining rooms and in the car, as well.
The topic of noise is today as least as important as engineering drives in conformity with CE standards. The lowest running noises are found in asynchronous gearless winches which are powered using a field-orientation cconcept at actual value of 1 Vpp for regenerative braking. This type of motor requires more space, however. Modern, multi-stage worm gearing is also very quiet, as is hypoid gearing is also very quiet, a8also incorporating a pinion gear stage). Only slightly louder are synchronous gearless winches, followed by modern planetary gearing.
If the drive unit-in spite of all optimization efforts-still generates excessive running noise, then it is possible to enclose the area around the drive unit with rock wool insulating panels. A U- or L-shaped cover for the drive unit (if engineering constrains permit), made up from insulating panels faced with rock wool, can reduce noise kevels by as much as 10 db/m. The noises in the drive unit gear are generated primarily because the mechanical tolerances are too great, because the motor case and/or handwheel is made of aluminium (gray casting is always to be given preference), the saturation value for the motor is excessive, the regulation parameters (motor response curve) have been set incorrectly, Vpp transducer technology has not been used or the pulse with modulation is too low or disharmonic. In some cases helical grooving was not incorporated when manufacturing the motor (meaning rough running at low speeds and loud noises at high speeds). Motors sucvh as this pose serious difficulties in operation and should be avoided. In the same way a number of poles which is too small (fewer than 8 poles) or an excessively high number of poles (more than 44 poles) can result in rough running in gearless winches since in these cases the demands in regard to manufacturing tolerances for these motors are very stringent. The quality of the encoder signal is also decisive (more on this topic at a later time).
Taking a synchronous motor as our example, we will describe the most frequently found sources of error in regard to connecting and running the motor.

The most important basic requirement for permanent-magnet motors is that the rotating

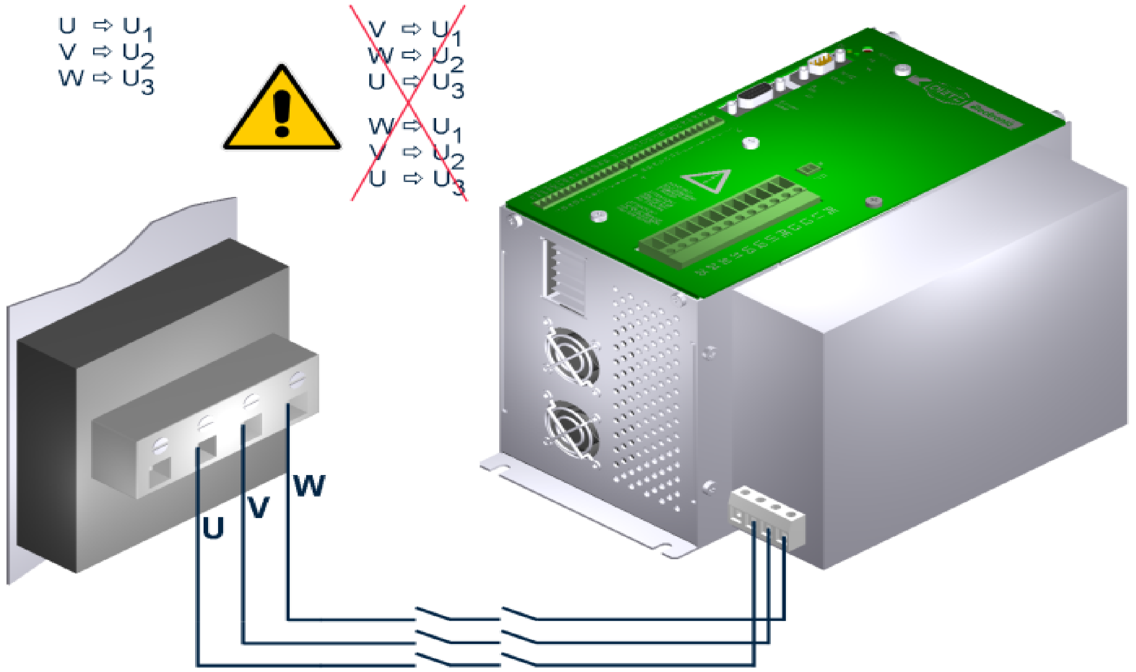

figure: 22

field and the phase angle be maintained without fail (Figure 22) A particular weak point here is the wiring between the contactors and the motor. Usually the individual phases are not actually passed along one-to-one. Asynchronous motors have no requirement for an exact phase sequence (a correct rotating field is sufficient here). Synchronous motors, by contrast, are highly sensitive the exact alignment of the encoder or resolver with the phase sequence as otherwise the inductor will not be correctly positioned.
IMPORTANT:An incorrect phase sequence will cause unexpected reactions at this type of of drive unit!
If a synchronous motor is operated over an extended period of time with the inductor connected incorrectly, then it will invariably be damaged (windings burn, permanent magnets in the rotor are remagnetized).
As a rule, synchronous motors are fitted with spezial rotation transducer systems (shaft angle encoders) to ensure correct commutation while, at the same time, delivering to the motor angle or speed regulation citcuit pulses appropriate for use as the actual values in the closed-loop regulation system. We differientiate here between synchronous gearless and synchronous planetary gear designs. The former system will as a rule be fitted with a combination transducer which provides an absolute value scale (13 bits, SSI Gray encoded) for commutation (inductor positon) and, in addition, two pairs of 1 Vpp scales, offset by 90°, with 2048 stripes per revolution of the motor. Also to be mentioned at this point is that there are systems available using other coding schemes (Hyperface, EnDat etc.) and other resolution values (512,1024 etc.). These systems are, however, unnecessarily complex and in practice are not always completely reliable.One special situation involves commutation using additional 1 Vpp signals with 12 stripes per motor revolution. Because here the quality of the scales and of the downline evaluation has to be extremely high, this system can, under certain circumstances, be very sensitive to disruptions. Thus when dealing with high-speed synchronous motors (i.e. those which drive planetary gearing) one uses the 2-pole resolver. Due to its inherent inaccuracy this design is, indeed, not suitable for use with synchronous gearless designs but is nonetheless quite adequate for motors running at higher speeds.

Specially designed electronics derive from the resolver signal both the commutation data and an encoder simulation of, for example, 1024 stripes (TTL in this case) per revolution of the motor. The resolver is simple and rugged while evaluation is complex.
A word of caution: All the transducer systems for actual values at synchronous motors have a precisely fixed mechanical position. You should never, without having previously consulted the motor manufacturer, remove or rotate the transducer or loosen screws at the shaft

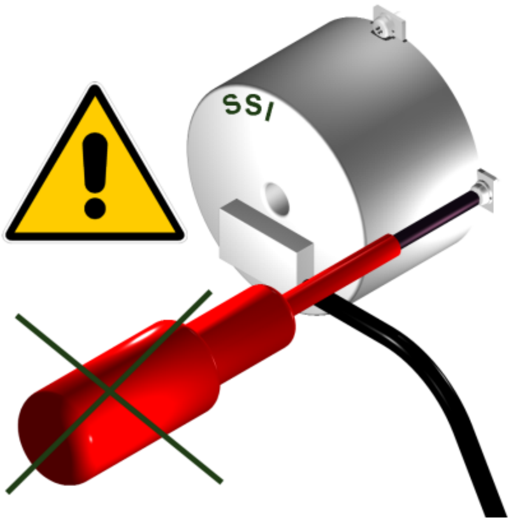

figure 23
If the transducer system ever gets out of adjustment, then the situation can be rectified only by way of a so-called "first initialisation" (which,unfortunately, can be carried out with suitable precision only when the motor is idling and free of all load); the rotor positon (rho = 0) is restored by doing this. The motor must never be run without the inductor having been adjusted (the effect is the same as that for incorrect phase sequence). "First initialisation" is normally handled by the motor manufacturer.
In roomless concepts the subject of emergency evacuation is always one of particular interest. How is one – following a power failure – to set in motion a gearless drive which may be located at an inaccessible site in the overhead? In the simplest case we can hope that the loading situation is favourable and then release the brakes intermittently by applying brief pulses. But this will not be enough for most customers. The good efficiency levels in the modern drive units utilized in roomless applications make it possible to use normal uninterruptible power supply (USP) systems at 230 V.
The advantage is that the entire control system and also the inverter (including the door operator motor) can, without any great effort, be supplied with power for travel to the nearest landing. As a rule the USP will be engineered so that the nearest floor can be approached, regardless of the loading situation and travel direction, and that is a great advantage. The USP system will be inadequate only in the event that evacuation to the ground floor is necessary. In this case a battery cabinet (240 V DC) will be required to supply the frequency inverter; the remaining controls can then be powered with a smaller USP (Figure 24).

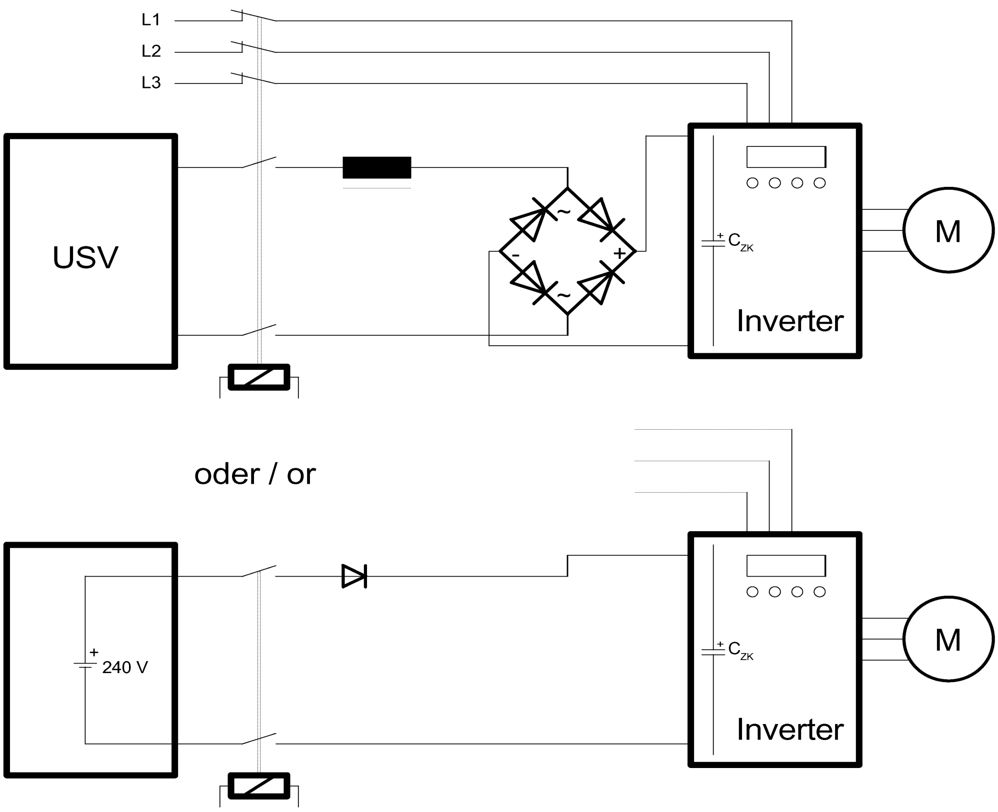

figure 24

The final topic in this chapter will be lift systems using regenerative braking. Good efficiency levels and high travel speeds (combined with large payloads) generate considerable amounts of heat in the braking resistors which have to absorb the energy generated by the motor. In a busy bank of elevators the energy-saving aspect is an additional consideration. Regenerative braking and energy return to the network can, if desired, also be engineered in conformity with IEEE 915

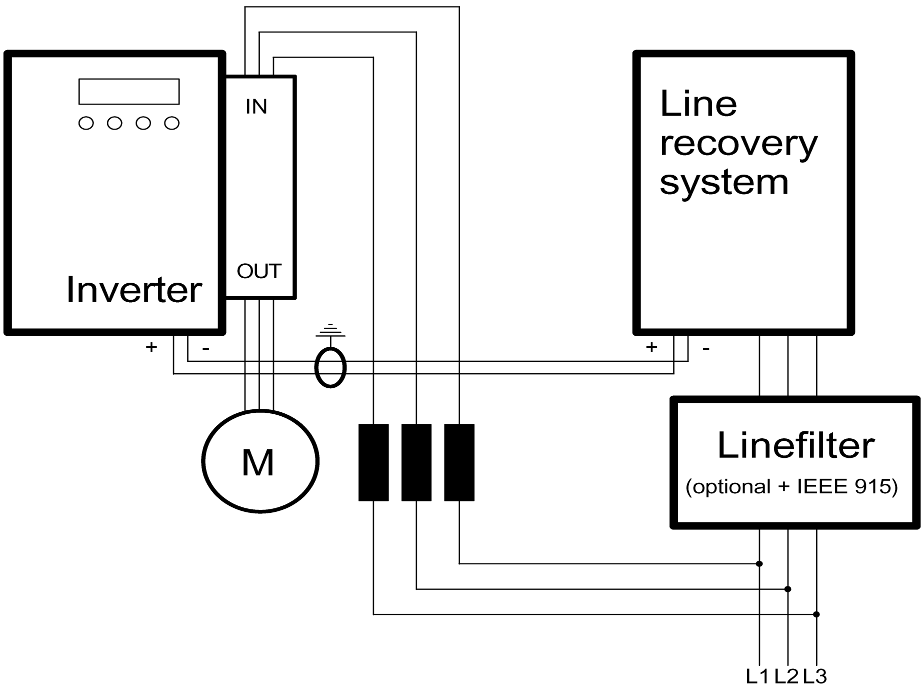

figure 25.

Where regenerative braking is combined with emergency evacuation it is necessary to leave a small braking resistor connected to the inverter since in this case the regenerative braking system cannot return its energy to the public utility network. This resistor will not cause any disturbance during normal service since the threshold for network return lies far below the working point for the braking chopper.
The system is now at least ready for inspection operation and it should now be possible to move it. When the motor first goes into operation it is necessary to pay careful attention to detect unusual noises, motor currents and temperatures. It will be necessary to check whether the drive unit runs at the prescribed rotation speed and/ or velocity. It is necessary to examine the time sequence through to the start of travel and to change the "up" and "down" signals at the inputs for directional control in the event that they are reversed (and never just change the motor`s phases or rotating field).

- Do the contactors always close first at the beginning of the trip and the brakes release only after the contacts have closed?
- Does the drive start free of jerking and without backing up?
- Is lift travel uniform and smooth?
- Do the brakes engage when the car comes to a standstill and do the main contactors open only after this has transpired?
  If the answers to all these questions is "yes" then you can begin the teach-in phase.