LOW MAINTENANCE, ENERGY SAVING ESCALATORS

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ABSTRACT

In the past decade escalators have spread widely, particularly in the field of traffic systems. Development work and research has therefore had the purpose to develop escalators economically which are energy–saving, require less maintenance and are resistant against environmental influence.

All types of drive components are examples of these developments.

1. Driving machine

The escalator driving machine should be manufactured with considerations for high availability and a long life time. It must also be designed for easy maintenance and repair.

The conventional escalator–drive consists of an electric motor, reduction components for power transmission and the mainshaft with chainwheels for the stepband. Due to the high speed gradient between the motor shaft and the step band the ratio in the driving components varies from 1:46 to 1:84 depending on the escalator speed. Drive systems can be, as illustrated in Figure 1, either:

(a) Electric motor – wormgear – chain drive
or (b) Electric motor – V–Belt drive – chain drive

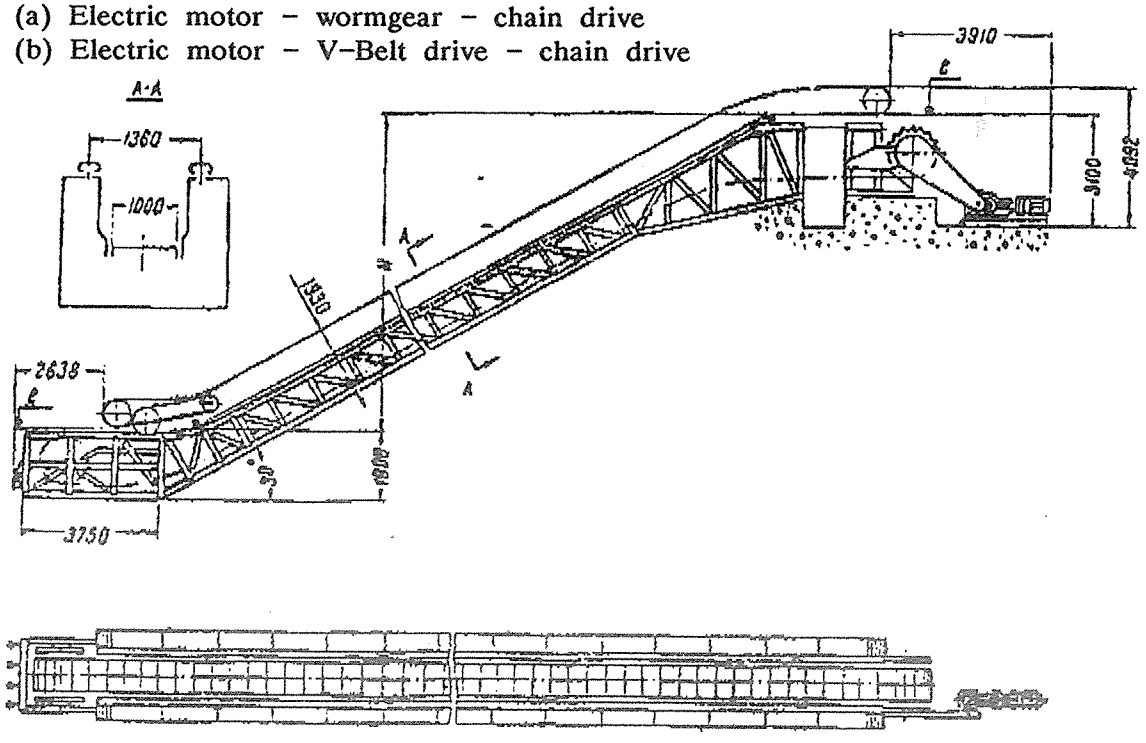

FIGURE 1. Escalator with chain–drive.

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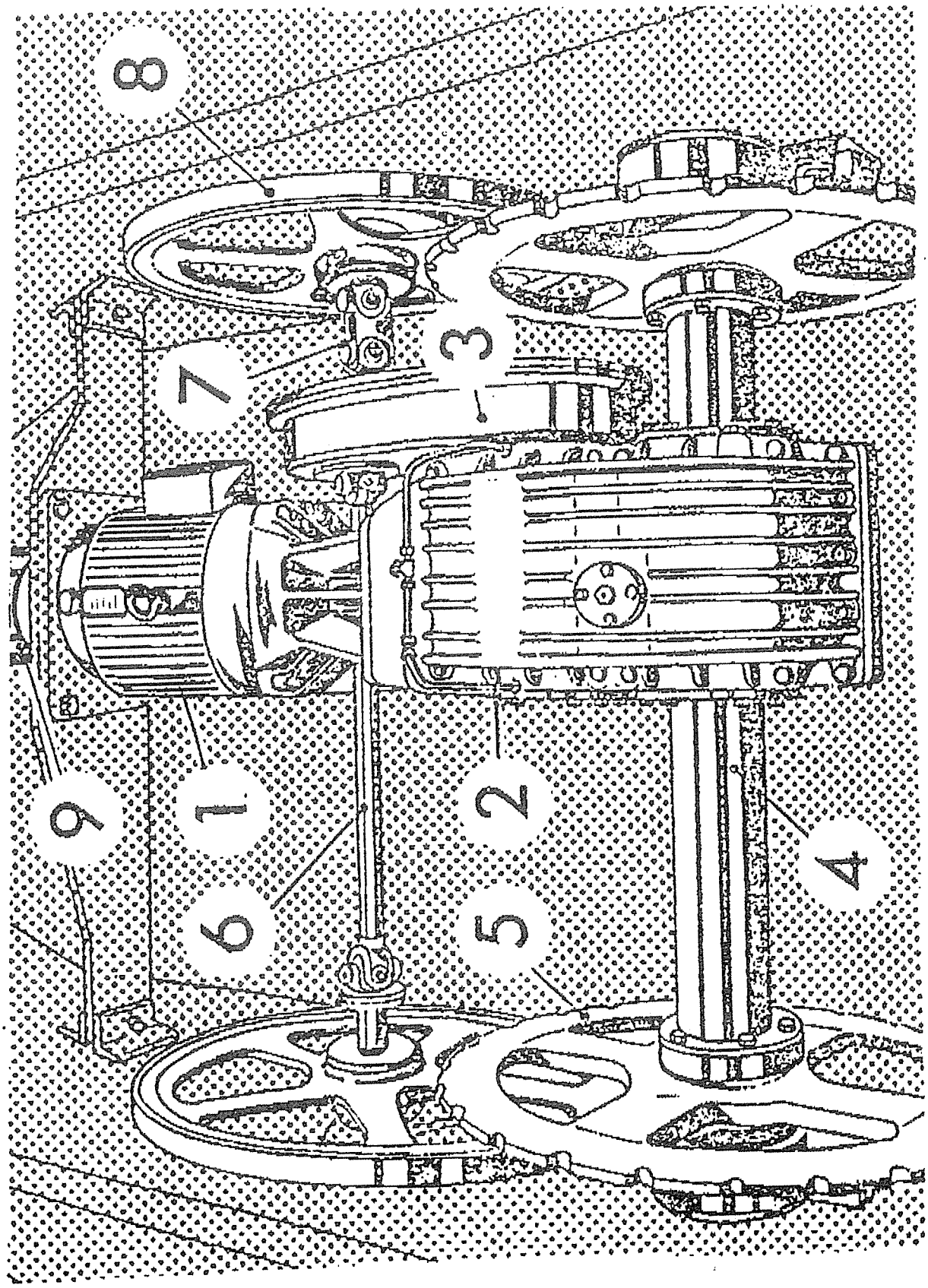


FIGURE 2 Water and dust tight drive unit

Belt drives are non-positive drives and require large dimensions, distance and axle forces. They always rotate with slip, depending on the power applied at the belt drum, the belt tension and stretch and the coefficient of friction. Under load the remained stretch will increase temporarily and can lead to permanent slip and the failure of belt drive. Temperature and humidity influence the belt stretch just as dust, dirt, oil and humidity diminish the coefficient of friction.

2. Chain drive

At chain drives the power transmission between roller-chain and sprocket happens as a combination of positive and power drive on sprocket-teeth and chain-links. The chainlinks contact each other during the run on and run off at the sprockets, which produces friction between the chain pins and the bushes. As a result of the friction energy losses occur and there is wear in the chain links, so that the pitch increases about Δt. This effect leads to chain elongation. Therefore the chain does not wind the sprocket onto the theoretical pitch diameter as in a larger diameter. Thus the effect of chain-climbing on the sprocket-teeth occurs. In an extreme case the chain winding reaches the head diameter of the sprocket and jumps over the teeth.

Therefore both belt and chain drive system from the safety point of view make emergency brakes on the mainshaft of escalators necessary.

Thus the wear susceptibility and the large maintenance costs of driving systems forced escalator design engineers to find better driving components and solutions.

3. New design

O&K-Orenstein & Koppel were the first manufacturer of escalators and passenger Conveyors to develop at the beginning of the 1960's the "Compact-drive-unit" with an integrated main shaft for the step-drive and universal shafts for the handrail drive. This drive unit is located in the top section of escalator step band. Due to this new and modern technology roller chains were completely eliminated. The drive unit is absolutely water and dust tight with a maintenance free drive gear. (See Figure 2).

The drive unit consists of:

Main gearbox with mainshaft.
Handrail gear with Kardanshafts for handrail-drive.
Electric motor connected to main gear by flexible clutch.
Operational disc brake on the second motor shaft.

The two stage main gear contains a wormgear and the diagonal toothed spurgear with the mainshaft. The worm-counter and mainshaft have tapered roller bearing spurgears and wormshaft and are case hardened and ground from high grade manganeese-chrome. The wormshaft is made from bronze-alloy with small part of nickel for better resistance. All gear parts are calculated and tested for the designed life time for a given horse power. The bearings are calculated for more than 100,000 operating hours. The gearbox is filled with synthetic oil for minimum of 10,000 operating hours.

The O&K developed and patented drive-unit is a absolute positive drive from the brake to the mainshaft respectively stepchain-sprockets.

O&K has standardised the drive units from the energy point of view

Single Drive	up to	19 kW	horse power
Double Drive	up to	38 kW	horse power
Heavy Load Drive	up to	100 kW	horse power

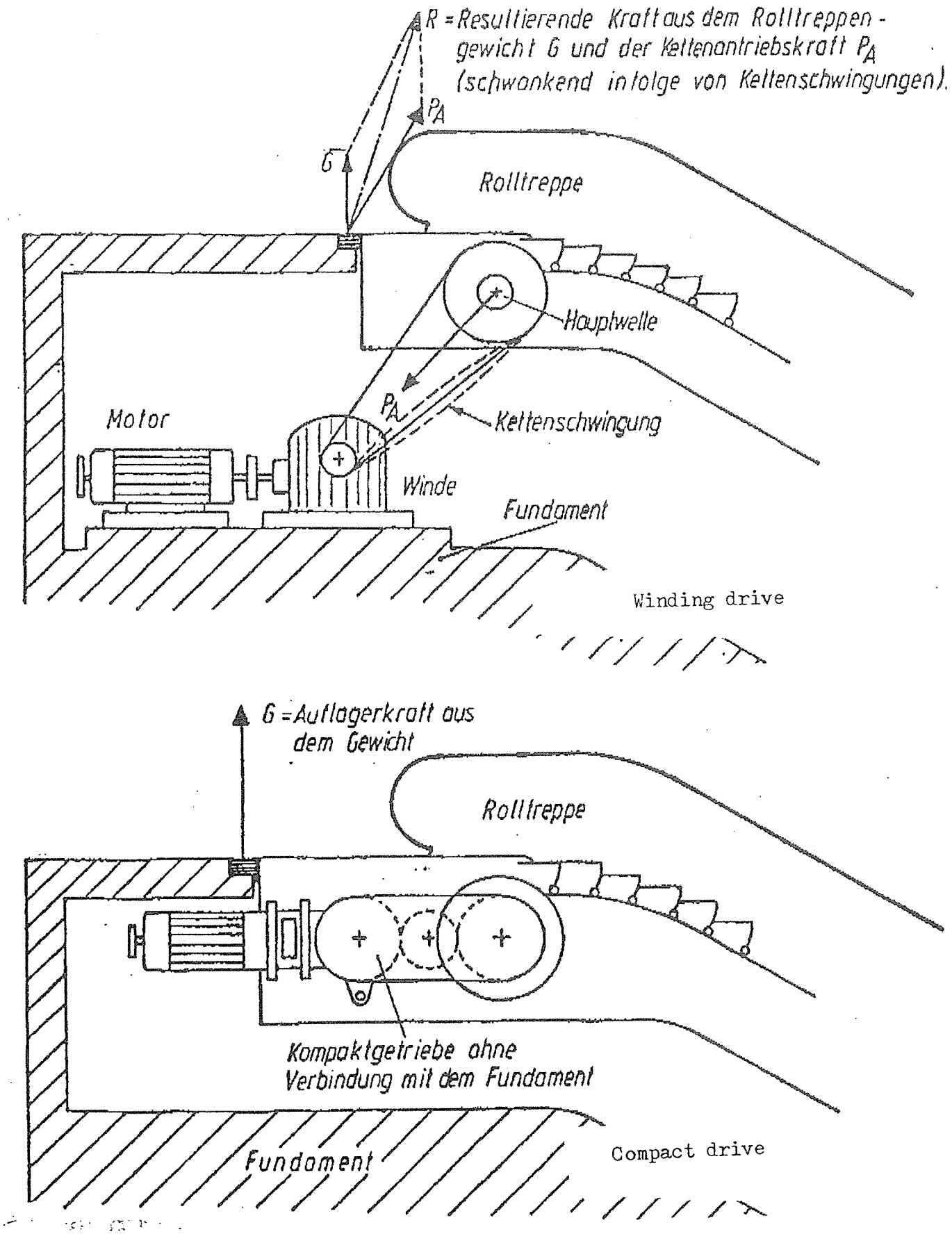


FIGURE 3 Heavy duty drive unit

so that vertical rises up to 50 m can be provided. Escalators with more than 17 m vertical rise are equipped with a special heavy load drive unit, Figure 3.

In contrast to conventional external drive machineries, where transmission from the motor and wormgear to the main drive shaft is by roller chains a packaged drive unit was designed, to be an integral part of the main frame. With this configuration only internal forces are exerted on the main power unit. The truss and foundations are not subjected to the forces of reaction, caused by chain truction. With external power units and chain drives additional fluctuating forces arise, caused by oscillations in the connecting chain. The resulting vibrations in the truss support are transmitted along the entire travel area and result in a higher noise level. The foundations in the larger machine rooms, therefore, must be stronger, which means higher building costs. The O&K driving system only needs to take the weight of the escalators.

The design of this drive unit corresponds to the previously described compact drive. (Figure 4). It comprises two electric motors directly connected with the worm gears, spur gears to the main drive shafts and two vertical spur gears up to the handrail drive wheels. The drive unit is integrated into the upper escalator truss section. These high rise escalators are completely prefabricated and test run in the factory. Afterwards they are split into sections for transportation to the jobsite. Thus, installation time is reduced to a minimum.

4. Energy Saving

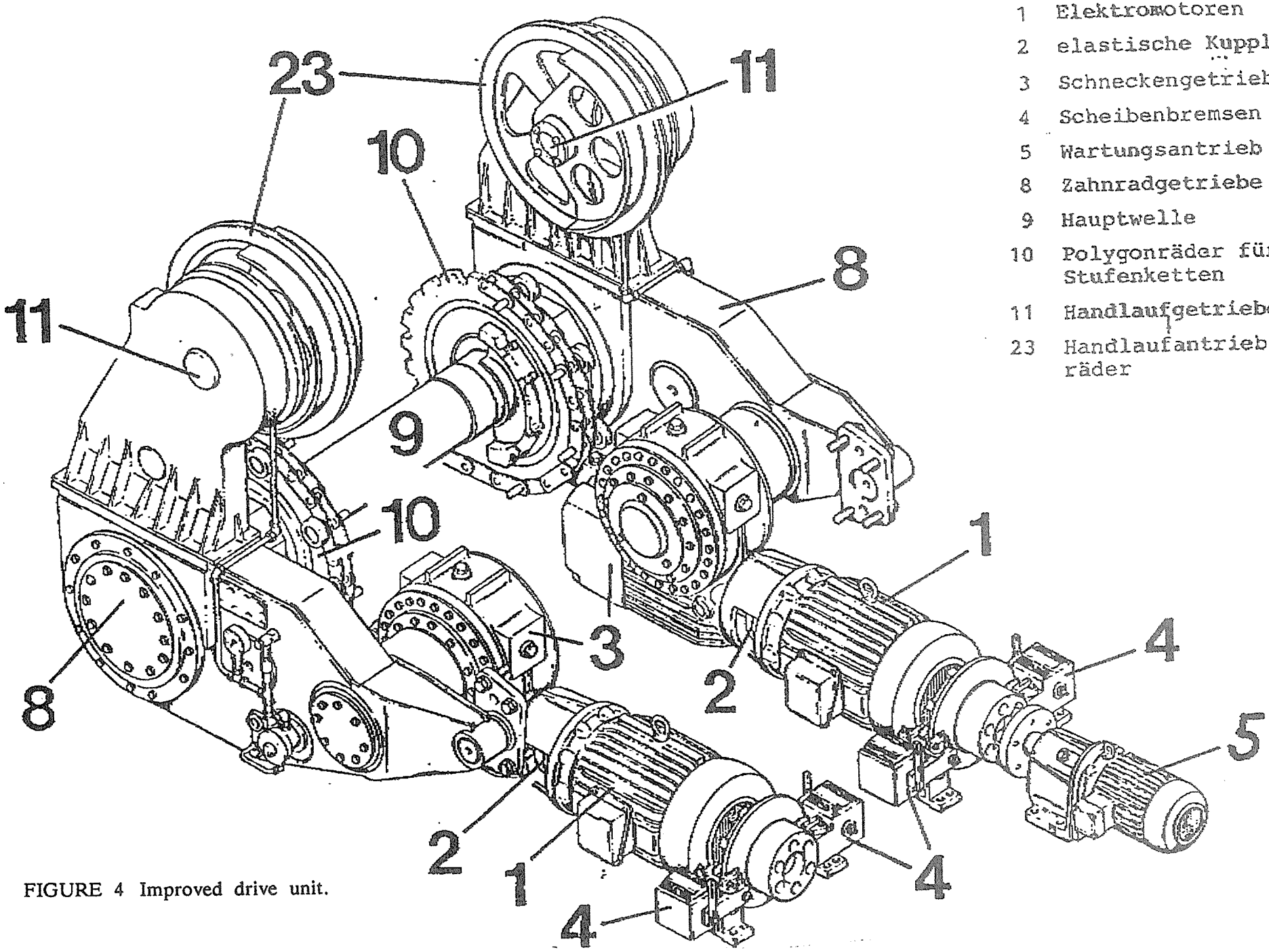
For escalator-drives three-phase squirrel cage motors are used with lower starting currents than is usual on standardised motors. The starting moment should be about twice the nominal moment to give more flexibility in escalator operation. But in many applications the designed horse power for maximum passenger traffic is not necessary and therefore uneconomical.

For this purpose a special energy saving control system has been developed. It is called the "Electronic regulation of Star-Delta Operation of escalators dependent on passenger traffic". Escalators operating permanently in the UP direction require about 60% of daily operation-time that horse power, motors already make it available by star connection.

For rush hours (with heavy passenger traffic) there must be the possibility of self-acting commutation from Star - to Delta operation and back again during low passenger traffic. For this commutation two criteria can be used: either motor speed (revolutions per minute) or true power corresponding to active voltage. O&K has developed and integrated in an electronic control system a speed dependent star-delta commutation.

The adjustment of the commutation-point (max. and min. speed) can be adjusted on the site of the escalator installation. For existing escalators this equipment can also be installed.

The actual energy saving figures vary and depend upon the vertical rise. The higher the rise the lower the savings. Practical experience gives savings of from 17% to 45%.



1 Elektromotoren
2 elastische Kupplung
3 Schneckengetriebe
4 Scheibenbremsen
5 Wartungsantrieb
8 Zahnradgetriebe
9 Hauptwelle
10 Polygonräder für Stufenketten
11 Handlaufgetriebe
23 Handlaufantriebs-räder

FIGURE 4 Improved drive unit.