

System arrangement of lifting mechanisms and method
of operating the system arrangement

5 The invention concerns a system arrangement for the drive train of
lifting mechanisms, in particular crane lifting mechanisms, comprising at
least one drive motor, at least one cable drum connected thereto, a
reduction transmission arranged between the drive motor and the cable
drum, an automatic overrun shutdown means, and at least one safety
10 brake and a method of operating the system arrangement.

 In a known lifting mechanism of the specified kind (EP 1 661 845 B1)
there are provided two drive motors which drive two cable drums by way of
a reduction transmission. Provided in the drive train, besides operating
brakes and safety brakes, are overrun shutdown means which, in the event
15 of an overload which exceeds a predetermined load, entirely or partially
separate the connection between the motors and the cable drums. That is
intended to ensure that the individual components of the drive train and
more specifically in particular the reduction transmission are neither
damaged nor ruined.

20 In addition a drive train for lifting mechanisms is known (DE 10 2013
209 361 A1) in which, in the case of an emergency stop braking action,
damage is avoided by the provision of an automatic overrun shutdown
means between the drive motor and the operating brake. The shutdown
means is preferably in the form of a freewheel, wherein the freewheel
25 represents an effective safety device if the load to be carried is lowered.

 The known systems have already proven their worth in practice. The
operating brakes and the safety brakes in the known drive trains are in the
form of spring-closing brakes which open hydraulically, pneumatically,
magnetically or electro-hydraulically. In the event of a power failure or an
30 emergency shutdown, that has the result that the braking circuits are
automatically closed. In that case each braking circuit in itself is capable of
stopping the load within the predetermined parameters. The arrangement
of the independent braking circuits is substantially due to the fact that on

the one hand, in the event of transmission breakdown the load can no longer be stopped with the operating brakes, but on the other hand the operating brakes are required in order to hold the load in the normal case at the rotary speed '0' of the drive motors, with the linked high switching
5 cycles. In accordance with the status at the present time the safety brakes are not suitable for high switching cycles and consequently close only in the event of transmission breakdown, power failure, emergency shutdown and the like.

However a number of problems arise due to the two braking circuits
10 which are implemented in an emergency situation. Due to the shorter dead time firstly the safety brakes operates. In that case the masses building up due to the mass inertias of the motors and motor couplings also have to be braked. High load peaks therefore occur in the reduction transmission. In the load direction 'LOWER' the situation additionally involves load changes
15 or tooth flank changes at the gears of the reduction transmission. Those problems can lead to serious transmission damage, in particular in the case of crane lifting mechanisms with particularly frequent shutdown situations and involving high lifting speeds. In addition, due to the operation of both braking circuits, inevitable 'over-brakings' of the lifting mechanism occur,
20 with the resultant negative effects on the statics and other crane components.

Therefore the object of the invention is to eliminate those disadvantages.

According to the invention that object is attained in that instead of at
25 least one passive operating brake there is provided at least one active motor locking means for holding the load when the drive motor is decelerated electrically to a rotary speed '0'.

By virtue of the invention therefore it is possible to completely dispense with the operating brakes provided in the drive trains of known
30 lifting mechanisms. In the case of a power failure, an emergency braking situation or a transmission breakdown the required braking operation can be implemented exclusively by the safety brakes, while in normal operation

at a zero speed of the drive motors, without the need for operation of the safety brakes, the motor locking means are used to hold the load.

The motor locking means are preferably of a positively locking configuration. Alternatively however it is also possible for the motor locking means to be of a force-locking or friction-locking configuration.

In contrast to the operating brakes used hitherto the motor locking means are actively operative and are held open for example by spring force. This ensures that, in the case of a power failure, an emergency braking situation or a transmission breakdown, the motor locking means does not close automatically but, at the rotary speed '0', is actuated hydraulically or electro-hydraulically, pneumatically or magnetically.

The motor locking means can be arranged jointly with a motor coupling between the respective drive motor and the reduction transmission.

Alternatively however it is also possible for the motor locking means to be arranged on the side of the drive motor, that faces away from the motor coupling or the reduction transmission.

The drive motor can also be flange-mounted directly to the reduction transmission without the interposition of a motor coupling.

When using a motor locking means of positively locking configuration it is preferably in the form of a selector shift tooth arrangement.

To implement such a shift tooth arrangement a stator gear which projects in a direction towards the drive motor and which has an outside tooth arrangement can be arranged on the housing of the reduction transmission while arranged non-rotatably on the motor shaft or the input shaft of the transmission is a rotor gear also having an outside tooth arrangement, wherein provided for connecting or separating the motor locking means there is a shift element which is provided with an inside tooth arrangement and with which the stator gear and the rotor gear can be selectively coupled.

If the motor locking means is arranged at the rear side of the drive motor it is possible to provide on the housing of the drive motor a stator ring gear which is fixedly connected thereto and which has a face tooth

arrangement operative in the axial direction while arranged on the motor shaft is a rotor ring gear which is axially displaceable thereon and which is arranged non-rotatably and which has an equivalent face tooth arrangement at the planar face thereof and which can be coupled to the
5 stator ring gear fixedly connected to the motor housing for locking the drive motor.

In that case the rotor ring gear can be held in the uncoupled position by means of compression springs while for actuation of the motor locking means the rotor ring gear is displaced in a direction towards the stator ring
10 gear into the coupled position.

The overrun shutdown means is preferably in the form of a freewheel. It can be integrated into the reduction transmission, in which case it is arranged selectively on the input shaft, the intermediate shaft or the output shaft of the reduction transmission.

15 The freewheel integrated into the transmission is permanently locked in normal operation, due to the load direction remaining the same in the lifting and lowering modes, which permits normal operation of the lifting mechanism. If in the lowering mode braking of the lifting mechanism occurs by means of the safety brakes then the rotating masses rotate freely
20 to the freewheel so that no damage to the transmission or other components occurs. In addition as a result the braking travel of the load is also curtailed as no accelerating masses have to be also braked.

A further structural option provides that a cable drum joint connection is provided between the output shaft of the reduction
25 transmission and the cable drum, the freewheel being integrated into the cable drum joint connection.

For additional safety the safety brakes can be divided into two independent control circuits so that there is a redundant resource as a reserve. In that way the drive train according to the invention, which is
30 intended in particular for crane lifting mechanisms, can be still further optimised. That additional optimisation also has a particularly advantageous effect for the transport of hazardous goods.

The method according to the invention substantially provides that the motor locking means is activated immediately after the electrical deceleration of the drive motor or motors to the rotary speed '0'.

The invention is shown by way of example in the drawing and is
5 described in detail hereinafter with reference to the drawing in which:

Figure 1 shows a first embodiment of the invention,

Figure 2 shows a second embodiment of the invention,

Figure 3 shows a third embodiment of the invention,

Figure 4 shows a fourth embodiment of the invention,

10 Figure 5 shows a view on an enlarged scale of a specific configuration of the motor locking means, and

Figure 6 shows another embodiment of the motor locking means.

Referring to the drawing the drive train according to the invention which is intended in particular for crane lifting mechanisms comprises two
15 drive motors 1, 1', two cable drums 2, 2', a reduction transmission 3 disposed between the drive motors 1, 1' and the cable drums 2, 2', an automatic overrun shutdown means and two safety brakes 4, 4' fitted to the cable drums 2, 2'.

In addition the drive train according to the invention has active
20 motor locking means 5, 5' which serve to hold the load in the event of the drive motors 1, 1' being electrically decelerated to the rotary speed '0' and which can be actively actuated. In that way it is possible to dispense with the per se known passive operating brakes normally arranged between the drive motors 1, 1' and the reduction transmission 3.

25 Provided as the overrun shutdown means is a freewheel 6 which, in each of the embodiments by way of example shown in Figures 1 to 4, is integrated in the reduction transmission 3. In the illustrated examples the freewheel 6 is arranged on the input shaft 7 of the reduction transmission 3. Alternatively however the freewheel 6 could also be arranged on the
30 intermediate shaft 8 or the output shaft 9 of the reduction transmission 3.

In all four embodiments of the drive train according to the invention there is a cable drum joint connection 10 and 10' respectively between the output shaft 9 of the reduction transmission 3 and the respective cable

drum 2 or 2'. In the structure shown in Figure 4 the freewheel 6 is integrated in the cable drum joint connections 10 and 10' respectively.

In the embodiment shown in Figure 1 the motor locking means 5 or 5' is arranged together with the motor coupling 11 or 11' between the
5 respective drive motor 1 or 1' and the reduction transmission 3.

Figure 5 shows a partly sectional view on an enlarged scale of the motor locking means 5. In this embodiment the motor locking means 5 is of a positively locking configuration, more specifically in the form of a selector shift tooth arrangement. It comprises a stator gear 13 which is
10 arranged on the housing 12 of the reduction transmission 3 and which projects from the housing 12 in the direction towards the drive motor 1 and is provided with an outside tooth arrangement 14. The shift tooth arrangement further includes a rotor gear 16 which is arranged non-rotatably on the motor shaft 15 or the input shaft 7 of the transmission and
15 which is also provided with an outside tooth arrangement 17. A shift element 18 serves for coupling or uncoupling the two gears 13 and 16, the shift element 18 being provided with an inside tooth arrangement which fits with the outside tooth arrangements 14 and 17 of the gears 13 and 16.

In the upper part Figure 5 shows the uncoupled condition in which
20 the shift element 18 is carried exclusively on the stator gear 13 so that there is no connection to the rotor gear 16. In the lower part of Figure 5 the shift element 18 extends over the outside tooth arrangements 14 and 17 of both gears 13 and 16 so that the motor shaft 15 is blocked by means of the motor locking means 5.

In the embodiment shown in Figure 5 the rotationally fixed mounting
25 of the rotor gear 16 is effected by way of a fitting key 19 which is fitted into corresponding grooves in the input shaft 7 of the reduction transmission 3 and the rotor gear 16. In addition the rotor gear 16 is connected non-rotatably and axially immovably to the motor shaft 15 by way of the motor
30 coupling 11.

In operation of the lifting mechanism the shift element 18 is held in its disengaged or uncoupled position by means of spring elements (not shown in the drawing). To produce the engaged or coupled position there is

applied an active force which is produced in opposite relationship to the spring force and which can be produced by the most widely varying means, for example hydraulically or electro-hydraulically, pneumatically or also magnetically.

5 In the embodiments shown in Figures 2 to 4 the motor locking means 5 and 5' is arranged on the side of the drive motor 1 or 1', that is remote from the reduction transmission 3.

 With such a structure, as shown in Figure 3, the drive motor 1 or 1' can be flange-mounted directly to the reduction transmission 3 without the
10 interposition of a motor coupling 11 or 11' respectively.

 Figure 6 shows a specific configuration of this motor locking means as shown in Figures 2 to 4. As can be seen in detail, provided on the housing of the drive motor 1 is a stator ring gear 20 which is fixedly connected thereto and which has a face tooth arrangement 21 operative in
15 the axial direction. Arranged on the motor shaft 15 is a rotor ring gear 22 which is displaceable axially thereon and which is arranged non-rotatably and which has an equivalent face tooth arrangement 23. The axially displaceable and non-rotational connection between the rotor ring gear 22 and the motor shaft 15 can be made by means of a fitting key or a taper
20 profile (not shown in greater detail in the drawing).

 In the upper part of Figure 6 the two ring gears 20 and 22 are shown in the disengaged or uncoupled position. That position is produced by means of compression springs 24 which in operation of the lifting mechanism hold the two ring gears 20 and 22 apart.

25 In the lower part of Figure 6 the two ring gears 20 and 22 are shown in the engaged or coupled position. To reach that locked condition there is provided an actuating device (not shown in the drawing) which presses the rotor ring gear 22 against the stator ring gear 20 in opposition to the compression springs 24. For uncoupling purposes the actuating device is
30 moved back so that the rotor ring gear 22 is disengaged again by means of the compression springs 24.

 Therefore in normal operation, at the rotary speed '0' of the drive motors 1 and 1' respectively, the load can be held by means of the motor

locking means 5 and 5' without the safety brakes having to operate so that the safety brakes are not stressed with high switching cycles. The drive train according to the invention therefore not only operates more reliably and more securely but also achieves a longer service life.

- 5 In the embodiment shown in Figure 4 there are two additional safety brakes 25, 25'. The four safety brakes 4, 4' and 25, 25' can be actuated in paired relationship by way of separate control circuits 26, 27 so that this affords a redundant resource as an additional safety aspect.

List of references

	1, 1'	drive motors
	2, 2'	cable drums
	3	reduction transmission
5	4, 4'	safety brakes
	5, 5'	motor locking means
	6	freewheel
	7	input shaft of the reduction transmission
	8	intermediate shaft
10	9	output shaft
	10, 10'	cable drum joint connections
	11, 11'	motor couplings
	12	housing of the reduction transmission
	13	stator gear
15	14	outside tooth arrangement
	15	motor shaft
	16	rotor gear
	17	outside tooth arrangement
	18	shift element
20	19	fitting key
	20	stator ring gear
	21	face tooth arrangement
	22	rotor ring gear
	23	face tooth arrangement
25	24	compression spring
	25, 25'	additional safety brakes
	26	control circuit
	27	control circuit

CLAIMS

1. A method of operating a system arrangement for lifting mechanisms comprising at least one drive motor (1, 1'), at least one cable drum (2, 2') connected thereto, a reduction transmission (3) arranged
5 between the drive motor (1, 1') and the cable drum (2, 2'), an automatic overrun shutdown means, and at least one safety brake (4, 4'), wherein there is provided at least one active motor locking means (5, 5') for holding the load when the drive motor (1, 1') is slowed down and the motor locking
10 means is activated immediately after electrical deceleration of the drive motor or motors to a rotary speed '0'.

2. A system arrangement for lifting mechanisms comprising at least one drive motor (1, 1'), at least one cable drum (2, 2') connected thereto,
15 a reduction transmission (3) arranged between the drive motor (1, 1') and the cable drum (2, 2'), an automatic overrun shutdown means, and at least one safety brake (4, 4'), wherein there is provided at least one active motor locking means (5, 5') for holding the load when the drive motor (1, 1') is decelerated electrically to a rotary speed '0'.

20

3. A system arrangement according to claim 2 wherein the motor locking means (5, 5') is of a positively locking configuration.

4. A system arrangement according to claim 2 wherein the motor
25 locking means (5, 5') is of a force-locking or frictional-locking configuration.

5. A system arrangement according to claim 3 or claim 4 wherein the motor locking means (5, 5') is actuatable hydraulically or electro-hydraulically, pneumatically or magnetically.

30

6. A system arrangement according to one of claims 2 to 5 wherein the motor locking means (5, 5') is arranged jointly with a motor coupling

(11, 11') between the drive motor (1, 1') and the reduction transmission (3).

7. A system arrangement according to one of claims 2 to 5 wherein
5 the motor locking means (5, 5') is arranged on the side of the drive motor (1, 1'), that faces away from the reduction transmission (3).

8. A system arrangement according to claims 2 to 5 wherein the
drive motor (1, 1') is flange-mounted directly to the reduction transmission
10 (3) without the interposition of a motor coupling.

9. A system arrangement according to one of claims 2 to 8 wherein
the motor locking means (5, 5') is in the form of a selector shift tooth
arrangement.

15

10. A system arrangement according to claim 9 wherein a stator
gear (13) which has an outside tooth arrangement (14) and which projects
in a direction towards the drive motor (1, 1') is arranged on the housing
(12) of the reduction transmission (3), that a rotor gear (16) also with an
20 outside tooth arrangement (17) is arranged non-rotatably fixedly on the
motor shaft (15) or the input shaft (7) of the transmission (3), and that
there is provided a shift element (18) which is provided with an inside tooth
arrangement and with which the stator gear (13) and the rotor gear (16)
can be selectively coupled.

25

11. A system arrangement according to claim 7 and claim 9 wherein
provided on the housing of the drive motor (1, 1') is a stator ring gear (20)
which is fixedly connected thereto and which has a face tooth arrangement
(21) operative in the axial direction and that arranged on the motor shaft
30 (15) is a rotor ring gear (22) which is displaceable axially thereon and
which is arranged non-rotatably and which has an equivalent face tooth
arrangement (23), which rotor ring gear can be coupled to the stator ring

gear (20) fixedly connected to the motor housing for locking the drive motor (1, 1').

12. A system arrangement according to claim 11 wherein the rotor
5 ring gear (22) is held in the uncoupled position by means of compression springs (24) and that to actuate the motor locking means (5, 5') the rotor ring gear (22) is displaced in a direction towards the stator ring gear (20) into the coupled position.

10 13. A system arrangement according to one of claims 2 to 12 wherein the overrun shutdown means is in the form of a freewheel (6).

14. A system arrangement according to claim 13 wherein the
freewheel (6) is integrated into the reduction transmission (3).

15

15. A system arrangement according to claim 14 wherein the
freewheel (6) is arranged selectively on the input shaft (7), the
intermediate shaft (8) or the output shaft (9) of the reduction transmission
(3).

20

16. A system arrangement according to one of claims 13 to 15
wherein a cable drum joint connection (10, 10') is provided between the
output shaft (9) of the reduction transmission (3) and the cable drums (2,
2'), and the freewheel (6) is integrated into the cable drum joint connection
25 (10, 10').

17. A system arrangement according to one of claims 2 to 16
wherein the safety brakes (4, 4') are arranged in two independent control
circuits (26, 27).