

The invention relates to a method according to the precharacterising clause of patent claim 1 and to a conveyor system for carrying out this method according to the precharacterising clause of claim 14.

In relatively large office buildings or hospitals, the object exists of conveying different types of conveyed material from one point to another point as efficiently as possible. Conveyor systems are used in a known manner for this purpose, in which transportation takes place in guided conveyor vehicles. The conveyor vehicles have conveyor containers for holding the conveyed material which is conveyed using the conveyor vehicles from a station arranged adjacent to a section of the conveyor track (sending station) to another conveyor station (receiving station), located adjacent to another section of the conveyor track.

Conveyor systems are known in which the movement of conveyor vehicles is controlled along a main conveyor track from which auxiliary conveyor tracks branch off to individual stations. In this case, a destination address is allocated in each case to each of the conveyor vehicles, which address is interrogated at the junction points of the individual auxiliary conveyor tracks from the main conveyor track as the respective conveyor vehicle moves along the main conveyor track, in order to determine whether the conveyor vehicle has reached the addressed destination station.

In addition, a computer-aided conveyor system is known in which a central main processor is connected to each conveyor vehicle having conveyor containers. The conveyor vehicles, for their part, each hold a microprocessor which exchanges data with the main processor and permits storage of a destination address assigned to the allocated conveyor vehicle; in this way, the known conveyor system permits the transportation of the conveyed material to be controlled to its destination address.

According to a further known system (US-A-3,908,113), each conveyor vehicle is provided with a bar code for identification which can be read by reading means arranged distributed above the system. In this case, when a conveyor vehicle is sent out, a destination address allocated to the receiving station is transmitted together with the code number to a central control unit. If the conveyor vehicle moves into a switch to which a read unit is allocated, the code number is recorded by the read unit and a control signal, corresponding to the destination address, is passed via the central control unit to the switch in order to control the conveyor vehicle towards the receiving station in accordance with the associated destination address. However, such a system does not provide adequate interrogation reliability since incorrect identifications can occur because of damage to or dirt on the bar codes. Furthermore, moving a bar code over an optical read unit once does not provide adequate interrogation reliability. Finally, costly traffic controls are necessary in order to prevent incorrect identifications when a conveyor vehicle is stationary.

The invention is based on the object of specifying a method which permits reliable control of the movements of a multiplicity of conveyor vehicles in a conveyor system.

According to the invention, this object is achieved with respect to the method by means of the features contained in the characterising part of claim 1. For the conveyor system, the object is achieved by means of the features contained in the characterising part of claim 14. Expedient developments are specified in the subclaims.

The following text describes an exemplary embodiment of the invention using the drawing, in which:

Figure 1 shows a functional diagram of an exemplary embodiment of the conveyor system according to the invention,

- Figure 2 shows the data format of information transmitted from the central control unit to the switch control units,
- Figure 3 shows an output control list for a switch control unit,
- Figure 4 shows a data format for a response signal from a switch control unit to the central control unit,
- Figure 5 shows a circuit diagram of a code signal transmitter in a conveyor vehicle,
- Figure 6 shows a circuit diagram of a receiving means of a switch control unit,
- Figure 7 shows a circuit diagram of a drive control means of a conveyor vehicle,
- Figure 8 shows a detector- and control means of a switch control unit,
- Figure 9 shows the schematic layout of a switch means,
- Figure 10 shows a schematic layout of the conveyor system according to the invention having nine switch means and six stations
- Figure 11 shows a conveying route list as stored in a memory of the central control unit of the conveyor system according to the invention in accordance with Figure 10, and
- Figures 12A to 12D show flow diagrams of control and monitoring to functions of the conveyor system according to the invention.
- Figure 1 shows the functional diagram of the conveyor system according to the invention, in which conveyed material is transported in conveyor vehicles 10 via conveyor tracks 12 between sending and receiving stations. Each of the conveyor vehicles 10 has a dedicated code signal transmitter which emits a code signal which is different to those of the other vehicles 10. The conveyor tracks 12 comprise a main conveyor track 14, which forms a main section or a loop, along which the

conveyor vehicles 10 are moved to auxiliary conveyor tracks 16 which branch off from the main conveyor track 15. Both the main conveyor track 14 and the auxiliary conveyor tracks 16 contain in each case detector rails 18 and power supply rails 20. Each individual conveyor vehicle 10 contains a motor to which a supply voltage is fed, via the power supply rails 20, to drive the conveyor vehicle 10 along the conveyor tracks 12. The detector rails 18 are used for detecting the code signal emitted by the respective code transmitter of the conveyor vehicles 10 or for detecting the presence of a conveyor vehicle 10 on the respective conveyor track 12. For this purpose, the detector rails 18 can be arranged at given points along the conveyor tracks 12 so that it is possible, with their aid, to determine an approximate position of the conveyor vehicles 10 on the conveyor tracks 12.

The conveyor system according to the invention furthermore contains a number of switch means 22 which are arranged at given points along the conveyor tracks 12. As a rule, the switch means 22 represent means for switching the conveyor vehicles 10 between the main conveyor track 14 and the auxiliary conveyor tracks 16. However, the switch means 22 may also be used to change the direction of movement of the conveyor vehicles 10 along the main conveyor track 14. Each switch means 22 contains control rails 24 and a movable track section 26.

In the same way as the detector rails 18, the control rails 24 of the switch means 22 contain rail sections for detecting the code signals of the individual conveyor vehicles 10 and rail sections for detecting the presence of the conveyor vehicles 10. In addition, the control rails 24 comprise further rail sections for stopping the conveyor vehicles 10.

The movable track section 26 is mounted such that it can be moved between two positions relative to the main conveyor track 14 and to the auxiliary conveyor tracks 16. In the first position, the movable track

section 26 is aligned flush with the main conveyor track 14 between two ports of the respective switch means 22. In the second position, the movable track section 26 is aligned between two other ports of the switch means 22, with the auxiliary conveyor tracks 16. For control purposes, the numbers 0-3 are in each case allocated to the ports of the individual switch means 22 in such a manner that the movable track section 26 is in an even-numbered position when it is aligned with the ports 0 and 2 and is in the second (odd) position when it is lined up with the ports 1 and 3.

The conveyor system according to the invention contains a number of sending/receiving control units 28 which are allocated to corresponding sending and receiving stations for sending out and receiving conveyor vehicles 10. A station address is allocated in each case to each sending/receiving control unit 28 for its identification. As a rule, each sending/receiving control unit is arranged in each case on an auxiliary conveyor track. In a preferred configuration of the conveyor system according to the invention, the stations are of two types, namely used as turning stations and as passage stations. In this case, a turning station permits the movement of the conveyor vehicles 10 in each case on the same auxiliary conveyor track into the respective station and from there once again out in each case on the same auxiliary conveyor track 16.

This has the consequence that the last conveyor vehicle 10 to move into the turning station must be the first to leave it again. A passage station is characterised in that it allows the conveyor vehicles 10 to move in only a single direction along the auxiliary conveyor track 16, so that a conveyor vehicle 10 which is the first to be driven into the passage station is also the first to leave it. Thus, while only one conveyor vehicle can be either received or sent out at the same time in a turning station, a passage station simultaneously permits one conveyor vehicle 10 to be received and

a further conveyor vehicle to be sent out. In a preferred exemplary embodiment of the conveyor system according to the invention, at least some of the switch means 22 can be constructed as end stations or can be connected to one, but preferably to two, stations for sending and receiving conveyor vehicles 10.

The conveyor system according to the invention furthermore contains a number of switch control units 30 of which in each case one unit is connected in each case to one switch means 22. The switch control units 30 are used for monitoring and controlling the associated switch means 22 and their movable track sections 26 as well as for monitoring the control rails 24 in the respective switch means 22.

A switch means 22 is controlled by means of the associated switch control unit 30 which, via a motor with a drive means in the switch means 22, moves the movable track section 26 until the desired end position of the movable track section 26 is signalled to the switch control unit 30 by means of limit switches. Each switch means 22 furthermore contains in each case one polarity reversing relay 32, controlled by the associated switch control unit 30, in order to be able to reverse the polarity of the supply voltage on the sections of the power supply rails 20 in the area of the movable track section 26. In this case, triggering of the polarity reversing relay 32 causes a movement of a conveyor vehicle 10 which is located on the movable track section 26 in one direction, while failure to trigger the polarity reversing relay 32 results in a movement of the conveyor vehicle 10 in the opposite direction. The associated switch control unit 30 receives input signals via the control rails 24 in order to monitor the switch means 22.

Each switch control unit 30 may be connected in each case to one or two sending/receiving control units 28 which, for their part, are connected to the station or stations to which the associated switch means 22 sends

conveyor vehicles 10 or receives them from it or them. The numbers of ports connected in each case to one station of the switch means 22 are in each case signalled via programmable address switches to the switch control units 30. In the same way, further programmable address switches are used to signal to the switch control unit 30 whether an individual station is used as a turning station or as a passage station.

This information is used to determine the individual control steps for controlling the movement of a conveyor vehicle 10 between a station and the switch means 22 connected to it.

A central control unit 34, which is connected to each of the switch control units 30, is used for central control of the conveyor system according to the invention. The central control unit 34 contains a program-controlled processor and a memory as well as an input keyboard 36 for inputting data and information to the memory, and a display unit 38 for visual display of the desired information concerning the movement states of the conveyor vehicles 10. The central control unit 34 is used for outputting information to the various switch control units 30 so that, even when there are a large number of different conveyor vehicles 10 in the conveyor system, the movement of an individual conveyor vehicle 10 from a sending station to a receiving station is facilitated in as short a time as possible.

In order to ensure precise control by means of the central control unit 34, the latter is programmed with comprehensive information on the configuration of the conveyor system according to the invention. Thus, a corresponding address is signalled to the central control unit 34 for each switch control unit 30. The central control unit 34 in each case receives a number of a so-called standard entry port (SE) and a so-called standard exit port (SX) for each of the associated switch means 22. The standard entry port (SE) is generally the port of the switch means 22 which is located on the main traffic

line of the conveyor vehicles 10 on the main conveyor track 14, and thus defines the initial or quiescent position of the movable track section 26. The standard exit port (SX) is the port of the switch means 22 which points in the direction of the main traffic flow and at which all conveyor vehicles 10 leave the switch means 22 if no other port has been defined by an instruction as the exit for the conveyor vehicles 10.

The central control unit 34 emits sending information, which is transmitted serially to each switch control unit 30, to control and monitor the movement of the conveyor vehicles 10. The sending information, whose data format is shown in Figure 2, contains several Bytes. The first Byte contains the address of the switch control unit 30 and of the associated switch means 22 for which the following Bytes are intended. The second Byte contains the numbers of the ports of the switch means 22 addressed in Byte 1 which form the standard entry ports and the standard exit ports. Byte 3 is used by the central control unit 34 to demand information from the switch control units 33 and is also used for controlling specific functions related thereto. Byte 4 is not used. Byte 5 contains the code number of one of the conveyor vehicles 10 in the conveyor system according to the invention; the central control unit 34 uses this code number to inform the switch control unit 30 addressed in Byte 1 about the code number of the respective conveyor vehicle 10 whose route is intended to be controlled by the associated switch means. The central control unit 30 uses Byte 6 to report to the switch control unit 30 addressed in Byte 1 the number of the port of the associated switch means 22 which is intended to be used as the exit by the conveyor vehicle 10 identified in Byte 5 when the conveyor vehicle leaves the switch means 22 again. Bytes 7 and 8 are each used for transmitting state or control information to the switch control unit 30. Two different Bytes are provided for this purpose because each switch control unit 30 may be connected to two sending/receiving

control units 28, as mentioned above, so that the information in Byte 7 is to be allocated to the one sending/receiving control unit 28 and the information in Byte 8 is to be allocated to the other sending/receiving control unit 28.

In conjunction with emitting the code signals and the code numbers, contained therein as information, of the conveyor vehicles 10, an output control list 40, corresponding to the presentation in Figure 3, is stored in each case in a memory in each switch control unit 30, one memory location being provided in each case for each conveyor vehicle 10 in the conveyor system. Each memory location has a length of 8 bits, bits 4 and 5 identifying the port of the corresponding switch means 22 which is used as the exit for the relevant conveyor vehicle 10. By way of example, port 3 is used as the exit for the conveyor vehicle 10 with the code number n. This has the consequence that, apart from a change by the central control unit 34, the conveyor vehicle with the number n leaves the relevant switch means 22, whose associated switch control unit 30 has been stored in the list shown in Figure 3, leaves at port 3.

Whenever the central control unit 34 selects a switch control unit 30, the relevant switch control unit 30 responds with a dedicated response signal. Figure 4 shows a data format for such a response signal. The response signal contains 8 Bytes, the first Byte containing the address of the responding switch control unit 30 and the associated switch control means 22. Byte 2 contains monitoring information at given times, or state information concerning the switch means 22. Byte 3 provides information to the central control unit 34 concerning the entry of a conveyor vehicle 10 into the control area of the switch control unit 30. Byte 4 contains the code number of a conveyor vehicle 10 which number is used together with Byte 3, in the event of a conveyor vehicle 10 being detected, as information for the central control unit 34. Bytes 5 and 6 contain

information for the sending and/or receiving of a conveyor vehicle 10 in the area of the station which is controlled by the corresponding switch control unit 30. When a conveyor vehicle 10 is sent, Byte 6 contains the destination or receiving address of the conveyor vehicle 10 sent out, while Byte 4 contains the code number of this vehicle. Byte 4 is used together with either Byte 3 or with Bytes 5 and 6 in each response signal. Since the switch control unit 30 preferably controls two sending/receiving control units 28, the exit signal contains two further Bytes 7 and 8 instead of Bytes 5 and 6 in order to make the corresponding information available for a second addressed sending/receiving control unit 28.

In the following text, Figures 5 and 6 are used to describe how the respective conveyor vehicles 10 are detected in the conveyor system according to the invention. Each conveyor vehicle 10 in the conveyor system contains a code signal transmitter 44 with a programmable address switch 42. A code number, which is several bits long, can be set with the aid of the address switch 42 such that, for example, in the case of an 8 bit long code number, a total of 256 conveyor vehicles each having different code numbers can be used in the conveyor system. Arranged on the output side of the programmable address switch 42 is a parallel/serial data converter 46 which converts the parallel output data of the programmable address switch 42 into serial data. A driver amplifier 48 whose output signal has a level of approximately 6 V, is connected to the serial output of the parallel/serial data converter 46. This signal is supplied via a diode 50 to the control rail 24 as soon as the conveyor vehicle 10 comes into contact with this control rail 24 via a sliding contact.

As Figure 6 shows, the control rail 24 is connected to a switch control unit 30. As soon as a conveyor vehicle 10 makes contact with a control rail 24, the amplified serial output signal from the code signal transmitter 44 of the conveyor vehicle 10 is transmitted

via the control rail 24 to a receiving means 52 in the switch control unit 30. The receiving means 52 contains a comparator 54, 56, 58 with a differential amplifier 54, whose inverting input (-) is connected to a voltage tap of a voltage divider composed of two resistors 56 and 58, and is thus at a voltage of approximately 4 V. Since the output signal of the code transmitter 44 of the conveyor vehicle 10 is at a level of approximately 6 V, the voltage of 4 V on the inverting input (-) of the differential amplifier 54 is used as a threshold voltage. The serial output signal of the code signal transmitter 44 is supplied via the control rail 24 to the non-inverting input (+) of the differential amplifier 54, and is amplified therein. The amplified serial signal is converted into a parallel signal in a downstream serial/-parallel data converter 60, which parallel signal corresponds to the code number of the conveyor vehicle which is set with the programmable address switch 42 of the code signal transmitter 44.

The output of the serial/parallel converter 60 is connected to a data memory 62 which supplies the code number of the switch control unit 30 on demand. For this purpose, the serial/parallel converter 60 and the data memory 62 are connected on the control side to the switch control unit 30. After reading the code number of the respective conveyor vehicle 10, the relevant switch control unit 30 is able, by means of an access to the output control list 40 stored in it (c.f. Figure 3), to define the port of the corresponding switch means 22 which is used as the exit for the conveyor vehicle 10.

In addition to the respective transmitting means 44, each conveyor vehicle 10 contains a drive control means 64 corresponding to the representation in Figure 7. The drive control means 64 contains a motor 66 which is electrically connected via sliding contacts to the power supply rails 20. The power supply rails 20 consist of two contact rails 68 and 70, which lie side-by-side and each carry different voltage potentials so that the motor 66,

which is connected to both contact rails 68 and 70, drives the conveyor vehicle 10. The drive control means 64 furthermore contains a switching relay 72 which, in a first switch position, connects the motor 66 to the voltage potential on the contact rail 70, so that a current flow takes place via the power supply rails 20 through the motor 66 and this drives the conveyor vehicle 10. In the second switch position, the switching relay 72 short-circuits the motor terminals in order thus to stop the motor 66 and hence to halt the conveyor vehicle 10.

The switching relay 72 is controlled via the control rail 24 by means of the switch control unit 30 respectively connected to it. To this end, each switch control unit 30 contains in each case one detector- and control means 76, which are shown in detail in Figure 8. The detector- and control means 76 contains a threshold voltage detector 78, 80, 82 with a differential amplifier 78, whose non-inverting input (+) is connected to the voltage tap of a voltage divider having the resistors 80 and 82. The threshold voltage present at this voltage tap is approximately 22 V. The inverting input (-) of the differential amplifier 78 is connected to the voltage tap of a further voltage divider, which consists of a resistor 84 and the control rail 24. As long as there are no conveyor vehicles 10 in the area of the conveyor rail 24, the voltage signal on the inverting input (-) of the differential amplifier 78 is approximately 24 V and is thus greater than the threshold voltage on the non-inverting input (+). In consequence, the differential amplifier 78 emits an output signal at a low level (low). On the other hand, if there is a conveyor vehicle 10 in the area of the control rail 24, the voltage on the inverting input (-) of the differential amplifier 78 is reduced to approximately 2 V by means of the internal resistance 86 of the conveyor vehicle 10 (c.f. Figure 7) for the case where the value of the internal resistance 86 is approximately 8.2 kohm and the value of the resistor 84 is approximately 100 kohm. This has the

consequence that a high signal level (high), which indicates the presence of the conveyor vehicle 10 on the control rail 24, is produced at the output of the differential amplifier 78.

5 In addition to the detection of the presence of a conveyor vehicle 10 by means of the detector- and control means 76 described above, the voltage on the control rail 24 is also used for controlling the conveyor vehicle 10 and, to this end, is supplied via a zener diode 88 (c.f. Figure 7) of the drive control means 64 of
10 the conveyor vehicle 10. The zener diode 88 is a two-stage arrangement having a first transistor switch 90 and a second transistor switch 92 arranged downstream from it, the second transistor switch 92 lying in a current
15 path with the excitation coil 94 of the switching relay 72.

 During the presence of a conveyor vehicle 10 in the area of the control rail 24, the voltage on the control rail 24 is approximately 2 V, so that the zener
20 diode 88, which has a zener voltage of approximately 12 V, is in a non-conducting state. This has the consequence that the downstream first switching transistor 90 is switched off and the second switching transistor 92 is switched on, so that an excitation current flows through
25 the excitation coil 94 of the switching relay 72 and the switching relay 72 is switched into the first switch position, which connects the motor 66 to the contact rails 68 and 70. In this mode, the conveyor vehicle 10 is driven by the motor 66.

30 The detector- and control means 76, shown in Figure 8, of the switch control unit 30 furthermore has a transistor 96 which is connected via a resistor 98 to the control rail 24. In order to stop the conveyor vehicle 10, the switch control unit 30 produces a stop
35 signal which is supplied to the base of the transistor 96 and switches the transistor 96 on. In this case, the resistor 98 interacts via the control rail 24 with the internal resistance 86 of the drive control means 64 of

the conveyor vehicle 10 as a voltage divider which applies a voltage of approximately 19 V to the zener diode 88 in the drive control means 64 of the conveyor vehicle 10. Since this voltage exceeds the zener voltage (approximately 12 V) of the zener diode 88, the zener diode 88 is switched on so that the downstream first switching transistor 90 is likewise is switched on and the second switching transistor 92 is switched off. This results in an interruption in the current flow through the excitation coil 94 of the switching relay 72, so that the switching relay 72 trips into its second switch position in which the motor terminals of the motor 66 are short-circuited, and the conveyor vehicle 10 is correspondingly stationary.

A rectifier bridge circuit 100, whose AC side is connected to the contact rails 68 and 70, is used as the power supply for the two-stage arrangement with the first switching transistor 90 and the second switching transistor 92, as well as the excitation coil 94 of the switching relay 72.

In order to achieve interference-free operation of the conveyor system according to the invention, the code signal transmitters 44 of the various conveyor vehicles 10, the drive control means 64 of the conveyor vehicles 10 or the detector- and control means 76 of the switch control units 30 must not influence one another. If an output signal at a level of approximately 6 V is present at the output of a code signal transmitter 44, this signal has no influence on the conductivity of the zener diode 88 in the drive control means 64, so that no current flows through the excitation winding 94 of the switching relay 72 and the motor 66 remains connected to the contact rails 68 and 70. If the conveyor vehicle 10 is switched to stop because of a stop signal, the diode 50 at the output of the transmitting means 44 of the conveyor vehicle 10 is switched off by the voltage of approximately 19 V on the control rail 24 so that a possible reduction in the voltage on the zener diode 88,

caused by the output impedance of the transmitting means 44, below the zener voltage (approximately 12 V) is prevented. This has the consequence that it is not possible to detect the code number of the conveyor vehicle 10 while said conveyor vehicle 10 is stationary in the area of a control rail 24. However, in the case of the conveyor system according to the invention, it is not necessary to detect the code number of a conveyor vehicle 10 which is stationary, because of the control.

10 It should also be noted that, in the event of the transistor 96 being triggered by a stop signal from the switch control unit 30, the inverting input (-) of the differential amplifier 78 is at a voltage of 19 V, which in any case is less than the voltage on the non-inverting input (+) of 22 V, so that a high level (high) is received by the threshold voltage detector 78, 80, 82 as long as the conveyor vehicle 10 is stationary and is in contact with the control rail 24.

Figure 9 shows an exemplary embodiment of a switch means 22a. The switch means 22a shown has four ports, numbered 0 to 3. A conveyor vehicle 10, which moves to one of the four ports 0 to 3 in the switch means 22a leaves said means at one of the three other ports on the route to its destination. The ports 0 and 2 are each connected to sections of the main conveyor track 14, sections of an auxiliary conveyor track 16a and 16b being connected to the ports 1 and 3. As has already been described above in the explanation of the layout of conveyor system according to the invention, one port of the switch means 22a is defined as the standard entry port (SE) and another port is defined as the standard exit port (SX). For the case when, in the switch means shown, the conveyor vehicles 10 move, for example, in the direction from left to right, the port 0 is selected as the standard entry port (SE) and the port 2 as the standard exit port (SX) since these two ports 0 and 2 lie in the course of the main traffic line, namely the main conveyor track. The switch means 22a furthermore contains

a movable track section 26a which is positioned between the standard entry port 0 and the standard exit port 2. If a conveyor vehicle 10 moves on one of the branching sections of the auxiliary conveyor track 16a or 16b, the
5 movable track section 26a is moved into the position shown by dashed lines.

Arranged on the movable track section 26a are control rails 24a which consist of a pair of detector rails 105 and a stop rail 104 located between them. The
10 stop rail 104 is used for stopping a conveyor vehicle 10 and for detecting its presence. The detector rails 105 detect the presence of a conveyor vehicle 10 on the movable track section 26a for the case when the conveyor vehicle 10 is not located in the area of the stop rail
15 104. The control rails 24a are thus used to signal to the switch control unit 30 via the detector rail 105 when a conveyor vehicle has moved into the associated switch means 22a, and it is furthermore used to bring the conveyor vehicle 10 to rest over the stop rail 104 on the
20 movable track section 26a. Once the conveyor vehicle 10 has been stopped, the movable track section 26a can be moved into its second position, shown by dashed lines, in order to facilitate further movement of the conveyor vehicle 10 on the sections of the auxiliary conveyor
25 track 16a and 16b.

The sections of the main and auxiliary conveyor tracks connected to the ports 0 to 3 of the switch means 22a likewise in each case have a stop rail 104 and a detector rail 106. The detector rails 106 are used, on
30 the one hand, for detecting the presence of a conveyor vehicle 10 on the relevant conveyor track by means of the downstream detector- and control means 76 of the associated switch control unit 30. In addition, the receiving means 52 of the switch control unit 30 reads in the
35 code number of the conveyor vehicle 10 via the detector rail 106. The stop rail 104 is used in the same way as the corresponding stop rail 104 of the movable track section 26a to detect the presence and to stop a conveyor

vehicle 10. Since each conveyor track in the area of the respective port 0 to 3 of the switch means 22a in each case has a stop rail 104 and a detector rail 106, it is possible to prevent the transportation of a conveyor vehicle 10 into the switch means 22a as long as there is already a conveyor vehicle 10 in the switch means 22a; in this case, the switch control unit 30 is informed at all times about the presence and the code numbers of the conveyor vehicles 10 which are ready to move into and to leave the switch means 22a.

In conjunction with the movement of the conveyor vehicle 10 from the movable track section 26a onto one of the branching sections 16a and 16b of the auxiliary conveyor track, the polarity reversing relay 32 (c.f. Figure 1) is used to set the desired voltage polarity on the power supply rails 20a of the movable track section 26a such that the conveyor vehicle 10 can leave the switch means 22a in a different direction, namely on the section 16a or on the section 16b.

The exemplary embodiment of the conveyor system shown schematically in Figure 10 is used in the following text to explain the method of operation of the conveyor systems according to the invention. In the exemplary embodiment shown, six stations A to F are provided for sending and/or receiving conveyor vehicles 10; in each case one sending/receiving control unit 28a to 28f is allocated to each sending/receiving station A to F. The conveyor system furthermore contains nine switch means 22a to 22i which are respectively connected to a dedicated switch control unit 30a to 30i for controlling and monitoring the movement sequence of the conveyor vehicles 10.

Some of the switch means 22 are used for different functions. Switch means 22e and 22i are thus intended exclusively for diverting the movement direction of the conveyor vehicles 10 at each end of the main conveyor track 14. The main conveyor track 14 consists of two parallel directional tracks, along which the conveyor

vehicles 10 move in an opposite direction in each case. Each conveyor vehicle 10 which moves into one of the two switch means 22e or 22i is transferred with the aid of the respective movable track section 26e or 26i from one
5 directional track into the other directional track of the main conveyor track 14.

The switch means 22a, 22f and 22g are used, inter alia, to divert the conveyor vehicle 10 onto a curved conveyor track 16a, 16d or 16e. The conveyor vehicle 10
10 can move in both directions on each of the curved conveyor tracks 16a, 16d and 16e, either from the corresponding switch means 22a, 22f or 22g to a turning/receiving station A, D or E, or in the reverse direction from one of the sending/receiving stations A, D or E to the
15 corresponding switch means 22a, 22f or 22g. This means that the switch means 22a can send conveyor vehicles 10 both to the sending/receiving station A as well as receiving said vehicles from said station. Likewise, the switch means 22f is used both for sending conveyor
20 vehicles 10 to the sending/receiving D and for receiving the conveyor vehicles 10 from this station D. In addition, station D is used in the exemplary embodiment shown of the conveyor system according to the invention for temporary parking of specific conveyor vehicles 10. In a
25 corresponding manner, the standard exit port (SX) of the switch means 22f is allocated to the port 2 which is connected to station D. As long as no other port of the switch means 22f is selected as the standard exit port (SX), all the conveyor vehicles 10 moving into the switch
30 means 22f are sent to station D. This fact is explained in more detail later. The switch means 22g is used in turn for sending or receiving conveyor vehicles 10 to or from the sending/receiving station E, via the curved conveyor track 16e.

35 In addition to the curved conveyor tracks 16a, 16d and 16e, the conveyor system shown in Figure 10 also contains auxiliary conveyor tracks 16b, 16c and 16f which permit conveyor vehicle transportation in only one

direction. These auxiliary conveyor tracks 16b, 16c and 16f are used to forward the conveyor vehicles 10 from the respective switch means 22a, 22d and 22h respectively in a direction towards the sending/receiving stations, so that these stations, which receive the conveyor vehicles 10 from this one direction, can also forward the conveyor vehicles only in the same direction. In detail, as already described, the switch means 22a is connected via the curved conveyor track 16a to the station A and is additionally connected via a section of the auxiliary conveyor track 16b to the sending/receiving station B for receiving the conveyor vehicles 10. The switch means 22d permits the transportation of the conveyor vehicles 10 via the auxiliary conveyor track 16c to the station C, and the switch means 22h is connected via a section of the auxiliary conveyor track 16f to the sending/receiving station F which receives the conveyor vehicles 10 from the switch means 22h. In order to transport the conveyor vehicles 10 from the stations B, C and F to in each case one switch means, the switch means 22c and 22g are in each case connected via sections of the auxiliary conveyor tracks 16b and 16f respectively to the stations B and F respectively, while the switch means 22d is connected to the station C for both receiving and sending out the conveyor vehicles 10 via the auxiliary conveyor track 16c.

Furthermore arranged in the course of the main conveyor track 14 is the switch means 22b which has two mutually parallel track sections 22b and 22b', which can move simultaneously. The two movable track sections 22b and 22b' are in this case mounted displaceably between the ports 0 to 3 of the switch means 22b in such a manner that the track section designated 26b can be displaced from a position aligned with ports 1 and 3 into a position between the ports 0 and 2, and the other track section 26b' is simultaneously displaced from a position between the ports 0 and 2 to the position shown in dashed lines. With the aid of this switch means 22b it is

possible to divert a conveyor vehicle 10 from one respective directional track of the main conveyor track 14 onto the other respective directional track, so that this provides the capability to shorten the movement route and the movement time of a conveyor vehicle 10 from one station to another station. For example, if a conveyor vehicle 10, which has station E allocated to it as the destination address, is sent from station A, the conveyor vehicle 10 moving into the movable track section 26b' between the ports 1 and 3 of the switch means 22b, is displaced between ports 0 and 2 so that the conveyor vehicle 10 can pass out from this position via the switch means 22g to the station E. If this were not the case, the conveyor vehicle 10 would also have to pass through switch means 22c, 22d, 22e and 22f on its route to station E.

With reference to the switch means 22e and 22i on the ends of the main conveyor track 14, it should be noted that it is also possible for the directional tracks of the main conveyor track 14 to be guided into one another at their ends, in each case in a semicircle, so that the two directional tracks of the main conveyor track 14 in this way form a closed loop. In this case, the two switch means 22e and 22i may be omitted. It is furthermore also not necessary for the two directional tracks of the main conveyor track 14 to run parallel side-by-side, as shown in Figure 10; to be precise, it may be advantageous in accordance with the respective spatial requirements for the directional tracks to be guided in a loop shape at a great distance from one another.

In the exemplary embodiment shown of the conveyor system according to the invention, the switch means 22 are used for connecting the auxiliary conveyor tracks to the main conveyor track 14. Within the context of the invention it is furthermore also possible to connect complete conveyor track systems to the main conveyor track 14 or to one another with the aid of the switch

means 22. No limitations relating to the control and monitoring of the conveyor system according to the invention result from this.

In conjunction with the input of information to
5 the central control unit 34, which is required for configuration of the conveyor system according to the invention, a conveying route list 110 is entered in the memory of the central control unit 34. Figure 11 shows
10 such a conveying route list 110 relating to the exemplary embodiment of the conveyor system according to the invention shown in Figure 10. The conveying route list 110 contains all the sending or receiving stations A to F and all the switch means 22a to 22i of the conveyor system according to Figure 10, the rows being allocated to the
15 sending/receiving stations A to F, and the columns of the conveying route list 110 being allocated to the switch means 22a to 22i. In order to store the necessary conveying route information for a conveyor vehicle 10 on the route to its destination station, the number of each port
20 0 to 3, used as the exit for the conveyor vehicle 10 of those switch means 22a to 22i through which the conveyor vehicle 10 passes on the route to the destination station is entered in each case in the row of the station which is used respectively as the destination. In this case,
25 only those switch means 22 are entered in the conveying route list 110, together with their ports 0 to 3 which are used as the exit for the conveyor vehicle 10 in which another port is defined as the exit for the conveyor vehicle 10 on its route to the destination station than
30 the respective standard exit port (SX). The conveying route list 110 is produced from the viewpoint of defining a shortest possible conveying route for the conveyor vehicle 10 on the route to its receiving station taking into account the switch means 22 with which the conveyor
35 vehicle 10 comes into contact and whose port which is used as the exit for the conveyor vehicle 10 is different from the respective standard exit port (SX). The content of the conveying route list 110 is in this case

independent of the station from which the conveyor vehicle 10 has been sent out.

In accordance with the conveying route list 110, a conveyor vehicle 10 to which the station B (c.f. Figure 10) is allocated as the destination address must therefore leave the switch means 22f at port 1 rather than at the standard exit port 2, the corresponding movable track section 26f being displaced into a position aligned with the port 1 by the associated switch control means 30f. If this conveyor vehicle 10 enters the area of the switch means 22b from the right, the associated switch control unit 30b will preferably define the port 0 as the exit for the conveyor vehicle 10 and not the standard exit port 3. Likewise, the conveyor vehicle 10 with station B as the destination address will not leave the switch means 22a at the standard exit port 2 but the conveyor vehicle 10 is instead controlled to leave the switch means 22a by means of the movable track section 26a being moved into a position aligned with port 3. In the other switch means 22 through which the conveyor vehicle 10 passes on its route to the destination station B, the respectively associated switch control means 30 controls the respective movable track section 26 in such a manner that the conveyor vehicle can leave the respective switch means 22 at its standard exit port (SX).

The following text explains the movement of a conveyor vehicle 10 from a sending station to a receiving station, using an example. In this case, it is assumed that station B contains a conveyor vehicle 10 which is intended to be sent to station E. First of all, the user of the conveyor system enters the address of the receiving station E into the sending/receiving control unit 28b allocated to the sending station B. This address information is received by the switch control means 30a, via which the sending/receiving control unit 28b is connected to the central control unit 34. If the receiving station E is ready to receive the conveyor vehicle 10, the central control unit 34 passes to the switch control unit

30a corresponding information relating to the sending of the conveyor vehicle 10. As soon as the conveyor vehicle 10 leaves the sending station B, its code number is detected via the detector rail 106 of the auxiliary conveyor track 16b, indicated by a dot in Figure 10. The code number is transmitted via the switch control unit 30a to the central control unit 34, together with the sending address of the sending station B. It is furthermore assumed that the conveyor system shown in Figure 10 is able to control and monitor 16 individual conveyor vehicles 10 and that the conveyor vehicle 10 sent to the receiving station E has the code number 13.

The central control unit 34 now accesses the conveying route list 110 stored in its memory in order to define the desired conveying route of the conveyor vehicle 10 having the code number 13 to the station E. At the station E, as the receiving station, the conveying route list 110 contains the instruction to allocate to the conveyor vehicle 10 the port 0 in the switch means 22b as the exit. This instruction is signalled to the switch control unit 30b by the central control unit 34. In a corresponding manner, the switch control units 30f and 30e in each case receive from the central control unit 34 the instruction, based on the conveying route list 110, to control the associated switch means 22f and 22g respectively such that the conveyor vehicle 10 having the code number 13 in each case leaves them at the port 1 or 2 respectively. The switch control unit 30g thus contains the information that the conveyor vehicle 10 having the code number 13 will reach the receiving station E if it leaves the switch means 22g at its port 2. On its route to station E, the conveyor vehicle 10 having the code number 13 will also pass through switch means 22c, 22d and 22e, the associated switch control units 30c, 30d and 30e defining the respective standard exit port (SX) as the exit for the conveyor vehicle 10.

In conjunction with the instructions received from the central control unit 34, the switch control

units 30b, 30f and 30g store the respective number of the port used as the exit for the conveyor vehicle 10 of the associated switch means 22b, 22f and 22g respectively in the output control list 40 (c.f. Figure 3), which is
5 respectively loaded in their memories, in the row for the conveyor vehicle 10 having the code number 13. In the list locations for the individual conveyor vehicles 10 in which there is no port number entered a substitute code word is stored instead, which designates the respective
10 standard exit port of the relevant switch means 22.

When the conveyor vehicle 10 having the code number 13 leaves the sending station B, the switch control unit 30a emits a response signal containing the code number 13 of the conveyor vehicle 10 to the central
15 control unit 34. As has already been shown in Figure 4, this response signal contains a number of information Bytes of which Byte 4 contains the code number 13 of the conveyor vehicle 10, Byte 6 contains the address of the receiving station E and Byte 1 contains the address of
20 the switch means 22a or of the switch control unit 30a which is allocated to it and emits the response signal. When the conveyor vehicle 10 having the code number 13 reaches the switch means 22c, the associated switch control unit 30c accesses the output control list 40
25 stored in it and removes therefrom the information that the standard exit port 2 must be allocated to the conveyor vehicle 10 located in the switch means 22c as the exit to the main conveyor track 14. This determination takes place by interrogating the code bit 6 in the row
30 for the conveyor vehicle 10 having the code number 13 of the output control list 40, a value 0 of the code bit indicating that the standard exit port (SX) is provided as the exit for the conveyor vehicle 10. For its part, the switch control unit 30c now emits to the central
35 control unit 34 sending information having the data format shown in Figure 4 which signals, in Bytes 3 and 4, to the central control unit 34 that the relevant switch control unit 30c designated in Byte 1 has confirmed the

presence of a conveyor vehicle 10 having the code number 13. In a corresponding manner, the switch control units 30d and 30e control the switch means 22d and 22e allocated to them in such a manner that the conveyor vehicle 10 having the code number 13 leaves both switch means 22d and 22e in each case via their standard exit ports 2 and 0 respectively.

In the switch means 22f and 22b, the associated switch control units 30f and 30b determine, from the output control lists 40 stored in them, that the port 1 of the switch means 22f and the port 0 of the switch means 22b are used as the exit for the conveyor vehicle 10 having the code number 13, rather than the respective standard exit port (SX). The switch control units 30f and 30b correspondingly control the movable track sections 26f and 26b respectively of the switch means 22f and 22b respectively such that they are aligned with the ports defined as the exits.

As soon as the conveyor vehicle 10 having the code number 13 reaches the switch means 22g, the output control list 40 indicates in the memory of the associated switch control unit 30g for the code number 13 that the relevant conveyor vehicle 10 is to be diverted to port 2. Before the conveyor vehicle 10 having the code number 13 moves into the switch means 22g, it is identified via the detector rail 106 on the section of the main conveyor track 14 connected to the port 3 and the arrival of the conveyor vehicle 10 is signalled to the central control unit 34. Until now, the central control unit 34 has monitored the complete movement sequence of the conveyor vehicle 10 having the code number 13 with the aid of the sending information received and emitted by it in the data formats specified in Figure 2 and Figure 4. Once the transfer of the conveyor vehicle 10 from the sending station B to the receiving station E has been completed, the central control unit 34 interrupts the execution of the program section running at that time in it and emits to the switch control units 30b, 30f and 30g the

instructions that, in the respective output control lists 40, the information values designating the respective exit for the conveyor vehicle 10 having the code number 13 are to be replaced by corresponding information values which designate the standard exit ports (SX) of the respective allocated switch means 22b, 22f and 22g.

The control sequence for the movement of two different conveyor vehicles 10 to and from a common switch means 22 is described in the following text using a further example. In this case it is assumed that the two conveyor vehicles 10 have the code numbers 7 and 12 and move on the main conveyor track 14 together in the direction towards the switch means 22a. A further precondition is that the destination address of station C is allocated to the conveyor vehicle 10 having the code number 7 and that the conveyor vehicle 10 having the code number 12 has station A as the destination, which station is connected via the curved conveyor track 16a to the switch means 22a. A final precondition is that the conveyor vehicle 10 having the code number 7 moves on the main conveyor track 14 in front of the conveyor vehicle 10 having the code number 12. As soon as the conveyor vehicle 10 having the code number 7 passes into the section of the main conveyor track 14 directly in front of the port 0 of the switch means 22a, the detector- and control means 76 in the switch control unit 30a detects, via the stop rail 104 (c.f. Figure 9) the presence of the conveyor vehicle 10 having the code number 7 directly in front of the port 0 and produces a stop signal for the stop rails 104 of those conveyor track sections which are connected to the other ports of the switch means 22a which are used as entries. In the case of the switch means 22a, only port 1 is used as a further entry, so that the switch control unit 30a produces a stop signal on the stop rail 104 of the section of the curved conveyor track 16a connected to port 1. Since the switch means 22 can in each case hold only a single conveyor vehicle 10, the entry of further conveyor vehicles 10

into the switch means 22a is prevented by the stop signal on the stop rail 104 as long as the conveyor vehicle 10 having the code number 7 is located in the switch means 22a. In the case of the switch means 22a, this has the
5 consequence that each conveyor vehicle 10 which is sent out from station A is stopped in front of port 1 of the switch means 22a.

As soon as the conveyor vehicle 7 reaches the subsequent detector rail 106 in front of port 0 of the
10 switch means 22a, after moving over the stop rail 104 on the main conveyor track 14, the associated switch control unit 30a also produces a stop signal for the stop rail 104 over which the conveyor vehicle 10 having the code number 7 has just moved, so that the subsequent conveyor
15 vehicle 10 having the code number 12 is held on the stop rail 104 until the conveyor vehicle 10 having the code number 7 has left the switch means 22a. As has already been explained above with reference to the conveyor vehicle 10 having the code number 13, the receiving means
20 52 in the switch control unit 30a reads in, via the detector rail 106, the code number 7 emitted by the transmitting means 44 of the conveyor vehicle 10. On the basis of the detected code number 7, the switch control unit 30a determines from the output control list 40
25 stored within it that port which is defined as the exit for the conveyor vehicle 10 having the code number 7. Since station C is allocated as the destination address to the conveyor vehicle 10 having the code number 7, in this case the standard exit port (SX) of the switch means
30 22a is used as the exit. This information results from the code bit 6 in the output control list 40 which indicates by means of a 0 as the information value that the corresponding conveyor vehicle 10 has the standard exit port (SX) allocated to it as the exit for leaving
35 the switch means 22a. Since the movable track section 26a of the switch means 22a is located in its quiescent position between the ports 0 and 2, the conveyor vehicle 10 having the code number 7 moves through the switch

means 22a without stopping and leaves it at port 2 on the route to its destination station C.

5 Via the detector rail 106 of the section of the main conveyor track 14 connected to the port 2 of the switch means 22a, the switch control unit 30a detects the time at which the conveyor vehicle 10 having the code number 7 has left the switch means 22a and in this way recognises that the control of the conveyor vehicle 10 having the code number 7 has terminated in the area of the switch means 22a. This is followed by the switch control unit 30a interrogating the stop rails 104 of the conveyor track sections connected to the ports which are used as inputs for the presence of further conveyor vehicles 10. In the case of the example considered here, 10 switch control unit 30a detects the presence of the further conveyor vehicle 10 having the code number 12 on the stop rail 104 of the section of the main conveyor track 14 which is connected to the port 0. The switch control unit 30a now cancels the stop signal on the stop rail 104 so that the conveyor vehicle 10 having the code number 12 continues its movement via the port 0 onto the movable track section 26a of the switch means 22a. At the same time, the conveyor vehicle 10 having the code number 12 moves over the detector rail 106, mounted in front of the port 0, on the main conveyor track 14, the switch control unit 30a - in the same way as has already been described above for the conveyor vehicle 10 having the code number 7 - sending a stop signal to the stop rail 104 located in front of the detector rail 106 and reading in the code number 12 of the relevant conveyor vehicle 10, via the detector rail 106. On the basis of the detected code number 12, the switch control unit 30a determines from the output control list 40 stored within it that port which is defined as the exit for the conveyor vehicle 10 having the code number 12. Since the conveyor vehicle 10 having the code number 12 has station A allocated to it as the destination address, in the case of the example described here, the port 1 is used as the

exit for the conveyor vehicle 10. It is thus necessary to
displace the conveyor vehicle 10 to the port 1, with the
aid of the movable track section 26a. As soon as the
conveyor vehicle 10 having the code number 12, which has
5 moved into the switch means 22a, reaches the stop rail
104 on the movable track section 26a, the switch control
unit 30a detects the presence of the conveyor vehicle 10
and emits a stop signal to stop the conveyor vehicle 10.
On this basis, the switch control unit 30a drives the
10 movable track section 26a from the position which is
aligned with the ports 0 and 2 into a new position which
is aligned with the ports 1 and 3 and is shown by dashed
lines here. As soon as the movable track section 26a is
located in this new position, the switch control means
15 30a drives the polarity reversing relay 32 to reverse the
polarity of the supply voltage on the power supply rails
20a of the movable track section 26a, so that when the
stop signal on the stop rail 104 is cancelled, the
conveyor vehicle 10 having the code number 12 leaves the
20 switch means 22a at its port 1. At the same time, the
conveyor vehicle 10 moves over the detector rail 105 of
the movable track section 26a and subsequently over the
detector rail 106 and the stop rail 104 of the section of
the curved conveyor track 16a connected to the port 1.
25 In this case, the switch control unit 30a detects, via
the stop rail 104, the time at which the conveyor vehicle
10 having the code number 12 leaves the switch means 22a
and in this way recognises the control of the conveyor
vehicle 10 having the code number 12 as being completed
30 in the area of the switch means 22a. After this, the
switch control unit 30a drives the movable track section
26a back to its quiescent position between the ports 0
and 2 again and ends the drive to the polarity reversing
relay 32, so that the movement direction of the conveyor
35 vehicle 10 on the movable track section 26a is once again
defined running from left to right in the direction
towards the standard exit port (SX) of the switch means
22a. Thereafter, the switch control unit 30a once again

interrogates the stop rails 104 of the conveyor track sections connected to the ports which are used as entries for the presence of further conveyor vehicles 10 in order to drive these, if applicable, through the switch means 22a successively, as described above.

If the user of the conveyor system according to the invention wishes to send another conveyor vehicle 10 out from station A once the presence of the conveyor vehicle 10 having the code number 12 has been confirmed by the switch control unit 30a, the central control unit 34 thus defers the evaluation of the sending information (c.f. Figure 4) transmitted from the sending/receiving control unit 28a via the switch control unit 30a to the central control unit 32 until the central control unit 32 has confirmed that the conveyor vehicle 10 which is ready to be sent in the station A is intended to be the next in the sequence of the conveyor vehicles 10 to be driven through the switch means 22a.

A further control function of the central control unit 34 is used to prevent the sending out of additional conveyor vehicles 10 into the conveyor system if a maximum permissible number of conveyor vehicles 10 circulating in the conveyor system has been signalled to the central control unit 34 by the user. In this case, the central control unit 34 rejects all sending information items emitted by the sending/receiving control units 28, which contain a request to send conveyor vehicles 10 out.

In addition to controlling the movement of the individual conveyor vehicles 10 through the conveyor system according to the invention, the central control unit 34 is equipped with a multiplicity of further monitoring functions. A first monitoring function relates to the detection of the mean time which a conveyor vehicle 10 requires for its movement from one switch means 22 to another switch means 22. In order to confirm whether a conveyor vehicle 10 is moving correctly along the main conveyor track 14 to its destination address,

the central control unit 34 determines whether a conveyor vehicle 10 requires an above-average movement time between two switch means 22. For this purpose, the central control unit 34 stores in its memory information concerning the movement sequences of the individual conveyor vehicles 10. This information comprises, in particular, the address of the sending and receiving stations allocated to the respective conveyor vehicles 10, the code numbers of the individual conveyor vehicles 10, and the movement time consumed in each case by the conveyor vehicles 10. In order to detect the movement time of the conveyor vehicles 10 between any two switch means 22, the central control unit 34 in each case contains a counter for each conveyor vehicle 10, which counter is reset whenever the conveyor vehicle 10 leaves a switch means 22. The detection of the moment at which a conveyor vehicle 10 leaves a switch means 22 has already been described comprehensively above. The central control unit 34 continuously compares the counter state of each individual counter with a given time value in each case. If the counter state exceeds the given time value, the central control unit 34 emits an fault message together with the code number of the respective conveyor vehicle 10, for the user of the conveyor system. The given time value is preferably selected to be somewhat greater than the time interval which a conveyor vehicle 10 requires for its route between the switch means 22 which are furthest away, or the detector rails 18 or the control rails 24.

An extension of the previously described monitoring function of the central control unit 34 relates, in conjunction with the above-described detection of the movement time of the conveyor vehicles 10 between two switch means 22 in each case, to the determination of the approximate position of the respective conveyor vehicle 10 in the conveyor system at the time when the counter state exceeds the given time value. This takes place in that the central control unit 34 also stores the address

of the respectively last switch means 22 through which the conveyor vehicle 10 has moved before the fault message occurs. On the basis of this additional information, the user of the conveyor system is able to search
5 for the relevant conveyor vehicle 10 in the conveyor system in the event of a fault.

A second monitoring function of the central control unit 34 detects the dwell time of each individual conveyor vehicle 10 in the conveyor system from the time
10 when it is sent out from a sending station. For this purpose, the central control unit 34 contains one further counter in each case for each conveyor vehicle 10 to be monitored, which counter is reset as soon as the relevant conveyor vehicle 10 leaves the sending station. If the
15 dwell time of the conveyor vehicle 10 in the conveyor system reaches a given maximum time, the central control unit 34 authorises the output of a further fault message. The given maximum time is in this case selected to be slightly greater than the maximum time to be expected
20 which a conveyor vehicle 10 requires when the conveyor system is operating correctly for its route from a sending station to a receiving station.

This second monitoring function is used for detecting possible faults which would otherwise remain
25 undiscovered. In order to explain this situation, it is intended in the following text to make reference to the example which has already been described above, in which a conveyor vehicle 10 having the code number 13 is sent from station B to station E. It is assumed that, because
30 of some fault, the switch means 22g directs the conveyor vehicle 10 to the standard exit port 0 as the exit rather than to the port 2. In this case, the conveyor vehicle 10 having the code number 13 would circulate continuously on the main conveyor track 14 through the switch means 22a,
35 22b, 22g, 22h and 22i and the position of the conveyor vehicle 10 would be detected by the central control unit 34 at each of these switch means. In the case of this fault, after a certain time, the dwell time of the

conveyor vehicle 10 having the code number 13 exceeds the given maximum time in the conveyor system so that the central control unit emits a fault message together with the code number 13 for the user of the conveyor system.

5 In conjunction with this monitoring function, the central control unit 34 advantageously contains a program section which results in the conveyor vehicle 10 being driven back into its sending station. The return of the
10 respective conveyor vehicle 10 can be carried out very easily because the central control unit 34 contains in its memory the addresses of the sending stations from which the individual conveyor vehicles 10 have been sent out into the conveyor system. As a variation of this, it
15 is possible to allocate the address of the storage station D as the destination address to the conveyor vehicle 10 rather than sending the relevant conveyor vehicle 10 back to its respective sending station.

 A third monitoring function of the central control unit 34 relates to the detection of the total
20 occupancy time of all the conveyor vehicles 10 in the conveyor system. In this case, the total occupancy time corresponds to the sum of all the occupancy times of the individual conveyor vehicles 10. By means of this monitoring function, the user of the conveyor system receives
25 all the necessary information concerning the utilisation level of the conveyor system according to the invention.

 According to the invention, a further monitoring function of the central control unit 34 relates to the driving of conveyor vehicles 10 for the case where the
30 receiving station which is being respectively allocated to them via the destination addresses is completely filled with other conveyor vehicles 10 and thus is no longer ready to receive. In order to identify overloading of a station, each station has allocated to it in each
35 case a rail which is connected to the switch control unit 30 belonging to the station. If a conveyor vehicle 10 is located on such a rail, this indicates to the respective switch control unit 30 that the relevant station cannot

accept any further conveyor vehicles 10. In this case, the relevant station blocks the access of further conveyor vehicles 10 and diverts them. The conveyor vehicles 10 diverted in this way continue their movement and, if the occasion arises, reach their desired destination address. Via the relevant switch control unit 30, the central control unit 34 in each case receives the number of conveyor vehicles 10 diverted at the completely full station. In the central control unit 34, the respectively instantaneous number of diverted conveyor vehicles 10 is compared with a given figure and, if this figure is exceeded, the central control unit 34 may, for example, authorise further conveyor vehicles 10 on the route to the completely filled station to be returned to their respective sending stations.

According to the invention, the central control unit 34 carries out an additional monitoring function which is used to prepare a given number of conveyor vehicles 10 in each station of the conveyor system. For this purpose, the central control unit compares the number of conveyor vehicles respectively located instantaneously in a station with the given minimum number of conveyor vehicles 10 in each station. If the respectively instantaneous number of conveyor vehicles 10 in the station is less than the given number, the central control unit 34 automatically sends a corresponding number of further conveyor vehicles 10 to the station. For this purpose, the conveyor system according to the invention can have a storage station from which the conveyor vehicles 10 required to fill up the other stations can be called up.

In addition to the control and monitoring functions described above, the central control unit 34 of the conveyor system according to the invention also provides for the display of important information relating to the individual conveyor vehicles 10 whose movement driven in the conveyor system is being controlled, via a display unit 38 (c.f. Figure 1). The input keyboard 36 allows the

user to select the desired information to be displayed. This information includes the display of all conveyor vehicles 10 which are in motion, with their respective code numbers and their respective sending and receiving stations. Further information items of this type relate to the display of the movement times of the individual conveyor vehicles 10, the display of the respectively instantaneous stopping location of the individual conveyor vehicles 10 and the display of the respective operating states of the individual stations and switch means 22. The information concerning the operating states includes, for example, the display of whether a station has output turning information to the central control unit 34 relating to the sending out of a conveyor vehicle 10, or whether the entry and exit of the conveyor vehicles 10 takes place via the corresponding standard entry ports (SE) or standard exit ports (SX) respectively of the switch means 22.

Figures 12A to 12D show the flow diagrams for the control and monitoring functions of the central control unit 34 described above.

The invention relates to a computer-aided conveyor system having a number of conveyor vehicles for conveying various types of conveyed material from sending stations to receiving stations. The conveyor system according to the invention has a main conveyor track along which the conveyor vehicles are moved between individual stations. Branching off the main conveyor track are auxiliary conveyor tracks on which the conveyor vehicles are transported between the main conveyor track and the sending or receiving stations.

Switch means are provided on a section basis along the main conveyor track. Each switch means has four ports and a movable track section. The four ports form connecting points for sections of the main conveyor track and/or auxiliary conveyor track, with which the movable track section can be moved into an aligned position. The movable track section is used in this case as a

connecting element or joining element between the main conveyor track and an auxiliary conveyor track. For this purpose, the movable track section can be displaced into two positions such that it forms a part of the main conveyor track in the first position and a part of the auxiliary conveyor track in the second position.

Each switch means is connected to one switch control unit in each case. The individual switch control units are in turn connected to a central control unit which carries out control and monitoring functions corresponding to the invention. Additionally connected via the individual switch control units to the central control unit in each case are sending/receiving control units which are allocated to the respective auxiliary conveyor tracks and in which different sending and receiving stations are arranged. A dedicated code signal transmitter is allocated to each conveyor vehicle to control and monitor the movement of the multiplicity of conveyor vehicles by means of the central control unit.

The user of the conveyor system according to the invention inputs to the central control unit a receiving address for that sending/receiving station to which it is intended to send a conveyor vehicle via the main conveyor track. Using these two items of information, namely the receiving address (or destination address) and the conveyor vehicle code, the central control unit is able to control the movement of the conveyor vehicle along a desired conveyor track. As soon as the conveyor vehicle reaches a switch means on its route, the associated switch control unit uses the information received by the central control unit and stored by the switch control unit to displace the movable track section of the switch means into the desired position so that the conveyor vehicle can continue its route along the desired or selected conveyor track. For this purpose, the switch control unit determines the conveyor vehicle code and uses it to define the desired position of the movable track section. When the conveyor vehicle finally reaches

a switch means from which the auxiliary conveyor track connected to the receiving station branches off, the switch control unit drives the movable track section into a position in which the conveyor vehicle is moved onto the auxiliary conveyor track and which can reach the receiving station addressed by the receiving address.

In addition to the function of controlling the movement of the conveyor vehicles from the sending stations to the receiving stations, with the aid of the conveyor vehicle code, the central control unit together with the associated switch control units provides a multiplicity of other additional functions which are important to the operation of the conveyor system according to the invention. The central control unit is thus additionally used for preventing conveyor vehicles being sent out from a sending station when the addressed receiving station is not available. In addition, during movement of a conveyor vehicle, the central control unit automatically varies the given route if the receiving station is not ready to receive. Furthermore, the central control unit is used for monitoring the approximate position of each individual conveyor vehicle during its movement along the conveyor track. In addition, it is possible to detect the respective time which has elapsed since a conveyor vehicle which is moving in the conveyor system according to the invention was sent out from a sending station. The utilisation time of each individual conveyor vehicle in the conveyor system according to the invention can be determined in a corresponding manner. A further control function of the central control unit is to make available an adequate number of conveyor vehicles for each individual station. In addition, empty conveyor vehicles or conveyor vehicles whose code cannot be confirmed are driven to defined stations by the central control unit.

A multiplicity of advantages results directly from the above description of the conveyor system according to the invention. For example, efficient

transportation of one of a number of conveyor vehicles to the desired destination is made possible by the computer-aided conveyor system according to the invention. As a consequence of the use of code transmitters on the conveyor vehicles the possibility exists of controlling the movement of each individual conveyor vehicle on the basis of its conveyor vehicle code. The code transmitter can thus be fitted to the conveyor vehicles at only a small cost and can directly replace actuators for controlling the movement of the conveyor vehicle. In addition, the conveyor system according to the invention permits display and monitoring of the movement of the different conveyor vehicles with different destination directions, so that the user of the conveyor system is informed about the destinations of the different conveyor vehicles, their respectively instantaneous position and their conveying time in the conveyor system.



Claims

1. A method for controlling the movement of guided conveyor vehicles (10) in a conveyor system from sending stations along conveyor tracks (12) to receiving stations via switch means (22), in which, when a conveyor vehicle (10) is sent from a sending station to a receiving station, a destination address allocated to the receiving station is transmitted, together with a code number allocated to the conveyor vehicle (10), from a sending/receiving control unit (28) allocated to the sending station to a central control unit (34) and for each admission of a conveyor vehicle (10) running along a conveyor track (12), that address is identified by receiving a code signal transmitted by the vehicle and corresponding to its code number, in a switch control unit (30) which controls the respective switch means (22) and is connected to the central control unit, and in which the switch means (22) is controlled by the allocated switch control unit (30) as a function of the code number corresponding to the received code signal and of the allocated destination address for forwarding in the direction of the receiving station the conveyor vehicle (10) which arrives in the switch means (22), characterised in that the code signal of a conveyor vehicle (10) is in each case detected by means of a detector rail (105, 106) allocated to the switch means (22) via an electrical contact and is transmitted serially, as soon as said rail is passed over by a conveyor vehicle (10).

2. A method according to claim 1, characterised in that the route of the conveyor vehicles (10) is determined in each case by the switch means (22) as a function of the destination addresses of the receiving stations, by means of a conveying route list (110) stored in the central control unit (34).

3. A method according to claim 1 or 2, characterised in that ends of the conveyor tracks (12) connected to ports (PORT) of each switch means (22) are monitored for the appearance of a code signal transmitted by a conveyor



vehicle (10), and in that detected code signals are received by the switch control unit (50) and are transmitted to the central control unit (34).

4. A method according to claims 2 and 3, characterised in that the number of that port (PORT) of the respective switch means (22) which is used as the output for the conveyor vehicle (10) having the respective code number according to an output control list (40) stored in each switch control unit (30) is allocated by the central control unit (34) in each case to each code number of a conveyor vehicle (10) stored in each switch control unit (30).

5. A method according to one of the preceding claims, characterised in that each switch means (22) receives the code signal of a conveyor vehicle (10) located in the switch means, on a track section (26) which can be moved between two ports (PORT).

6. A method according to one of claims 3 to 5, characterised in that, on the ends of the conveyor tracks (12) connected to the ports (PORT) of a switch means (22), the presence of conveyor vehicles (10) is detected by means of stop rails (104) which are arranged further from the respective port (PORT) than the detector rails (106).

7. A method according to claim 6, characterised in that conveyor vehicles (10) which have arrived on the stop rails (104) are stopped by the switch control unit (30), by sending a stop signal to the stop rails (104), as long as a conveyor vehicle (10) is in the switch means (22).

8. A method according to one of the preceding claims, characterised in that, together with the code number of each individual conveyor vehicle, the address of the sending station sending the vehicle is stored in a memory in the central control unit (34), and in that the respective destination address of a conveyor vehicle (10) is replaced by the address of the corresponding sending station in order to send the conveyor vehicle



(10) back to the sending station, if necessary.

9. A method according to one of the preceding claims, characterised in that a conveyor vehicle (10) to be sent from a sending station is prevented from leaving the sending station by sending a stop signal to a stop rail located at the exit of the sending station, if the receiving station addressed by the destination address is not ready for reception.

10. A method according to one of claims 1 to 8, characterised in that the destination address allocated to a conveyor vehicle (10) to be sent is replaced by the address of a storage station, if the receiving station determined by the destination address is not ready for reception, and in that the conveyor vehicle (10) is moved to the storage station.

11. A method according to one of the preceding claims, characterised in that the time required by a conveyor vehicle (10) for running from one switch means (22) to another switch means (22) is detected by the central control unit, and in that a fault message is produced by the central control unit (34) if the detected time exceeds a given time period.

12. A method according to one of the preceding claims, characterised in that the dwell period for each individual conveyor vehicle (10) in the conveyor system is detected by the central control unit from the moment of the vehicle being sent from a sending station, and in that a fault message is produced by the central control unit (34) if the dwell period exceeds a given maximum duration.

13. A method according to one of the preceding claims, characterised in that the instantaneous number of conveyor vehicles (10) respectively located in the receiving stations is detected by the central control unit (34), and in that the sending of a conveyor vehicle (10) from a sending station to a receiving station is prevented if the number of conveyor vehicles (10) located in the receiving station exceeds a given value.



14. A conveyor system for carrying out a method according to Claim 1, having guided conveyor vehicles (10) whose movement from sending stations along conveyor tracks (12) to receiving stations via switch means (22) is controllable, in which each sending station is connected, in each case via a sending/receiving control unit (28) allocated to that station, to a central control unit (34) for transmitting a destination address, which is allocated to the receiving station, for a conveyor vehicle (10) which is to be sent, in which in each case one switch control unit (30) is allocated to each switch means (22) for controlling it, characterised in that each conveyor vehicle (10) contains a code signal transmitter (44) for serial transmission of a code signal, in that there are receiving elements (24) in the area of each switch means (22) for receiving the code signal of a conveyor vehicle (10) located in the respective area, in that the receiving elements (24) consist of detector rails (105, 106) arranged in the area of the switch means (22) in the course of the conveyor tracks (12), and in that, in each conveyor vehicle (10), a sliding contact in each case connected on the exit side to the code signal transmitter (44) is connected in such a way that it makes contact with the detector rail (105, 106) when passing over the latter and such that the receiving elements (24), together with the corresponding switch control unit (30), are connected to the central control unit (34) for controlling the movement of the conveyor vehicles (10).

15. A conveyor system according to claim 14, characterised in that each end of the conveyor tracks (12) connected to in each case a port (PORT) of a switch means (22) has a detector rail (106).

16. A conveyor system according to claim 14 or 15, characterised in that each switch means (22) has in each case one track section (26) which can be moved between two positions, said track section being aligned with in each case two ports of the switch means (22) in each position, and in that the movable track section (26) also



has a detector rail (105).

17. A conveyor system according to one of claims 14 to 16, characterised in that the code signal transmitter (44) in each conveyor vehicle (10) contains an address switch (42) connected to the output of the code signal transmitter (44) via a parallel/serial data converter (46).

18. A conveyor system according to claim 17, characterised in that each switch control unit (22) contains a receiving means (52) having a comparator (54, 56, 58) whose input side is connected to the detector rails, and whose output side is arranged downstream of a serial/parallel data converter (60).

19. A conveyor system according to one of claims 14 to 19, characterised in that each detector rail (105, 106) is in each case a component of a control rail (24) with an additional stop rail (104), in that the stop rail (104) is firmly connected to a detector- and control means (76) of the switch control unit (22) and a stop signal (STOP) can be sent to the stop rail via said means, in that each conveyor vehicle (10) has a further sliding contact, and in that the further sliding contact is connected to a drive control means (64) for stopping and starting the movement of the conveyor vehicle (10).

20. A conveyor system according to claim 19, characterised in that, on the ends of the conveyor tracks (12) connected to the ports (PORT) of a switch means (22), the respective detector rail (106) is connected closer to the relevant port (PORT) than the associated stop rail (104).

21. A conveyor system according to claim 19 or 20, characterised in that the detector- and control means (76) of each switch control unit (22) in each case contains a threshold voltage detector (78, 82, 84) whose input side is connected to the stop rails (104) and an output of which transmits a detector signal (DETECT) if a conveyor vehicle (10) is present on the respective stop rail (104).



22. A conveyor system according to claim 21, characterised in that, in each conveyor vehicle (10), the driving means (64) has in each case an internal resistance (86) connected to the further sliding contact, and
5 in that in each switch control means (22), the detector- and control means (76) has a resistor (84) connected to the respective stop rails (104) in such a way that, when the further sliding contact makes contact with the respective stop rail (104), the internal resistance (86)
10 of the driving means (64) and the resistor (80) of the detector- and control means (76) form a voltage divider, to the voltage tap of which the input of the threshold voltage detector (78, 82, 84) is connected.

23. A conveyor system according to one of claims 14
15 to 22, characterised in that each switch control means (22) contains an electronic memory, connected to the central control unit (34), to store information for controlling the allocated switch means (22) as a function of the code number of the respective conveyor vehicle
20 (10).

24. A conveyor system according to claim 23, characterised in that the central control unit (34) contains a memory for storing a conveying route list (11) having given conveying routes for different receiving stations.

25. A conveyor system according to one of claims 14
25 to 24, characterised in that the central control unit (34) has a display unit (38) for monitoring the movement of the conveyor vehicles (10) in the conveyor system.