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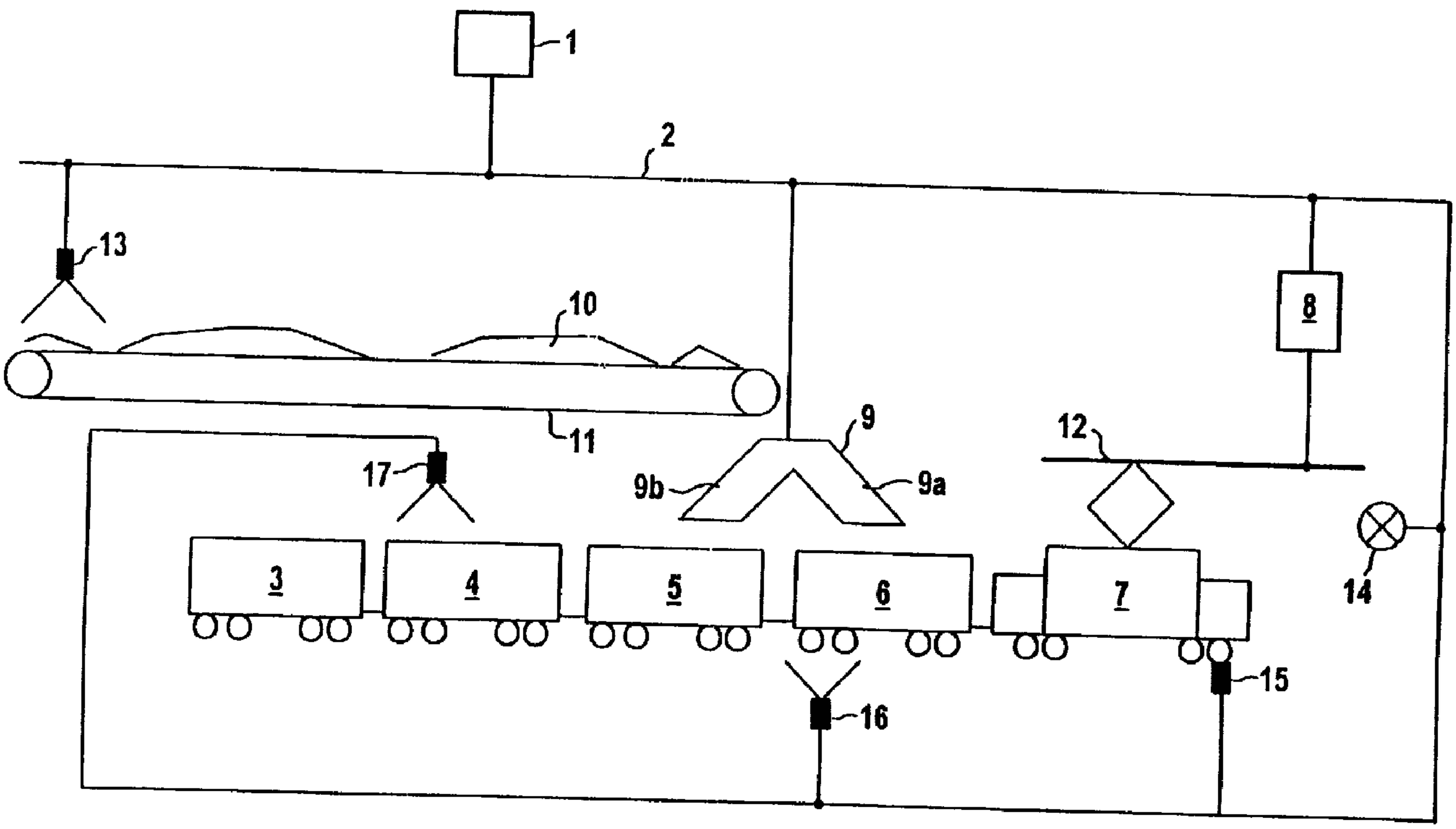
(54) Titre : INSTALLATION DE CHARGEMENT DESTINEE AU CHARGEMENT D'UN PRODUIT EN VRAC DANS UN MOYEN DE TRANSPORT

(54) Title: LOADING PLANT FOR LOADING A MEANS OF TRANSPORT WITH BULK MATERIAL



(57) Abrégé/Abstract:
The invention relates to a loading plant for loading a means of transport, in particular a train or a truck, with bulk material, the loading plant having a loading device for tipping the bulk material into the transportation container. The loading plant has a computer for automatically controlling the loading device and the means of transport, a model of the means of transport being implemented on the computer.

GR 97 P 3936 P

Abstract

Loading plant for loading a means of transport with bulk material

The invention relates to a loading plant for loading a means of transport, in particular a train or a truck, with bulk material, the loading plant having a loading device for tipping the bulk material into the transportation container. The loading plant has a computer for automatically controlling the loading device and the means of transport, a model of the means of transport being implemented on the computer.

Figure 1

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Description

Loading plant for loading a means of transport with bulk material

The invention relates to a loading plant for loading a means of transport having at least one transportation container, in particular a train or a truck, with bulk material, the loading plant having a loading device for tipping the bulk material into the transportation container, the loading plant having at least one computer to automatically control the loading device as a function of the amount of bulk material tipped out from the loading device.

Loading plants are an important part of modern bulk handling plants. These loading plants can be used for loading bulk goods or bulk materials onto freight cars or trucks.

Loading plants of the type mentioned at the beginning are disclosed in DE 33 32 274 A1 and DE-A 27 04 726 and also in the article "Wägeanlagen mit rechnergesteuertem Funktionsablauf [Weighing plants having a computer-controlled operational sequence]" by K. Homilius, INDUSTRIE-ELEKTRIK + ELEKTRONIK, Vol. 12, 1967, p. 498 to 500. In this case, use is already made of a computer.

A disadvantage of the known loading plants is, inter alia, the fact that loading plants of this type are very expensive and complicated in design. In this case, it is very complicated to arrange a weighing machine below a means of transport if means are provided at the same time for transporting away bulk material which has been spilled. In addition, only a very imprecise filling of the means of transport can be carried out in this manner.

DD 240 877 A1 discloses a loading arrangement for automatically loading freight trains whose freight cars are loaded from a loading chute to which the goods to be conveyed are delivered by a continuous conveyor which can be switched off, in particular for coal trains whose E-locomotives are equipped with a train-hauling system. In this arrangement, a filling-level monitoring means is provided in addition to a weighing machine, which means that this solution is also particularly complicated. Furthermore, US 4 659 274 A discloses a computer-controlled system for loading railroad trains with coal, in which the continuation of the interconnected train after individual freight cars are filled is ensured via the computer.

DE 44 03 893 A1 discloses a loading arrangement for filling loading containers with a flow of material, in particular for harvesting machines, there being arranged on an ejection pipe at least one visual and/or acoustic distance meter for measuring the loading container and for measuring filling-level heights of the filling material on the loading container. It turns out that solutions of this type are unsuitable for determining the filling height in a means of transport because of dirt accumulation and the formation of dust.

According to loading arrangements as disclosed in US Patent 4 460 308 and in DE 196 00 971 C1, bulk material for loading onto a means of transport is temporarily stored in hoppers, so that the corresponding filling amount for a transportation container is established by the loading of individual or a number of hoppers. However, because of the hoppers a loading arrangement of this type is very complicated and expensive. In addition, flexible loading, in particular in the case of different types of means of transport and for loading means of transport which have already been preloaded, is not possible.

DD 215 992 A1 discloses a loading direction in which the material flow in a transportation container is controlled as a function of the mass flow pouring in. In this case, a time-delay arrangement is provided. A particularly disadvantageous feature of this process is that the influx of material transportation containers is not subjected to a closed-loop control, but merely to an open-loop control. Since the actual filling level in the transportation container is not monitored, a loading arrangement of this type is not suitable for loading means of transport in an optimum manner.

Starting from the prior art which has been dealt with individually, it is the object of the invention to specify a loading plant of the type mentioned at the beginning which makes it possible to lower the operating costs in comparison with known loading plants. In addition, it is desirable to achieve a particularly rapid and/or optimum filling of the transportation containers.

According to the invention, the object is achieved by a loading system of this type for loading a means of transport having at least one transportation container, in particular a train or a truck, with bulk material, the loading plant having a loading device for tipping the bulk material into the transportation container, and the loading plant having at least one computer for automatically controlling the loading device as a function of the amount of bulk material tipped out from the loading device, in which the computer has a filling model for calculating a first manipulated variable (S_B) as a function of at least one of position (M_{Pos}) of the transportation container to be filled and loading state (M_{Bel}) of the transportation container to be filled prior to its loading, used by the computer to control the loading device, and a train-hauling model for calculating a second manipulated variable (S_Z) as a function of information concerning the amount of bulk material tipped out from the loading device, used by the computer to control the movement of the means of transport.

The loading plant according to the invention advantageously makes it possible to save on operating personnel for a loading plant of the type mentioned at the beginning, particularly at the loading level. Since loading plants of the type mentioned at the beginning generally operate in three-shift mode, this results in a clear cost advantage. In addition, particularly precise loading of the means of transport is achieved.

In a particularly advantageous refinement of the invention, the computer is designed such that it automatically controls both the loading device and the means of transport. In this case, the loading device and the means of transport are advantageously controlled in coordination with each other. In this manner, the filling of the transportation containers can be achieved in a particularly rapid and precise manner. In addition, there is a saving on operating personnel at the loading level.

In a furthermore advantageous refinement of the invention, the transportation container position sensor is designed as an ultrasonic or laser scanner or as an axle-driven counter.

In an advantageous refinement of the invention, the loading plant has a transportation container prefilling sensor for determining or for measuring the loading state of the transportation container to be filled prior to its loading.

In a furthermore advantageous refinement of the invention, the loading plant has a volume flow sensor for measuring the amount of bulk material supplied to the loading device, in particular the mass flow or volume flow thereof.

In a furthermore advantageous refinement of the invention, the transportation container prefilling sensor and/or the volume flow sensor is designed as a laser or ultrasonic scanner, in particular as a 3 D laser scanner.

Further advantages and details emerge from the following description of exemplary embodiments, with reference to the drawings and from the subclaims. In detail:

Figure 1 shows a loading plant,

Figure 2 shows the functional construction of a model-assisted loading plant,

Figure 3 shows a loading plant with an exemplary hardware configuration for a computer for controlling the loading plant.

Figure 1 shows an exemplary embodiment for a loading plant according to the invention. The latter has a computer 1 and also a loading device 9 which is designed as a chute. The freight cars 3, 4, 5, 6 of a train are loaded with bulk material 10 by means of the loading device 9. Reference number 7 denotes an E-locomotive. The E-locomotive 7 is supplied with electrical power via a contact wire 12. The contact wire 12 is supplied with electrical power via a converter 8 which can be designed as an inverter or rectifier.

a converter 8 which can be designed as an inverter or rectifier. The converter 8 is electrically connected to a generator (not shown) of electrical power or to a power supply system (not shown). The bulk material 10 is supplied by means of a conveyor belt 11 to the loading device 9, which is designed as a chute.

The loading plant furthermore has a volume flow sensor 13, a transportation container position sensor 16 and a transportation container prefilling sensor 17. The volume flow sensor 13 is used to measure the amount of bulk material 10 which is supplied on the conveyor belt 11 to the loading device 9. In an alternative refinement, the volume flow sensor 13 may also be designed as a mass flow sensor. The amount of bulk material therefore refers to the volume or the mass of the bulk material.

The freight cars 3, 4, 5 and 6 have transportation containers into which the bulk material 10 is tipped. The position of the freight car 6 which is to be filled, and therefore the position of the transportation container arranged on the freight car 6, is determined by means of the transportation container position sensor 16. The transportation container position sensor 16 can be designed as an ultrasonic or laser sensor or as an axle-driven counter. The design as an ultrasonic or laser sensor is particularly advantageous, since the transportation container position sensor 16 can thereby be used at the same time for detecting and monitoring possible overfilling of the transportation container. In this arrangement, the transportation container position sensor 16 is used to detect whether bulk material is dropping next to the transportation container.

The transportation container prefilling sensor 17 serves to determine the amount of bulk material in the transportation container prior to the loading. The transportation container prefilling sensor 17 is advantageously designed as an ultrasonic or laser scanner. When the transportation container prefilling sensor 17 is designed as a two-dimensional ultrasonic or laser scanner, it is particularly advantageous to allow the scanning beam of the ultrasonic or laser scanner to run transversely to the direction of travel of the train. A particularly advantageous design of the transportation container prefilling sensor 17 is its design as a three-dimensional laser scanner.

The loading device 9, the converter 8, the volume flow sensor 13, the transportation container position sensor 16, the transportation container prefilling sensor 17, a light signal and a starting position sensor 15 are connected, for data purposes, to the computer 1 via a data line 2. In the present exemplary embodiment, the data line 2 is designed as a bus system. The data line may be replaced by individual connections.

In the following, the sequences for filling a train by means of the loading plant are briefly explained: If a train pulls into the loading plant, the starting position sensor 15 is used to detect whether the train has reached a suitable position for starting the automatic loading. This is indicated to a train driver by a traffic signal 14. Once the automatic loading of the train has begun, the speed of the train is controlled by the computer 1 by means of the converter 8. This takes place, for example, by setting the voltage in the contact wire 12 by means of the converter 8. The freight cars 3, 4, 5, 6 are pulled under the loading device 9 by the locomotive 7. When the first freight car 6 which is to be filled reaches the filling position, which is detected by the transportation container position sensor 16, the loading procedure begins. In an alternative refinement to this, the train is controlled in such a manner that with the loading procedure already started, the freight car 6 reaches the filling position precisely whenever bulk material is tipped out by the loading device 9. In order to span the gaps between the freight cars 3, 4, 5 and 6, the loading device 9 has a front end 9a and a rear end 9b. If, for example, the front end 9a is situated over a gap between two freight cars, the bulk material is tipped by means of the rear end 9b into one freight car or into the following one.

It is particularly advantageous to realize the loading plant according to the invention as a model-assisted loading plant. Figure 2 shows the functional construction of a loading plant of this type in an exemplary refinement. This has a filling model 20.
By means of the filling model
20, a manipulated variable S_B for a loading device, as denoted, for example, with reference number 9 in Figure 1, is [lacuna] as a function of values, in particular measured values, concerning the position M_{ver} of the freight car to be loaded in the train unit, of the loading state M_{Bel} of the freight car to be loaded prior to the loading, its position M_{Pos} and as a function of the position M_{PBel} of the loading device and also as a function of a value for the amount Z_M of the bulk material emerging from the loading device and of parameters P_F for the filling model 20. The use of a filling model 20 of this type is particularly suitable for enabling automatic filling of means of transport. Furthermore, a filling model 20 of this type enables particularly precise filling of a means of transport.

In a particularly advantageous refinement of the invention, a train-hauling model 21 is, particularly in addition, provided. The train-hauling model 21 is used to advantageously model means of transport, loading devices and also supply arrangements for bulk material. The train-hauling model 21 determines values for the amount Z_M of bulk material emerging from the loading device. In a particularly advantageous refinement of the invention, the train-hauling model 21 determines manipulated variables S_Z for the movement of a train to be filled. For this purpose, the train is modeled by means of the train-hauling model 21. In a particularly advantageous refinement, this train model takes into consideration the compression or extension of the train during braking or acceleration. Corresponding parameters are supplied to the train-hauling model 21 as parameters P_B for the train-hauling model 21. Input variables of the train-hauling model 21 also include the volume and the volume speed M_{vol} of the bulk material supplied to the loading device, the speed M_{vB} of the conveyor belt and also the position M_{ver} of a train in the train unit.

Reference number 23 in Figure 2 denotes the loading process of a train. Reference number 22 denotes an optionally provided safety device. If the safety device 22 is not provided, the manipulated variables S_B for the loading device and S_Z for the train act directly on the loading process 23. The safety device 22 is optionally supplied with a value, calculated by the filling model 22, for the filling state Z_B of the transportation container. If the safety device 22 does not ascertain any states which are critical to safety, it takes over the value, determined by the train-hauling model 21, for the manipulated variable S_Z for the train and passes it on to the loading process 23 as a manipulated variable S'_Z for the train. Critical states are detected by the safety device 22 as a function of the manipulated variable S_B for the loading device, the value Z_B for the loading state and/or a measured value M_{Pos} for the position of the freight car to be loaded. If the safety device 22 determines a critical filling state of the transportation container, for example (imminent) overfilling, for example by evaluating the value of the loading state Z_B or on account of the measuring signal of a transportation container position sensor 16, designed as a scanner, as shown in Figure 1, the safety device 22 determines a new manipulated variable S_Z for the train. This new manipulated variable S'_Z causes the train to accelerate. If the safety device 22 ascertains that this acceleration is not sufficient, or that the train is not reacting to the new manipulated variable S'_Z for the train, for example by evaluating the measured value for the freight car position M_{Pos}, it emits a new manipulated variable S'_B for the loading device. The use of a safety device 22 of this type constitutes a particularly advantageous refinement of the loading plant according to the invention.

Figure 3 shows a loading plant having an exemplary hardware configuration for a computer for controlling the loading plant. The loading plant has conveyor belts 50, 51, 52 with which bulk material is transported to a loading device. In the present exemplary embodiment, the loading device has, as an alternative to the chute according to Figure 1, a reversing conveyor belt 62 and also a gantry 61. The gantry 61 can be moved forward and backward as indicated by the double arrow 63. The conveyor belts 52 and 62 are designed as reversing conveyor belts. The conveyor belts 51, 52, 62 have drives 54, 55, 56 and also incremental transmitters 57, 58, 59 for measuring the rotational speed. Other sensors for the rotational speed can be used instead of the incremental transmitters 57, 58, 59. By means of the drives 54, 55, 56 and also the incremental transmitters 57, 58, 59, which are connected to a programmable controller 33 via a data line 64, the conveyor belts 51, 52, 62 are subjected to a closed-loop and open-loop control. The open-loop control and closed-loop control is implemented at the programmable controller 33. Furthermore, the gantry 61 is subjected to a closed-loop control by means of the programmable controller 33. For this purpose, a gantry drive, indicated by the double arrow 63, and also a transmitter 60 are provided.

As in the exemplary embodiment according to Figure 1, a volume flow sensor 13, a light signal 14, a hard position sensor 15, a transportation container position sensor 16 and also a transportation container prefilling sensor 17 are provided. Furthermore, an additional volume flow sensor 38 is provided which is provided at the beginning of a conveyor belt system, indicated by the conveyor belt 50, for example following a removal device. Furthermore, adapting means 34, 35, 36, 37 for the volume flow sensors 38, 13 and the transportation container prefilling sensor and for the transportation container position sensor are provided. A programming unit 32 can be provided for programming the programmable controller 33. The programmable controller 33 is connected via a data line 44 to a converter (not shown). The programmable controller 33 is furthermore connected by a data line 70 to a PC 30. Provision can be made for the PC

30 to be assigned a printer 31. In an exemplary refinement, the filling model 20 and the safety device 22 according to Figure 2 are implemented on the programmable controller 33. The train-hauling model 21 according to Figure 2 is implemented on the PC 30. Owing to the great demands for reliability, the programmable controller 33 is designed as Simatic S7. The PC 30 is arranged on the control/cabin level 80. The programmable controller 33 is arranged on the E-surface level 81, i.e. on the level with the electrical power supply systems.

In an advantageous refinement, provision is made for adapting the filling model 20 and in particular the train-hauling model 21. For adapting or for training the train-hauling model 21, the latter is supplied with additional measured values from the process 23, in particular a measured value for the position M_{Pos} of the train. The train-hauling model, in particular, is adapted in this manner on line to the process.

In a furthermore advantageous refinement of the invention, an initial learning phase is provided. In this case, the loading process is controlled by an operator. The models, in particular the filling model 20 and the train-hauling model 21, are developed from the actions of the operator.

CLAIMS:

1. A loading plant for loading a means of transport having at least one transportation container, in particular a train or a truck, with bulk material (10), the loading plant having a loading device (9, 61, 62) for tipping the bulk material (10) into the transportation container, in that the loading plant has at least one computer (1) for automatically controlling the loading device (9, 61, 62) as a function of the amount of bulk material (10) tipped out from the loading device (9, 61, 62), characterized in that the computer (1) has a filling model (20) for calculating a first manipulated variable (S_B) as a function of at least one of position (M_{Pos}) of the transportation container to be filled and loading state (M_{Bel}) of the transportation container to be filled prior to its loading, used by the computer to control the loading device (9, 61, 62), and a train-hauling model (21) for calculating a second manipulated variable (S_Z) as a function of information concerning the amount of bulk material (10) tipped out from the loading device (9, 61, 62), used by the computer to control the movement of the means of transport.

2. The loading plant as claimed in claim 1, characterized in that it has a transportation container position sensor (16) for measuring the position (M_{Pos}) of the transportation container to be filled.

3. The loading plant as claimed in claim 2, characterized in that the transportation container position sensor (16) is designed as an ultrasonic or laser scanner or as an axle-driven counter.

4. The loading plant as claimed in any one of claims 1 to 3, characterized in that it has a transportation container prefilling sensor (17) for measuring the loading

state (M_{Bel}) of the transportation container to be filled prior to its loading.

5. The loading plant as claimed in any one of claims 1 to 4, characterized in that it has a flow sensor (13) for measuring the amount of bulk material (10) tipped out from the loading device (9, 61, 62), in particular the mass flow or volume flow thereof.

6. The loading plant as claimed in either one of claims 4 and 5, characterized in that the transportation container prefilling sensor (17) and/or the flow sensor (13) is designed as a laser or ultrasonic scanner, in particular as a 3-D laser scanner.

7. The loading plant as claimed in any one of claims 1 to 6, characterized in that the computer (1) is designed to automatically control the means of transport.

8. The loading plant as claimed in claim 1, characterized in that the filling model calculates the first manipulated variable additionally as a function of the amount of bulk material (10) tipped out from the loading device (9, 61, 62).

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PATENT AGENTS

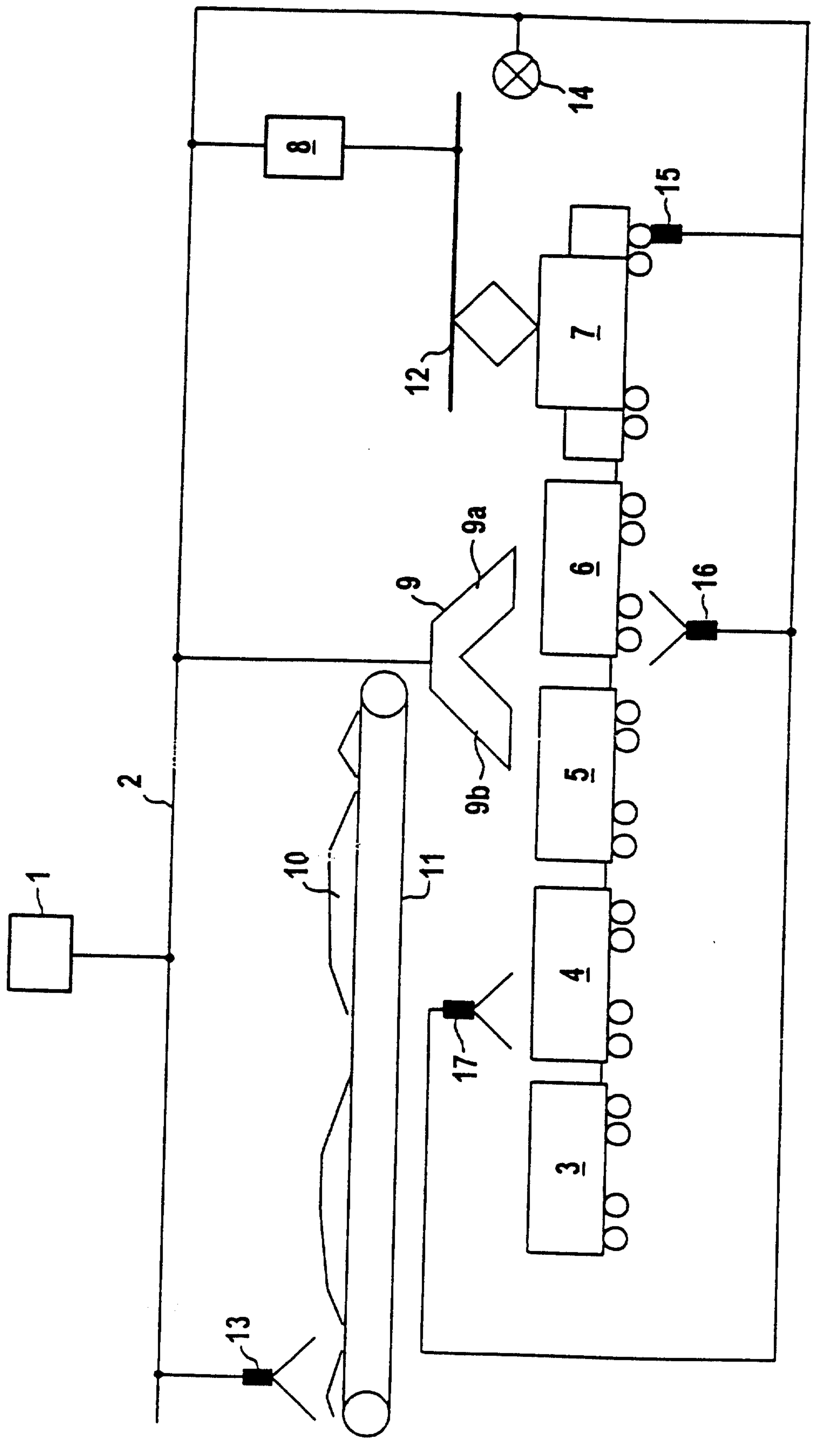

FIG 1

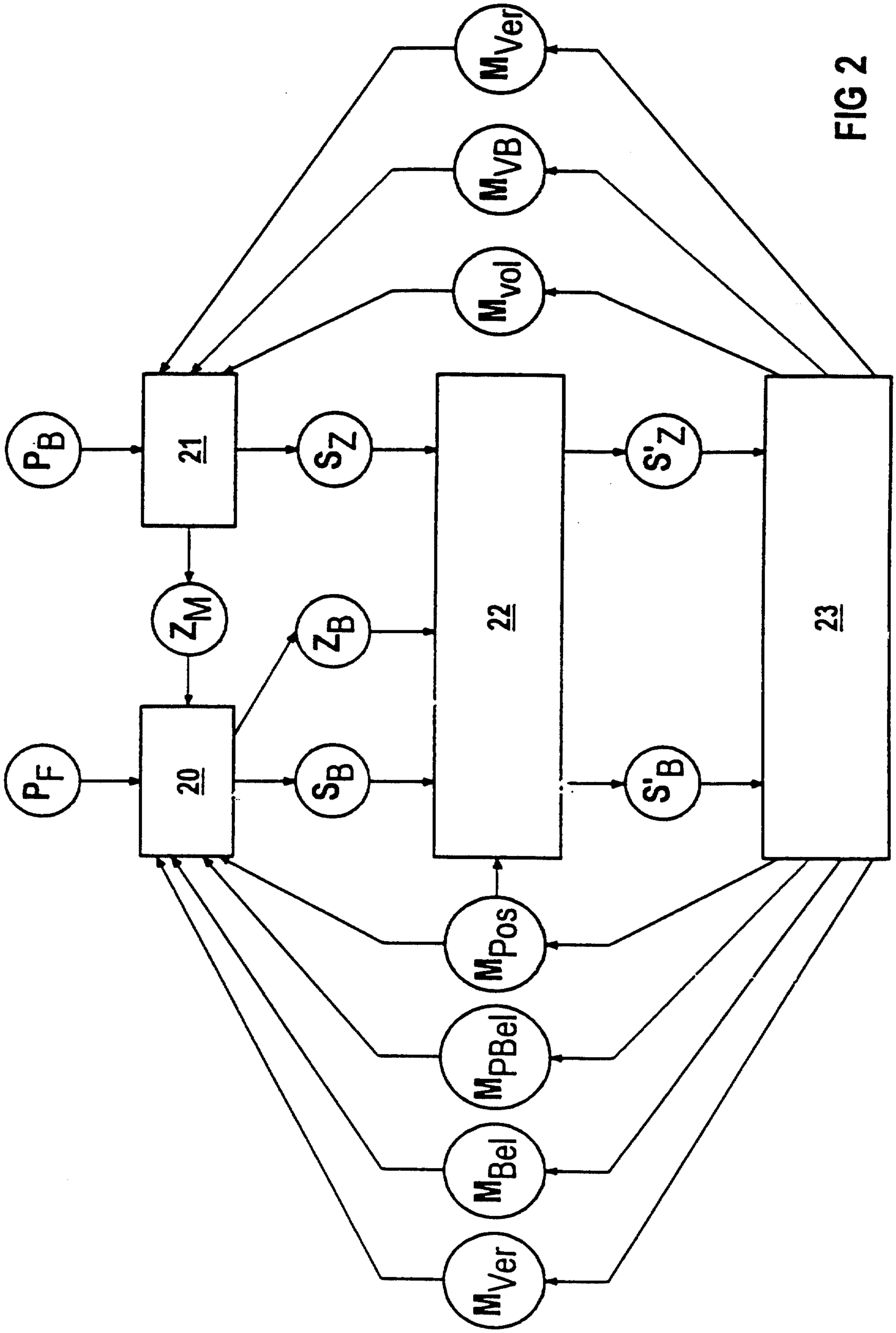

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FIG 2

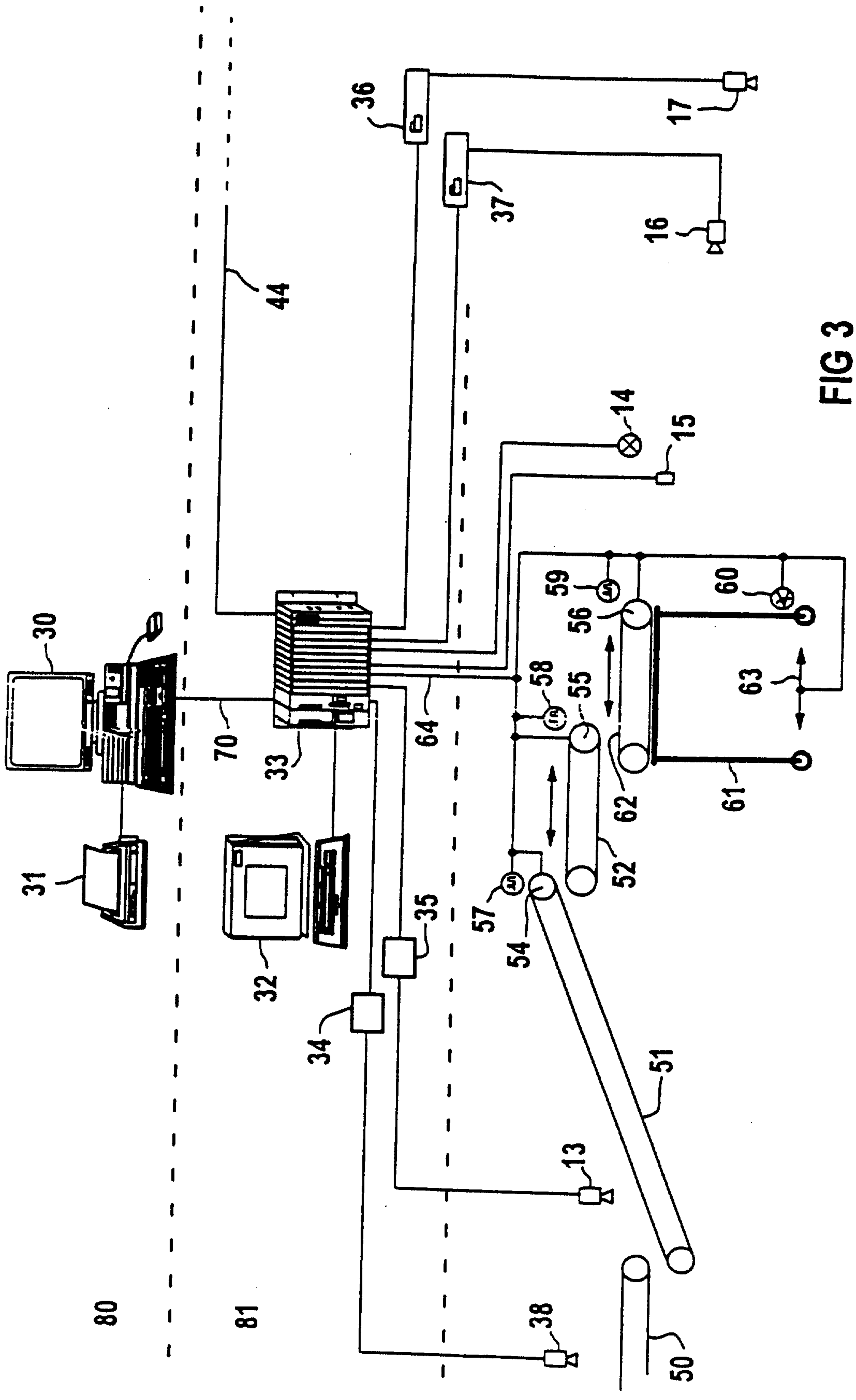

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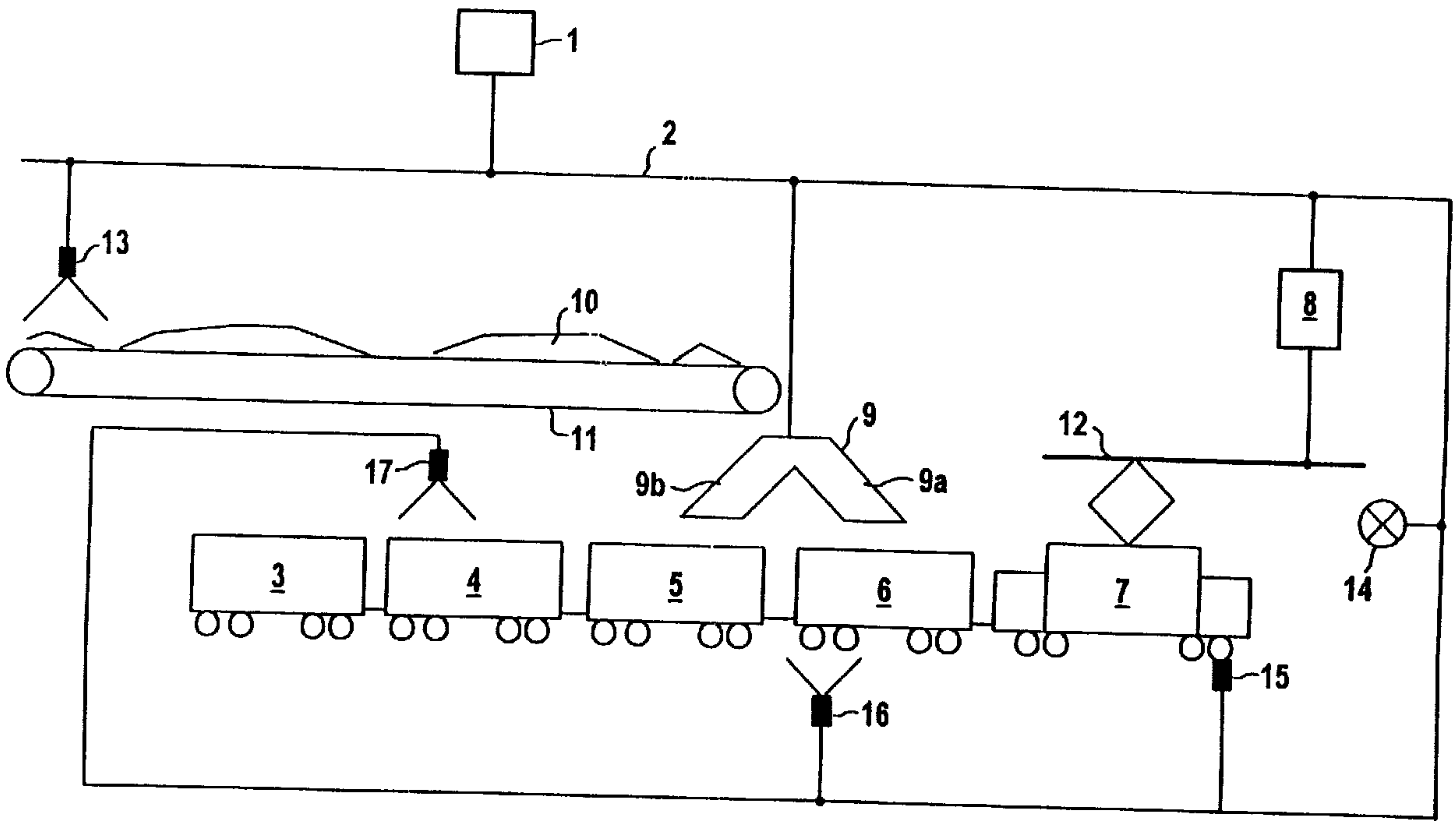
FIG 3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