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CA 2187996 C 2005/08/02

(11)(21) 2 187 996

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 1996/10/16
(41) Mise à la disp. pub./Open to Public Insp.: 1997/04/18
(45) Date de délivrance/Issue Date: 2005/08/02
(30) Priorité/Priority: 1995/10/17 (02935/95) CH

(51) Cl.Int.[6]/Int.Cl.[6] B66B 5/02, B66B 1/24
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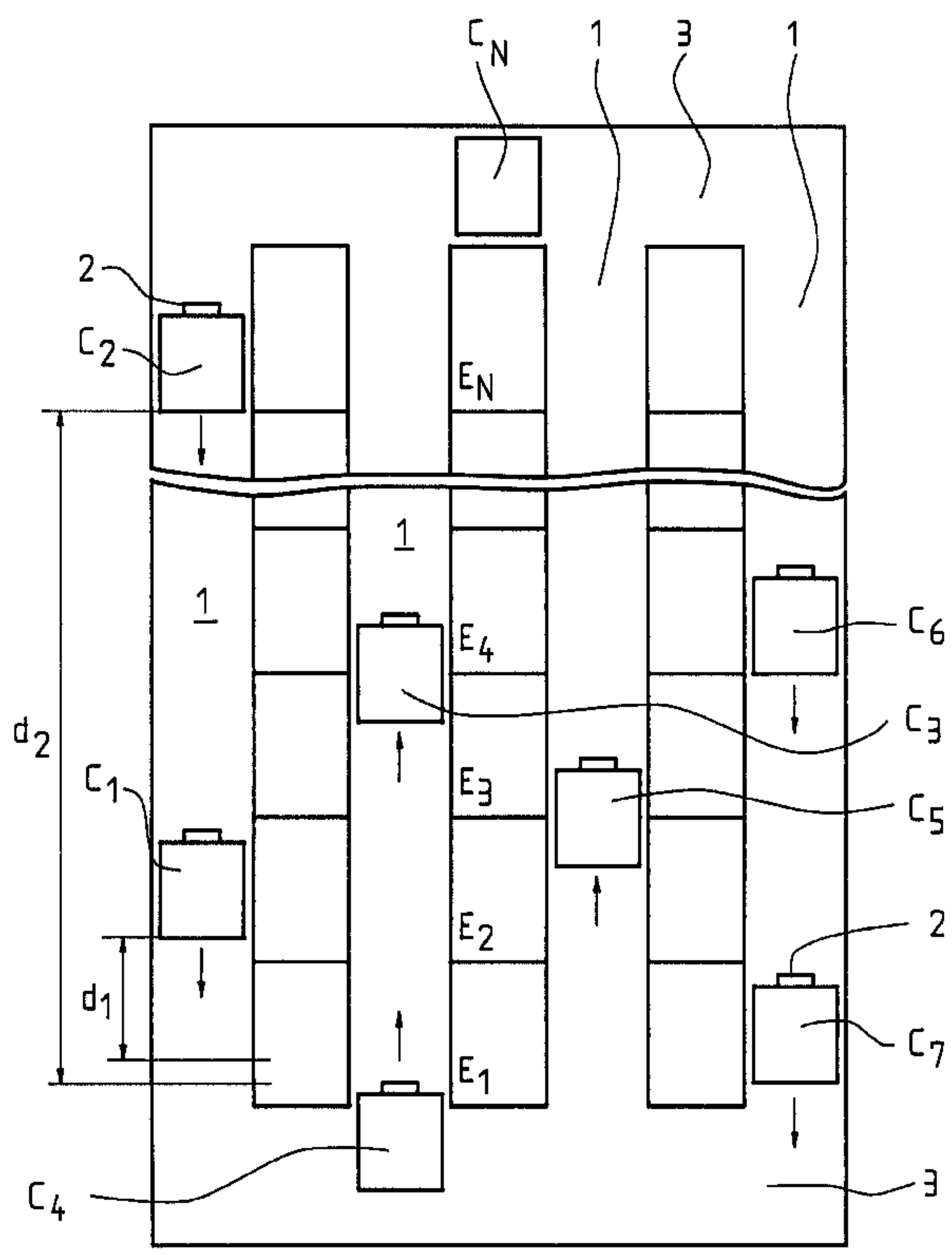
(54) Titre : EQUIPEMENT DE SECURITE POUR APPAREIL DE LEVAGE A BENNES MULTIPLES
(54) Title: SAFETY EQUIPMENT FOR MULTIMOBILE LIFT GROUPS



(57) Abrégé/Abstract:
With this safety equipment in a multimobile lift group, collisions between cages (C1..CN) operating in the same shaft (1) can be prevented. For this purpose, each cage (C1..CN) is equipped with a safety module (10). In order not to cause any collision in the case of a stop command of a cage (C1..CN), the safety module (10) must know the positions and speeds of the other cages (C1..CN) at all times. A decision module (12) integrated into the safety module (10) processes the travel data received by way of the communications system (11) and decides whether a cage (C1..CN) may or may not stop. Furthermore, the decision module (12) determines the braking behaviour of a cage (C1..CN) (normal stop, emergency stop or triggering of the cage-catching device).

Summary

With this safety equipment in a multimobile lift group, collisions between cages (C1..CN) operating in the same shaft (1) can be prevented. For this purpose, each cage (C1..CN) is equipped with a safety module (10). In order not to cause any collision in the case of a stop command of a cage (C1..CN), the safety module (10) must know the positions and speeds of the other cages (C1..CN) at all times. A decision module (12) integrated into the safety module (10) processes the travel data received by way of the communications system (11) and decides whether a cage (C1..CN) may or may not stop. Furthermore, the decision module (12) determines the braking behaviour of a cage (C1..CN) (normal stop, emergency stop or triggering of the cage-catching device).

(Fig. 1)

 2187996

Safety Equipment for Multimobile Lift Groups

The invention concerns a safety equipment for a multimobile lift group, which prevents collisions between several lifts operating in one shaft.

A lift plant with several shafts, in which several vertically and horizontally automotive passenger transport equipments can operate in the same shaft, has become known from EP 595 122. Each cage can travel horizontally from one shaft to another shaft and is provided with an individual drive, for example with a friction wheel drive, the friction and guide wheels of which roll along in the shaft corners. Each cage furthermore comprises an independent control for the management of the cage calls or destination calls, for which purpose the distance from a cage, which is possibly situated above or below, is measured. Moreover, a conventional cage-catching device is provided at the lifting carriage of the cage as protection against excess speed or in the case of crash.

In the case of the afore-described equipment, only safety equipments for excess speed or faulty operation of a cage are provided. In the case of an emergency stop or also for a normal storey stop of a cage, it cannot be ensured whether further cages, which are situated above or below in the same shaft, can still stop in time in order to avoid a collision.

The invention is based on the object of proposing a safety equipment for a multimobile lift group of the initially mentioned kind, which equipment prevents collisions between cages situated in the same shaft.

This problem is solved by the invention characterised in patent claim 1.

The advantages achieved by the invention are to be seen substantially in that the performance capability of the multimobile lift group can be exploited fully by an optimal adaptation of the spacings between the cages with the aid of the safety equipment and that the safety module is constructed to be redundant so that the lift installation does not have to depend on only a single safety module.

Advantageous developments and improvements in the safety equipment indicated in claim 1 for a multimobile lift group are given by the measures recited in the subclaims. The safety equipment is particularly suitable for automotive cages. Furthermore, due to the arrangement of a safety module at each cage, other cages, for example one following in the same shaft, can be monitored and trigger an emergency stop when a faulty function occurs at the monitored cage.

An embodiment of the invention is illustrated in the drawing and more closely explained in the following, in which:

Fig. 1 shows a schematic illustration of a multimobile lift plant,
Fig. 2 shows a schematic illustration of the lift cages with the safety equipment,
Fig. 3 shows a retardation curve for lift cages,
Fig. 4 shows a model of the lift travel curves,
Fig. 5 shows a schematic illustration of the possible braking behaviour and the stop commands for a cage,
Figs. 6 and 7 show a schematic illustration of the cage states for the decision module and
Fig. 8 show a schematic illustration of the components for the safety equipment.

Fig. 1 shows a schematic illustration of a multimobile lift installation. Several vertically and horizontally automotive lift cages C1..CN operate in a lift plant with, for example, four shafts 1 and the storeys E1..EN. Each cage C1..CN is driven by an own independent drive 1, for example by a frequency-regulated drive. The construction can take place in, for example, the form of the friction wheel drive described in EP 556 595. Several cages C1..CN can move independently upwards or downwards in each shaft 1. The shafts 1 are each connected together at their upper and lower ends by a respective connecting passage 3. In this manner, the cages C1..CN can change their direction of travel by a change of shaft. A change in the direction of travel can likewise take place when only one cage C1..CN is situated in a shaft 1.

In conventional lift groups, the emergency stop and the engagement of the cage-catching device are the two basic principles in the case of excess speed or faulty operation. In a multimobile lift group as shown in Fig. 1, several cages C1..CN can operate in the same shaft 1 at the same time. In such a lift group, a safety equipment must ensure that collisions between the cages C1..CN can be prevented in the case of excess speed or faulty operation.

In the case of an emergency stop or on engagement of the cage-catching device, the cages C1 and C2, for example, need the respective distances d1 and d2 as braking travels. A collision between the two cages C1 and C2 would occur if the spacing amounts to d2-d1 at the beginning of the braking phase.

Equally, possibilities of collisions exist in normal operation of the lift group:

- Call allocation to a cage; when a storey call is allocated to, for example, the cage C1, this must stop at the desired storey and service the call. In the case of such a situation, it must be taken into consideration that the following cage C2 does not cause any collision without impairing the normal operation. According to the spacing between both the cages and the duration of the stop of the cage C1, a reduction in the speed of the cage C2 can suffice or, however, it must likewise stop, for example at a higher storey.
- Horizontal transfer of cages C1..CN; during the horizontal travel of cages in the connecting passages 3, collisions with cages travelling vertically in the shafts 1 must be avoided.

In order to be able to prevent the afore-described possibilities of collisions, the operational states of all cages C1..CN operating in the lift group must be known. The stopping strategy in the case plays an essential part in the case of multimobile lift groups. The decisive aspects are the safety and the performance capability of the lift plant. Too great a safety spacing between the cages C1..CN reduces the performance capability and thus the advantages of a multimobile lift plant by comparison with a conventional lift installation. Moreover, collisions cannot be prevented by a great spacing on its own.

Fig. 2 shows a schematic illustration of the lift cages C1..CN with a safety module 10. In order not to cause any collision in the case of a stop command for a cage C1..CN, the positions and speeds of each cage C1..CN in the multimobile lift group must be known to the safety module 10 at all times. This safety module 10 must be able to decide the necessary braking behaviour (characteristics of the retardation curve, kind of the braking) instantaneously for each cage C1..CN by reference to these travel data. A communications system 11 secures the information transmission between the lift cages C1..CN and the safety module 10. The safety equipment furthermore contains a decision module 12, which is responsible for the determination of the stop commands, within the safety module 10. The decision module 12 continuously receives the positions, speeds and stop possibilities from all cages C1..CN. The cages C1..CN moreover send a stop request, which the decision module 12 processes and grants the stop permission to the cage C1..CN.

The decision module 12 can decide at any time to brake or stop a cage. It also decides whether a cage C1..CN may or may not stop in response to a stop request. Furthermore, the decision module 12 determines the manner of the stopping:
- normal stop,
- emergency stop or
- triggering of the cage-catching device.

The normal stop is regulated, for example in a frequency-regulated drive, by way of the torque. In the case of an emergency stop and for securing of the cage C1..CN in the case of a stop at a storey E1..EN, a drum brake for example is used as stopping brake. The cage-catching device arranged directly at the cage can be constructed as, for example, roller-catching device. The decision and the manner as well as also the location of the stop is communicated to the cage from the decision module 12.

On the basis of the actual travel data, the safety module 10 can also permit different directions of travel to the cages C1..CN in the same shaft 1 without causing collisions. This travel operation increases the efficiency of the lift group substantially.

A continuous data flow with the positions, speeds and destinations of the cages C1..CN would need an infinite communications channel. For this reason, a dynamic lift model is integrated into the safety module 10. This model permits a very rapid transmission of travel data (positions, speeds and travel destinations) and enables the decision module 12 to make an immediate determination and communication of the stop command to the cages C1..CN. The destination storey allocation is so restricted that unnecessary stops and cages C1..CN blocked between the storeys E1..EN are avoided.

Fig. 3 shows a retardation curve D for lift cages C1..CN. A cage C1 travels through the shaft 1 at the nominal speed v_n. In order to be able to stop at a certain storey E1..EN, the drive control follows the preset retardation curve D within a certain tolerance band Z from the beginning of the retardation with the nominal speed v_n at the point A to standstill v_s of the cage C1 at the desired storey E1..EN at the point F of the retardation curve D. When the cage C1 starts from a point B lying nearer to the point F, it cannot be accelerated to the nominal speed v_n, since the cage C1 can otherwise no longer be brought to standstill by means of retardation values reasonable for the passengers. Thus, the drive control on reaching point C follows the retardation curve D to standstill v_s at the point F.

Fig. 4 shows a dynamic model of the lift travel curves for a building with five storeys f1 to f5. According to the retardation curve D shown in Fig. 3, the travel curves for all possible storey distances, accelerations and retardations are illustrated in the dynamic model. Selectors s i,j are the intersections between the acceleration curves from the start storeys I and the retardation curves to the destination storeys j. The point f k is the stopping position on storey k. The information from all selectors s and stopping positions f and the transition time between these points form the dynamic model of a lift plant.

The knowledge of the position of a relevant point of a cage C1..CN in the network is tantamount to knowledge of the instantaneous positions and speeds. This permits the determination of the future positions and the stopping possibilities of the cages C1..CN. For that reason, a cage C1..CN need only indicate the position of a certain mark in the network in order to be able to transmit all information data demanded by the decision module.

Such a communication can take place in, for example, the following manner:

! 365.4 Cl s3,4.

This communication makes it known that cage C1 will reach the selector s3,4 at the time 365.4. The exclamation mark ! declares the communication as information. The manner of coding of the communication can be freely chosen and adapted to the communications system 11.

Fig. 5 shows a schematic illustration of the possible braking behaviour and the stop commands of a cage. The simple and rapid sending of the stop commands takes place through the decision module 12. As most important components, the command must contain the stopping position f k in the network, which the cage C1..CN must reach.

A stop command can take place for example in the following form:

!! 370.1 Cl f5.

This stop command instructs the cage C1 to reach the storey f5. The double exclamation mark !! indicates that a stop command is concerned. The time indication 370.1 is optional. It corresponds to the maximum arrival time at storey f5. Thereby, the braking behaviour is fixed implicitly (normal stop N, emergency stop E and cage-catching device P).

There are also other possibilities of forming the stop commands. For example, it can be indicated which of the braking behaviours shown in Fig. 5 must be followed. Example:

!! 370.1 Cl f5 [E].

The additional formation [E] describes the braking behaviour, in this case an emergency stop E, in order to be able to stop the cage C1 at the storey f5.

The stop commands are fixed implicitly. The decision module 12 can arrange a stop for a cage C1..CN long before the arrival at a selector f k. The decision module 12 is therefore detached from any real time problems, such as, for example, the commands for the brakes and so forth. Each cage C1..CN is responsible for the monitoring of its position and speed. Equally, the cages C1..CN are themselves responsible for the initiation of the braking phase or for the retardation control to the final stop, for which the stop command sent from the decision module 12 is complied with.

Figs. 6 and 7 show schematic illustrations of the cage states for the decision module 12. The decision module 12 must know the dimensions of the cages C1..CN, in particular their heights h, for the monitoring of the lift installation. The cage height h is taken into consideration by the decision module 12 as length of the bar shown in Fig. 7. Marks T represent the states of the cages C1..CN in the network. A configuration as in Fig. 6 would cause a collision of the two cages C1 and C2 by reason of the overlapping (hatched region) between the cage C2 in approach to storey f4 and cage C1 on the departure from storey f4. Such system states can be predicted and effectively prevented by the decision module 12.

Fig. 8 shows a schematic illustration of the components for the entire safety equipment. All cages C1..CN share the dynamic model shown in Fig. 4 one with the other or each cage C1..CN implements the dynamic model in a module M1. Equally, each cage C1..CN comprises a safety module 10. The safety is increased substantially by the redundant construction of the safety module 10, since the lift plant cannot rely on only a single safety module 10. On request of the lift control 20, a stopping module 21 sends the request to a receiver unit 22. The actual travel data, in particular the cage position and speed, are ascertained in a position module 12 on the basis of shaft information data 26 and the information data supplied by a real time clock 27. Position and speed are augmented in a processing unit 28 with the dynamic model from the module M1 and sent to an information unit 25. In the decision module 12, the data from the receiver unit 22 (stop request), the information unit 29 (position and speed) and from a further dynamic model of a module M2 are processed and the braking behaviour is fixed. The braking behaviour is passed from the decision module 12 to a command generator 30, which produces the stop command. This stop command is communicated to a brake module 31 of the cage C1..CN, which is responsible for the passing-on of the command or the initiation of the braking phase.

The travel data of all cages C1..CN are communicated by way of the communications system 11. Each cage C1..CN can fix its braking behaviour on its own in accordance with the own state and the travel data received from the other cages.

The safety equipment need therefore not rely on a single safety module 10. Each cage C1..CN has the possibility of controlling its stopping process itself. Moreover, each cage C1..CN can monitor other cages, for example the following one, and initiate an emergency stop when a faulty function occurs in the monitored cage C1..CN. By this system furthermore with the aid of the dynamic model, the spacings between the cages C1..CN can be kept as small as possible or as large as necessary in order to ensure an optimum efficiency of the lift operation.

As variant for the ascertaining of the travel data, sensors can also be used in place of the dynamic model. Sensors, for example infrared sensors, are arranged above and below at each cage C1..CN and measure the distances to cages C1..CN situated above and below in the shaft 1. A shaft information system, for example in the form of measuring strips which are arranged in the shafts 1 and scanned by light barriers fastened at the cages C1..CN, can serve for ascertaining the positions of the cages C1..CN. In this manner, the speed and position of each cage C1..CN can be ascertained. These travel data are likewise passed on to safety modules 10 and the braking behaviour of the cages C1..CN is determined subsequently.

These safety equipments are also applicable to other than automotive multimobile lift groups, for example to a lift group in which several cages C1..CN guided at cables in the same shaft 1 operate. Counterweights are arranged as balancing elements at the cable ends. In such a lift group, each cage C1..CN has an own independent drive which is mounted at the counterweight or in a machine room above or below the shafts 1.

The arrangement of the safety modules 10 need not necessarily take place on the cages C1..CN; they can also be accommodated in the machine room or on the storeys E1..EN.

Claims:

1. Safety equipment for a multimobile lift group, in which several lift cages (C1..CN) operate over several storeys (E1..EN) at the same time in at least one shaft, wherein each cage (C1..CN) is driven by an individual independent drive (2) and provided with an individual brake, characterised in that at least one safety module (10) computes the necessary braking behaviour of the cages (C1..CN) from actual travel data of the cages (C1..CN), in particular the cage position and speed, on the basis of step requests so that collisions between the cages (C1..CN) can be prevented and that each cage is provided with an individual safety module (10).

2. Safety equipment according to claim 1, characterised in that the cages (C1..CN) are constructed as vertically automotive passenger transport equipments.

3. Safety equipment according to claim 1, characterised in that the cages (C1..CN) are constructed as cable-guided passenger transport equipments.

4. Safety equipment according to one of the claims 1 to 3, characterised in that, in the case of mounting of the safety modules (10) at the cages (C1..CN), each safety module (10) can trigger braking operations at the own cage and neighbouring cages (C1..CN).

5. Safety equipment according to one of the claims 1 to 4, characterised in that the braking behaviour corresponds to a normal storey stop, an emergency stop or an engagement of a cage-catching device.

6. Safety equipment according to one of the claims 1 to 5, characterised in that a dynamic model of a lift travel curve is referred to for the ascertaining of the actual travel data of a cage (C1..CN).

7. Safety equipment according to one of the claims 1 to 5, characterised in that the ascertaining of the actual travel data takes place by means of sensors arranged on the cages (C1..CN) and a shaft information system.

8. Safety equipment according to one of the claims 1 to 7, characterised in that each safety module (10) contains a decision module (12), which determines the braking behaviour from the actual travel data and stop requests of the cages (C1..CN).

9. Safety equipment according to claim 8, characterised in that each decision module (12) passes the computed braking behaviour on to a command generator (30), which produces the stop command for the cages (C1..CN).

10. Safety equipment according to claim 9, characterised in that each decision module (12) can prevent a storey stop of a cage (C1..CN) in order to prevent a collision with a following cage (C1..CN).

11. Safety equipment according to any one of claims 1 to 10 wherein the cages (C1..CN) are constructed as vertically and also horizontally automotive passenger transport equipments.

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Fig. 1

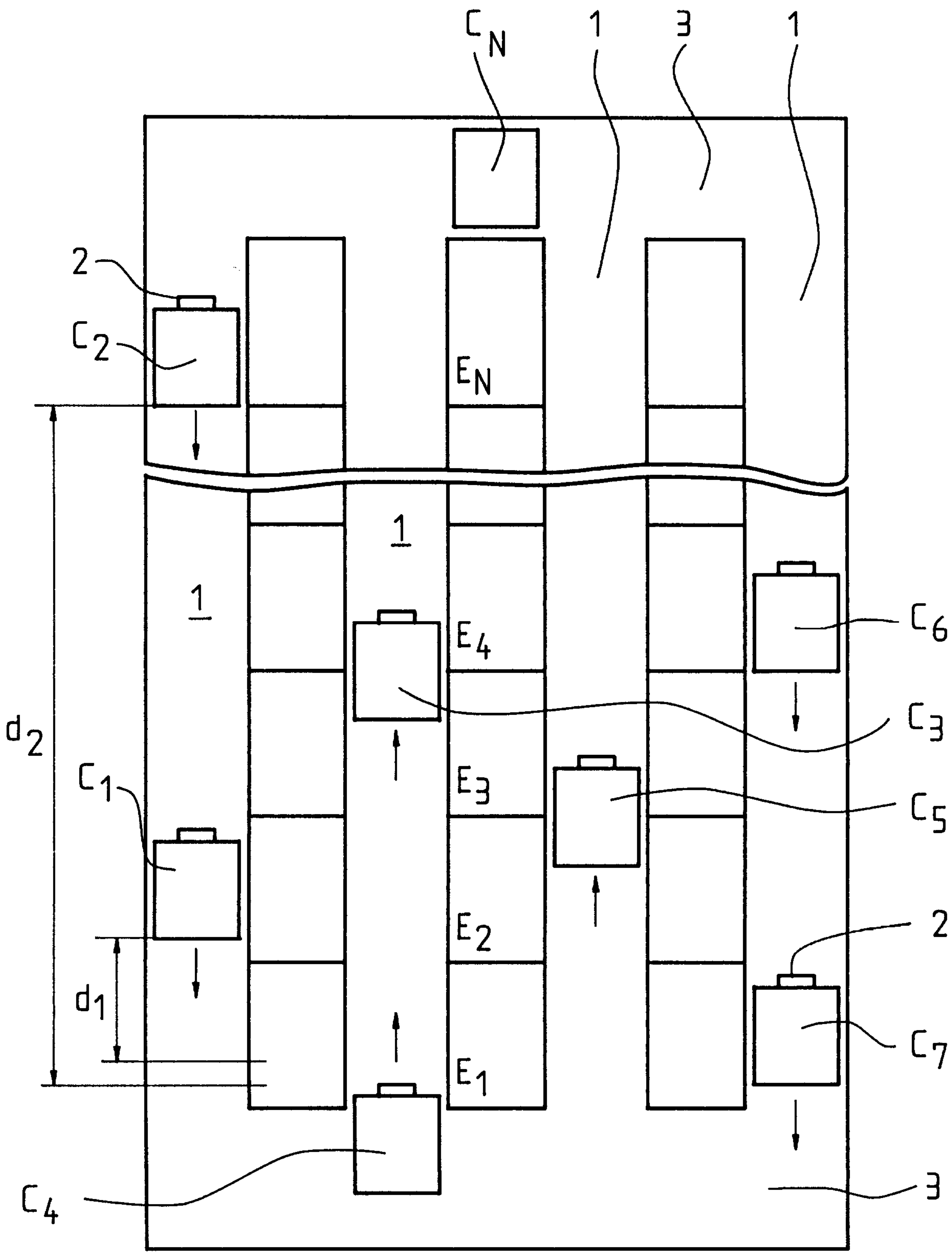

Fig. 2

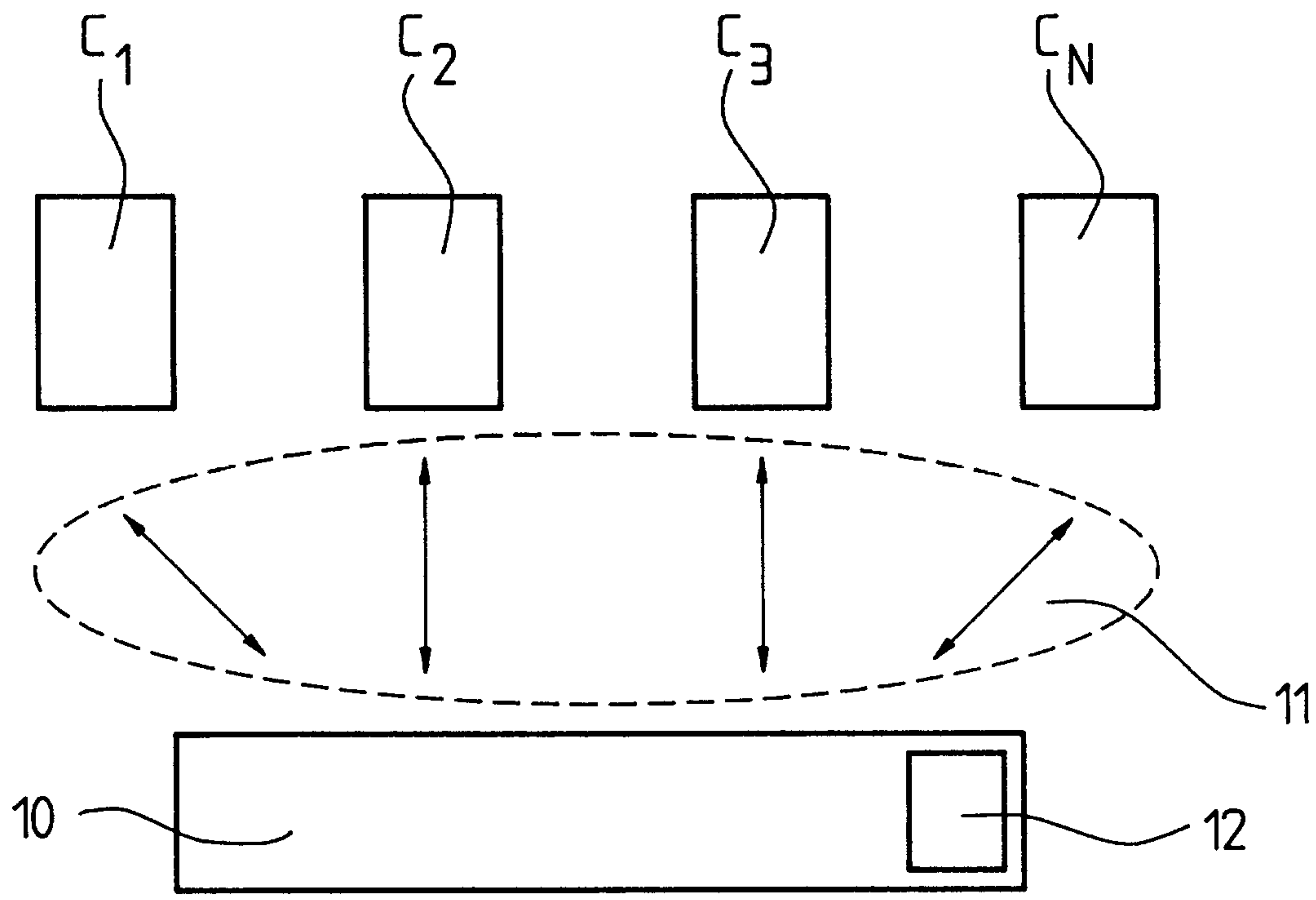

Fig. 3

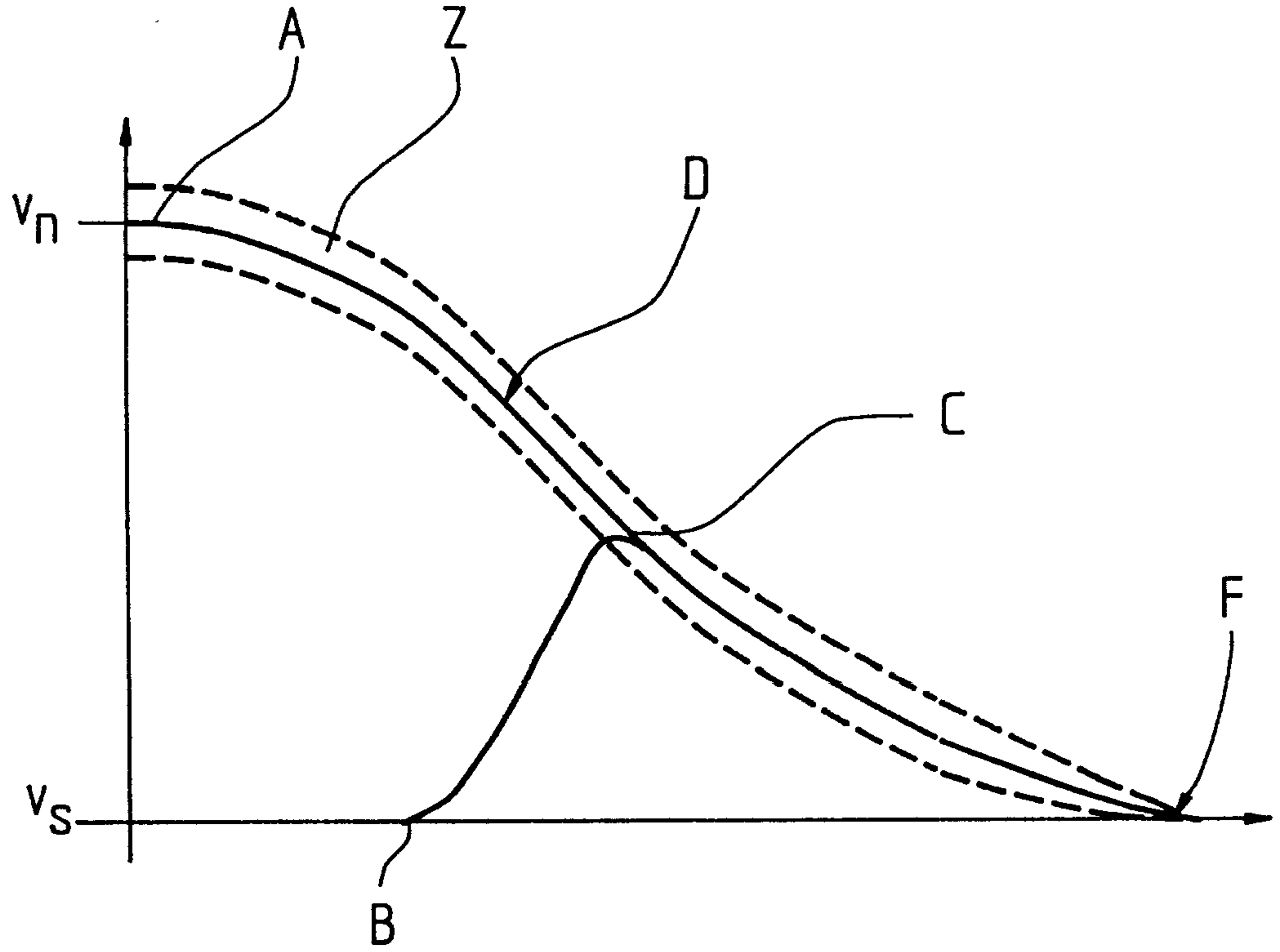

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Fig. 4

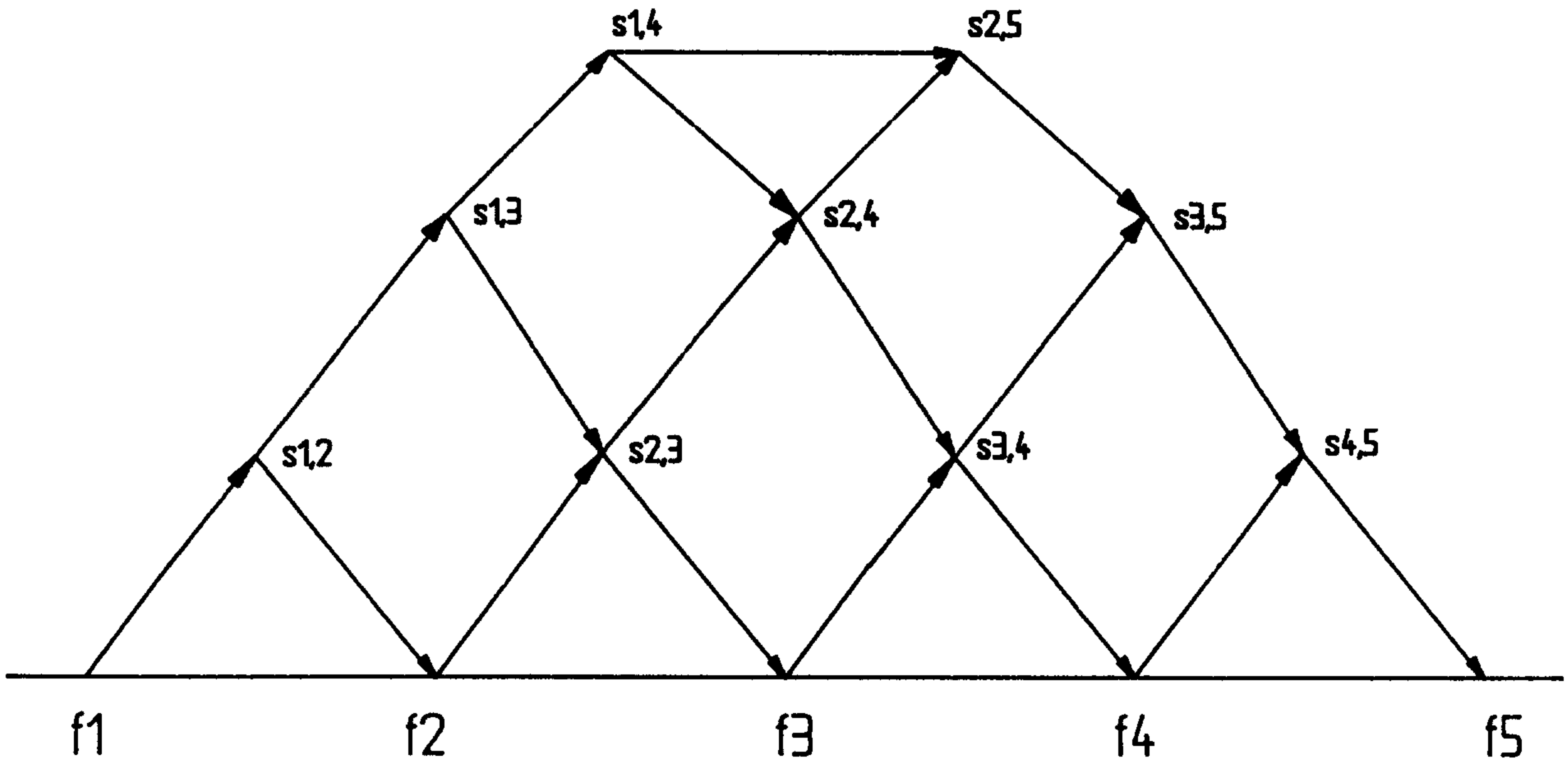

Fig. 5

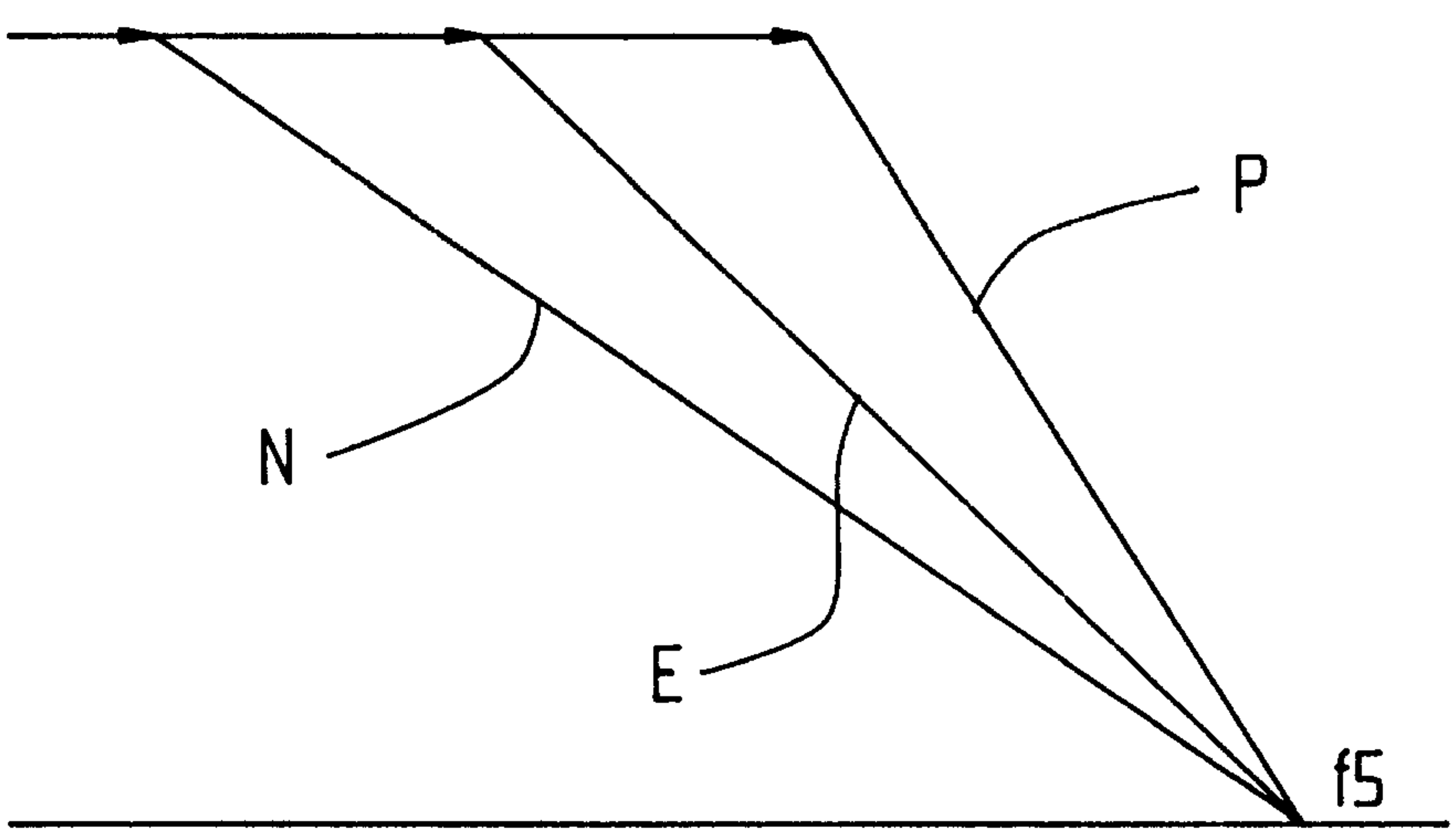

Fig. 6

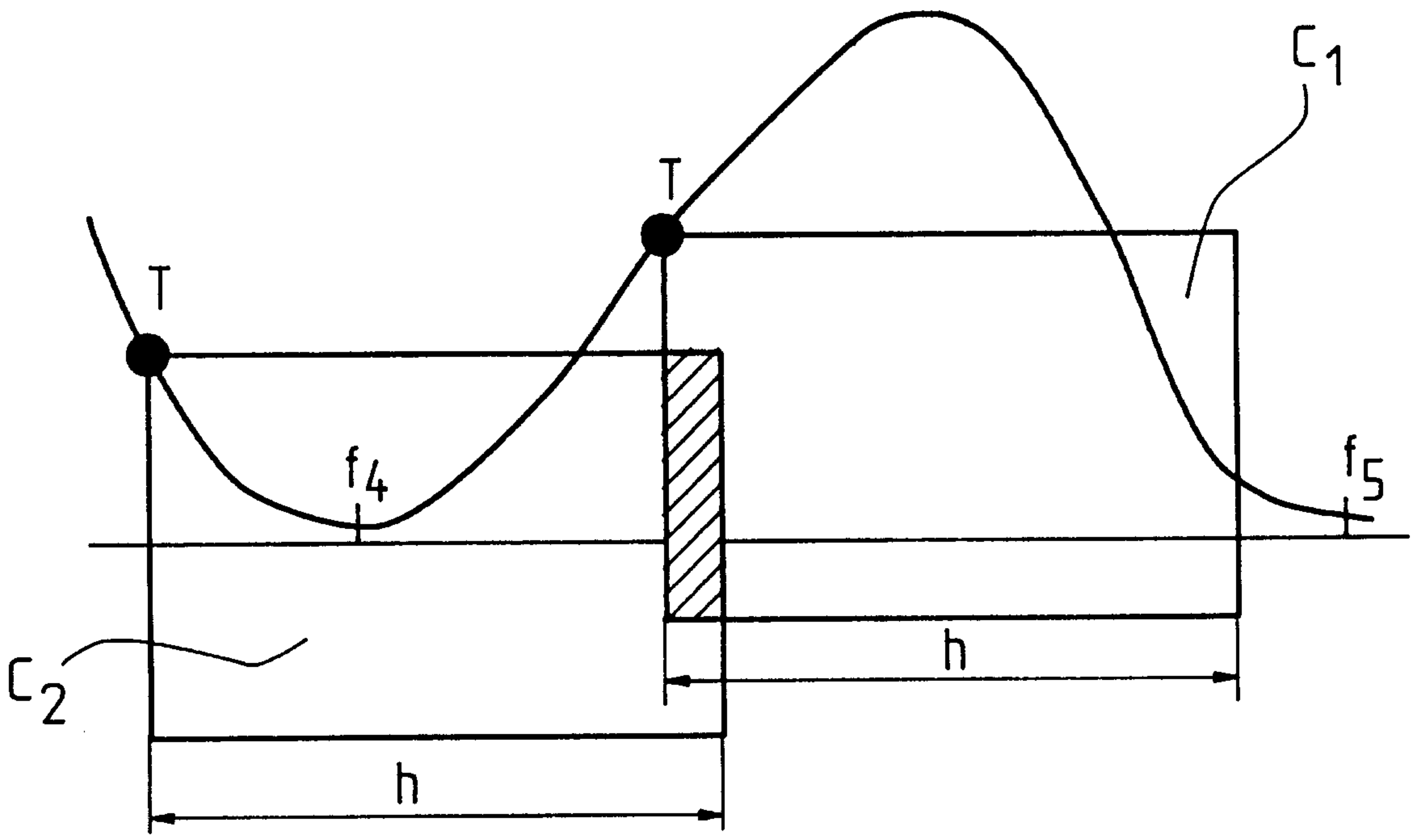

Fig. 7

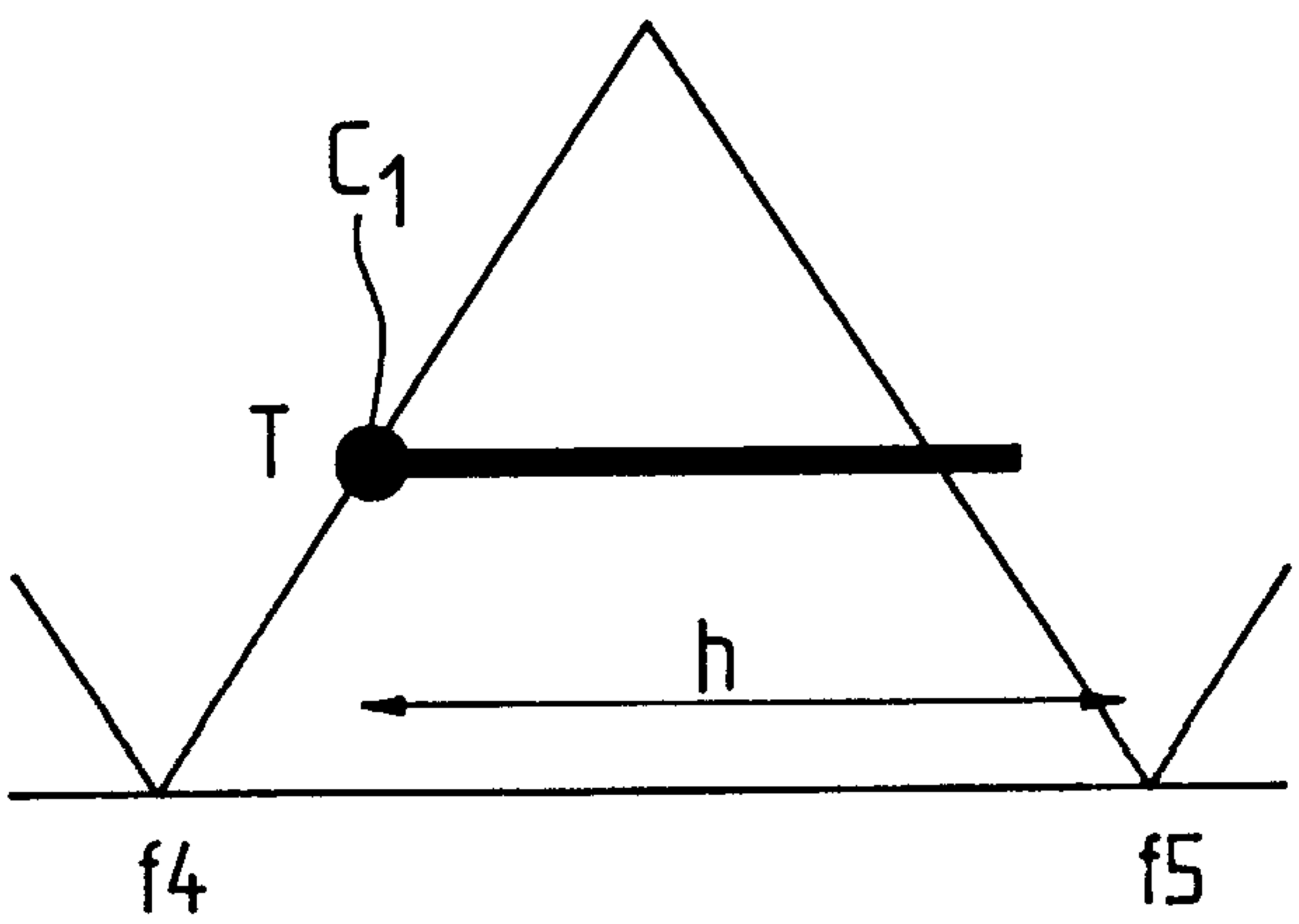

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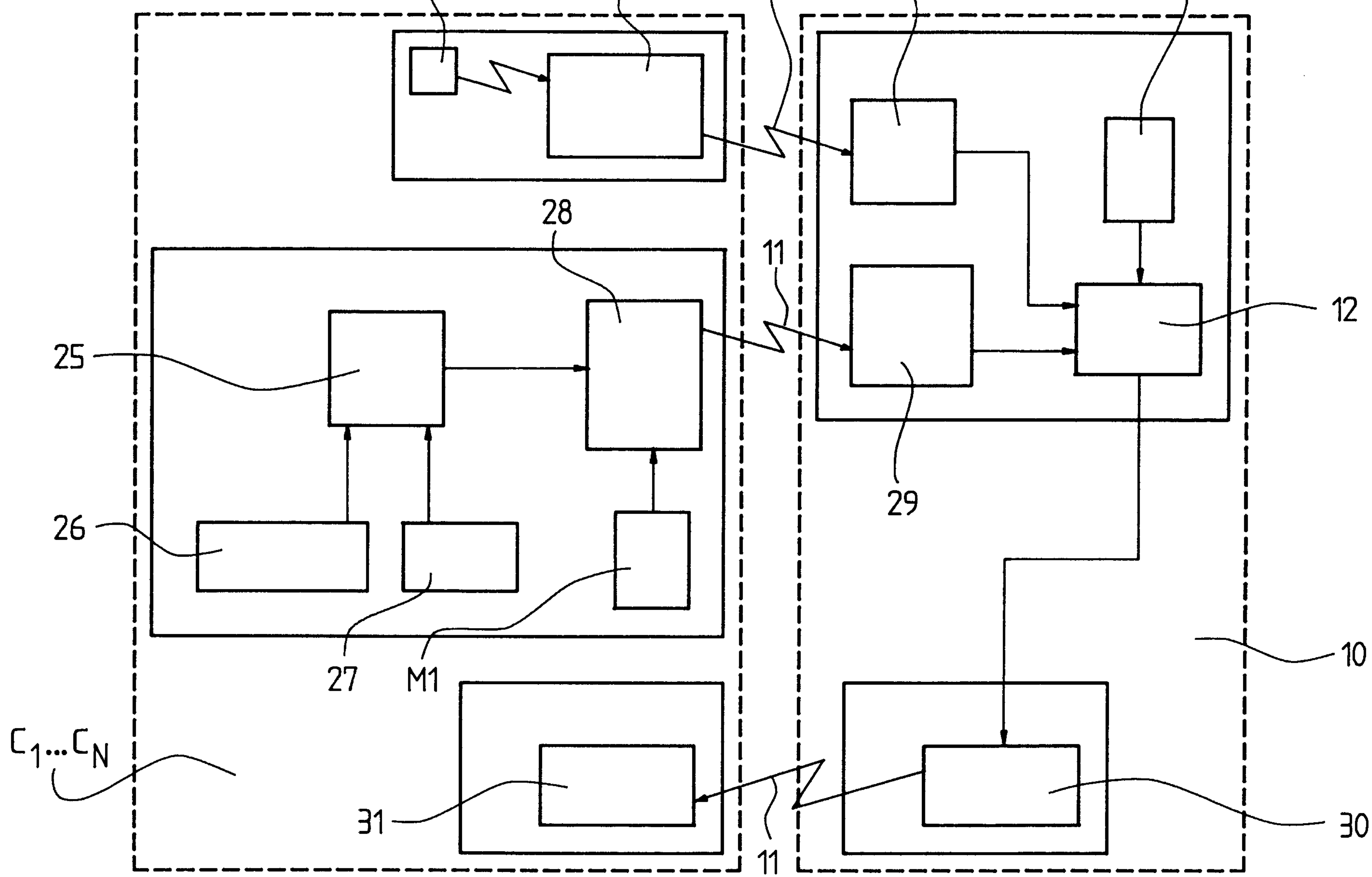
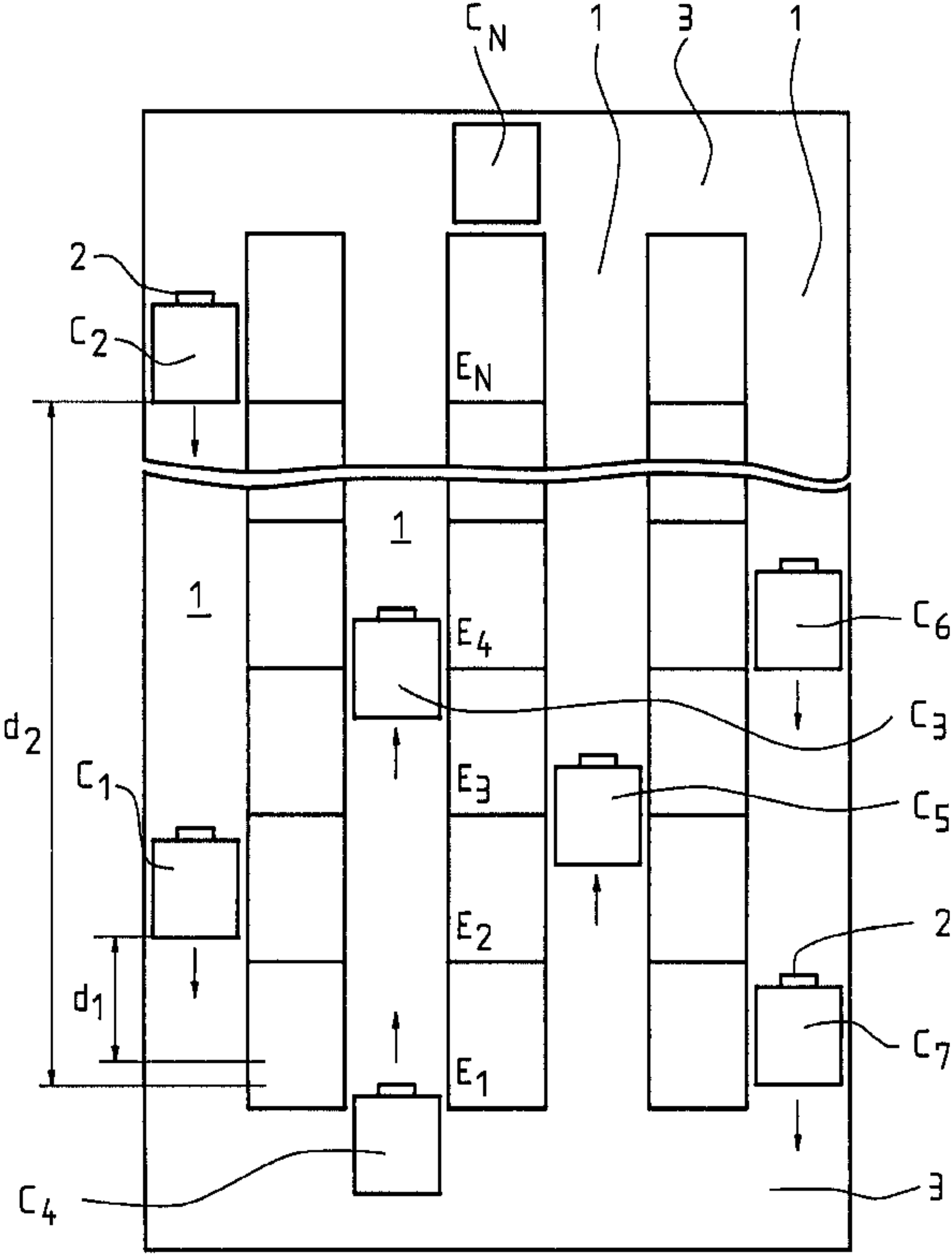
Fig. 8





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