

Description

The invention relates to a modular data storage system comprising: a plurality of identical data carriers having a recording layer in which data can be recorded in coded form and from which said data can be read; at least one recorder apparatus provided with supporting means for supporting a data carrier in a recorder operating position and provided with recording and/or read means for recording and/or reading the data and/or on or from a data carrier which is in the recorder operating position; at least one storage module for storing a plurality of said data carriers closely adjacent each other, which storage module comprises a module frame; an internal transport device accommodated with the module frame of the storage module for the transport of data carriers between a storage position and a transfer position and the back of the storage module; an external transport device, which cooperates with the storage module at the back, for the transport of data carriers between said transfer position at the back of the storage module and a loading position near a recorder apparatus; an enclosure for the external transport device located at the back of the storage module; and at least one electronic control unit for coordinating and controlling the transport of the data carriers between their storage positions in the storage modules and the loading positions near the recorder apparatus; the storage modules being capable of being arranged on top of and adjacent each other in optional configurations to form enclosed modular systems with a data-storage capacity adapted to specific requirements, the external transport device cooperating with each storage module at the rear and the enclosure of the external transport device being adapted to the resulting external dimensions of said configuration of combined storage modules.

Such a modular data storage device for the storage of computer data is known from United States Patent Specification 3,715,040. The data carriers comprise magnetic-tape reels provided with an amount of magnetic tape and the recorder apparatus comprises a professional magnetic-tape recorder suitable for the purpose. The magnetic-tape recorder is of the type frequently employed in peripheral requirement used in conjunction with larger computer systems. The recorder comprises two reel spindles, permitting transport of a magnetic tape from a reel on one reel spindle to another reel on the other reel spindle. A full magnetic-tape reel is manually placed on the one reel spindle, after which the magnetic tape is fed to the reel on the second reel spindle via a plurality of tape guides and magnetic heads and is attached to said second reel. Subsequently the recorder may be put into operation for reading the data on the magnetic tape or for recording data on the magnetic tape. After use the magnetic tape is rewound onto the first reel and the reel containing the tape is removed from the magnetic-tape recorder and may then be

stored for subsequent use. In the known data storage system the external transport device comprises two sections. A first section of the external transport device is located at the back of a plurality of stacked storage modules. Data carriers, specifically magnetic-tape reels comprising reels with magnetic tapes wound thereon, are moved into an upper position in a vertical direction along the backs of the storage modules. There the magnetic-tape reel is taken over by a horizontal section of the external transport device, which actuates a plurality of vertical sections of the external transport device and which can bring magnetic-tape reel into the loading position near a recorder. Said horizontal section is only suitable for bringing magnetic-tape reels into a loading position near a single recorder apparatus. The magnetic tape reels are moved to a position above the recorder apparatus, where they can be removed from the horizontal section of the external transport device by an operator. Subsequently the magnetic-tape reel is manually placed on the recorder apparatus. When a magnetic-tape reel is removed from the recorder by an operator it may be placed back in the loading position on the horizontal section of the external transport device. Since the transport devices transfer the magnetic-tape reels to a location near the recorder, this saves the operator a certain amount of work. However, the magnetic-tape reels still have to be handled manually by an operator, so that only the location of the storage position of the relevant magnetic-tape reel and the transport of said reel between the storage module and the recorder is effected automatically under the control of the control unit. The external transport device appears to be unsuitable for cooperation with a plurality of magnetic-tape recorders, unless intricate further steps, which are not mentioned in said United States patent specification are taken, such as adding branches to the horizontal section of the external transport device, complete with shunts and an intricate control system.

A fully automatic modular storage system for tape cassettes is known from DE-A-2519870. In this specification the position of the recorder in the modular system is fixed in the sense that a special loading—unloading station is necessary to access the recorder.

It is an object of the invention to provide a modular data storage system of the type mentioned in the opening paragraph, permitting the recorder apparatus to be remote-controlled without the intervention of an operator and permitting the use of a plurality of recorders and not necessitating a special loading—unloading station to access the recorders. To this end the invention is characterized in that: recorder apparatuses are constituted by recorder modules having a module frame, which together with the storage modules can be arranged on top of and adjacent each other in optional configurations to suit requirements; the said loading positions of the data carriers are disposed at the backs of the recorder modules; the external transport device

cooperates with the backs of the storage modules and recorder modules; the enclosure of the external transport device is adapted to the resulting external dimensions of said configuration of storage and recorder modules; and each of the recorder modules comprises an internal transport device, for the transport of a data carrier between said loading position at the back of the recorder module and said recorder operating position inside the recorder module.

Thus, in a modular data storage system in accordance with the invention, the recorder modules do not constitute separate self-contained devices. They are combined with the storage modules to form an integrated configuration of associated modules. As a result of this, a data carrier need only be moved over a minimal distance by the external transport device. The external transport device has access to all modules at the back, so that for example an external transport device as known from the said United States Patent Specification 3,715,040 may be used for the transport of data carriers between all storage modules and all recorder modules. In the said known data storage system the horizontal section of the external transport device cooperates with all vertical sections. Since no data carriers need to be handled by an operator, the modular data storage system may be fully enclosed, thereby providing an optimum protection against environmental influences. The internal transport devices of the recorder modules automatically transfer the data carriers, delivered by the external transport device, to the supporting means and place the data carrier in the recorder operating position. Since this involves no operator activities the data storage system may be remote-controlled.

In principle the data storage system in accordance with the invention may be located at an arbitrary distance from other devices cooperating with the system. These may be, for example, devices which supply input data to the data storage system for storage therein or devices which receive output data from the data storage system, such as document readers and display terminals respectively.

If the data carriers, as in the said United States Patent Specification 3,715,040, comprise magnetic-tape reels, a recorder apparatus should comprise means for automatically passing the magnetic tape from one reel via the guide means and the magnetic heads to the other reel and attaching said tape to the last-mentioned reel. Recorders capable of this are known. The free end of the magnetic tape on the magnetic-tape reel is provided with a more or less rigid portion, so that automatic threading of the magnetic tape is possible by means of a mechanism which cooperates with the more or less rigid portion. Alternatively, magnetic tape cartridges may be used, which are easier to load.

A known disadvantage of a magnetic tape for recording and storage of data is that specific data which are located somewhere on the magnetic

tape are only accessible for read-out after transport of a specific amount of magnetic tape past the magnetic heads. This is because the data are recorded on the tape in sequential tracks and only a small portion of the magnetic tape in the direct vicinity of the magnetic heads is directly accessible for read-out. Data carriers providing faster access to the data stored on them are for example the well-known magnetic discs or optical discs. The discs are rotated and the tracks on the discs are arranged in the form of concentric circles or of a spiral. By rapidly moving a suitable head over the surface of the rotating disc all the data on the disc are rapidly accessible. Such discs may be used in conjunction with a modular data storage system in accordance with the invention. When discs are used the recorder modules with their internal transport devices may bear resemblance to the known so-called "jukebox" equipment, in which gramophone records are automatically placed onto and removed from a turntable. Also in the field of computer peripherals recorder equipment is known in which a transport device automatically transfers a recording disc, which may be accommodated in an enclosure or cassette, between a loading position and a recorder operating position, see for example United States Patent Specification 4,170,030. In the apparatus known from said patent specification the data carriers comprise flexible magnetic discs accommodated in an enclosure. Another example, in which the data carriers comprise optical discs, is described in the article "An optical disc replaces 25 magnetic tapes", IEEE Spectrum, February 1979, pages 33-38, by G. C. Kenney et al.

Preferably an embodiment of the invention is used which is characterized in that further units which also belong to the system, such as the said electronic control unit, a power supply unit etc., are constituted by control modules, power-supply modules etc., each having a module frame, which modules may all be arranged on top of or adjacent each other in a specific configuration so as to form a modular system.

This embodiment provides a highly modular system having a high degree of "intelligence", that is that many of the control processes required can be performed within the data storage system itself. The system only requires simple commands for automatically performing the operations necessary to obtain the desired result.

The highly modular construction obviously has the advantages that very flexible arrangements can be obtained, defective or incorrectly functioning units can rapidly be replaced and it is possible to employ standard dimensions and thus a large amount of standard components. In this respect a further embodiment of the invention is of interest which is characterized in that the modules are arranged in a mounting rack, the module frame of each module is movable relative to the rack by means of a guiding device, and by means of the guiding device each of the movable module frames is movable between an operating position

inside the rack and a maintenance position at least partly outside the rack.

This provides rapid access to all modules at the front of the data storage system. In addition it is possible to employ a control such that it is possible to work on a module without disturbing the operation of the remainder of the system. The external transport device can be made to be readily accessible from the back by means of doors in the enclosure, so that repairs to the external transport device, replacement of parts, or testing are possible in a convenient and rapid manner.

Since in general the data storage system in accordance with the invention will be fully enclosed, whilst permitting manual insertion or removal of record carriers into or from the system, a further embodiment of the invention is of interest which is characterized in that in a front wall of at least one storage module an aperture is formed, which is adapted to the external dimensions of a data carrier, for the manual insertion or removal of a data carrier into or from the storage module; in the storage module there are provided signalling means for signalling the presence of a data carrier in the aperture; by means of the internal transport device the data carriers are movable in the storage module between the storage position and a transfer position in the aperture at the front of the storage module.

In this embodiment of the invention the internal transport device of the storage module has a double function, namely the transport of data carriers between the storage position and the transfer position at the rear of the module and the transport of data carriers between the storage position and the transfer position at the front of the storage module. The presence of the signalling means permits the transport between the storage position and the transfer position at the front of the storage module to be controlled by the control unit. The signalling means may also serve to ascertain whether a data carrier is located in the correct position in the aperture at the front of the storage module. In order to mitigate the drawback of having an opening in the front wall of the storage module an embodiment of the invention is of advantage, which is characterized in that the aperture in the front wall of the storage module can be blocked by means of movable blocking elements. Data carriers inserted through the aperture at the front of one of the storage modules may subsequently be transported to other storage modules by the relative internal transport devices in cooperation with the external transport device at the rear.

In the data storage system known from the said United States Patent Specification 3,715,040, the data carriers are arranged vertically in the storage position in a storage rack in a storage module, parallel to the front wall thereof. Each storage module has an internal width which is greater than twice the width of the data carrier, so that adjacent the storage rack an internal transport space is formed having a width greater than the

width of a data carrier. The internal transport device of the storage module comprises a sliding device for sliding a data carrier parallel to the front wall of the storage module into and out of the storage rack, between the storage position and a slid-out position within the transport space. Said internal transport device comprises a gripping device for gripping the data carrier in the transport space and furthermore comprises a translation device to move a gripped data carrier in the depth direction of the storage module between the slid-out position and a transfer position. An embodiment of the invention which also has said characteristic features of the known data storage device is further characterized in that the data carriers comprise discs having a first recording layer on a first side and a second recording layer in a second side, and the said internal transport device comprises a tilting device which is pivotable in two directions for tilting a disc in the transport space through 90° in a first direction or through 90° in an opposite second direction in order to transfer the disc in the transfer position in a first or in a second tilted orientation.

This embodiment of the invention is found to be eminently suitable for the use of data carriers in the form of optical discs accommodated in enclosures, the assembly comprising the disc and enclosure constituting a cassette. The optical discs may have a recording layer on each side, so that it may be necessary to be possible to arrange them on a recorder apparatus in two different positions.

If the said translation device in the storage module comprises an internal carriage, and embodiment is of interest which is characterized in that: the tilting device is located on the internal carriage and tilts the data carrier into a horizontal position; on said carriage a substantially L-shaped sensing arm is arranged having a first limb connected to said carriage, which limb extends horizontally in the direction of translation of said carriage towards the front of the storage module and has an end which is remote from said carriage, and having a second limb connected to said end, which second limb extends transversely of the first limb; and the second limb carries signalling elements for signalling the correct horizontal position of a data carrier.

The tilting device already positions the cassette in a horizontal position in the storage module. Subsequently further transport of the cassette may be effected in its horizontal position and the cassette may be also horizontally brought to the recorder operating position. In the recorder module the optical disc may be driven by means of a vertical spindle and the data may be recorded on or read from the optical disc by means of an optical pick-up via a slot in the wall of the cassette.

The transport of the cassettes in a horizontal position has a number of distinct advantages. The optical discs may comprise two glass plates having a diameter of approximately 30 cm, so that the cassette may have a relatively large mass,

namely approximately 1 kg. It is therefore useful to support the cassettes over a comparatively large area during transport, so that the horizontal position is favourable. For a correctly operating recorder module it is further of advantage if the optical disc is rotated about a vertical axis, because the load exerted on the drive spindle by the weight then acts in the direction of the axis of rotation. Since the axis of rotation and the force of gravity act in the same direction, it is easier to achieve automatic alignment of the centre of the optical disc relative to the axis of rotation of the drive spindle.

In combination with the last-mentioned embodiment, an aperture is disposed at the front of the storage module, a further embodiment of the invention is of interest, which is characterized in that: on said internal carriage there is provided a second substantially L-shaped sensing arm having a first limb connected to the carriage, which limb extends horizontally in the direction of translation of the carriage towards the rear of the storage module and has an end which is remote from the carriage, and having a second limb, connected to said end, which second limb extends transversely of the first limb; the second limb carries signalling means for signalling the correct horizontal position of a data carrier; of each of the substantially L-shaped sensing arms at least a portion of the first limb, which portion is situated nearer the second limb, is pivotable between a sensing position and a pivoted position, in which position a data carrier can be moved horizontally without being impeded by the sensing arm; and near the front of the storage module there is disposed a front run-on cam and at the rear of the storage module a rear run-on cam, which during the movement of the carriage of the storage module to the front or to the rear respectively cooperate with the pivotal portion of the substantially L-shaped sensing arm which faces the relevant side in order to move said arm from the sensing position to the pivoted position.

When the modular data storage system in accordance with the invention, similarly to the system in said United States Patent Specification 3,715,040, is equipped with an external transport device comprising a vertical guiding device at the rear of a plurality of stacked modules and further comprises a changer which is vertically movable along the guiding device for changing the data carriers and which is provided with a retaining device for a data carrier, it may be advantageous to use an embodiment of the invention which is characterized in that, in the case of a plurality of modules arranged adjacent each other, the external transport device comprises a horizontal guiding device at the rear of the configurations of modules which are arranged on top of and adjacent each other, and the entire vertical guiding device is horizontally movable along the horizontal guiding device so that the changer is both horizontally and vertically movable along the back of the configuration of modules.

In said embodiment of a modular data storage

system the changer of the external transport device is movable both in the vertical and in the horizontal direction, if desired simultaneously. In comparison with said known modular data storage system an advantage of the presence of such an external transport device is that the data carriers need not be transferred between various sections of the external transport device. Only a single changer is employed, in which the data carrier stays during the transport by the external transport device. This eliminates a technical complication, whilst moreover a faster transport of the data carrier along the backs of the modules is possible because superfluous movements may be avoided.

An embodiment of the invention, in which the external transport device comprises a changer which is movable along the back of a plurality of modules and which has a retaining device for a data carrier, is characterized in that the changer is provided with two retaining devices for two data carriers in order to enable two data carriers to be interchanged at the back of a module. This embodiment of the invention has the great advantage that the transport of data carriers by the external transport device is roughly twice as fast as in the case of the single retaining device for only one data carrier, without the need to increase the speeds with which the changer is moved in the vertical and the horizontal direction. When this embodiment is used the control system for the changer is adapted accordingly. During the time that a data carrier is located in the recorder operating position on a recorder module the control device directs the changer to a storage module, for the storage of the data carrier in said module, and subsequently to a storage module in order to collect another data carrier, which data carrier is subsequently transported to the back of the recorder module. The data carrier which is located on a recorder module and which is to be replaced by the next data carrier can be moved from the recorder operating position to the transfer position by the internal transport device of the recorder module, after which it is taken over by the first retaining device of the changer. Said changer moves over a small distance and the data carrier just collected is transferred to the recorder module in the reverse sequence. The changer returns the data carrier just received to its storage module and another data carrier is fetched from a storage module and transported to the recorder module.

An embodiment of the invention in which the data carriers are formed by cassettes comprising a flat rectangular enclosure accommodating a single optical disc which can carry data and be read on two sides, will now be described in more detail with reference to the drawing.

In the drawing:

Fig. 1 is a perspective front view of a modular data storage system in accordance with the invention, comprising a plurality of storage modules, one of which for maintenance purposes has been moved outwards over a certain distance, each

storage module containing sixty-four optical-disc cassettes,

Figure 2 is a perspective rear view of the modular storage system in accordance with Figure 1,

Figure 3 is a perspective view of a control module,

Figure 4 is a perspective view of a storage module, some parts of the storage module being cut-away for the sake of clarity,

Figure 5 is a perspective view of the greater part of an internal transport device of the storage module,

Figure 6 is a perspective view of some parts of the storage module at the location of the front aperture,

Figure 7 is a perspective view of a number of parts of the storage module at the location of an opto-electronic locating device for accurately locating the position of a cassette in a storage rack of the storage module,

Figure 8 is a perspective view of a recorder module, some parts being cut away for the sake of clarity,

Figure 9 is a partly cut-away perspective view of an optical disc,

Figure 10 is a partly cut-away perspective view, of an optical-disc cassette in accordance with Figure 1, which cassette constitutes a standard data carrier for a data storage device in accordance with the invention,

Figure 11 is a partly cut-away perspective view of a part of the recorder module of Figure 8,

Figure 12 is a partly cut-away perspective view of another part of the recorder module of Figure 8,

Figure 13 is a perspective rear view of the external transport device at the back of the data storage system,

Figure 14 is a perspective view of a cassette changer of the external transport device, a single cassette being partly disposed inside the cassette changer,

Figure 15 is a partly sectional and partly cut-away plan view of the cassette changer of Figure 14,

Figure 16 is a partly sectional and partly cut-away view of the cassette changer of Figure 14, viewed from the data storage system,

Figure 17 is a cross-sectional view of the cassette changer taken on the line XVII—XVII in Figure 16, and

Figure 18 is a side view of the cassette changer looking in the direction of the XVIII—XVIII in Figure 16.

The various details of the modular data storage system are not drawn to the same scale in all the figures, but to a scale which most clearly illustrates the details to be described.

The modular data storage system comprises a plurality of identical data carriers in the form of cassettes 3 with optical discs 1 (see Figures 9 and 10 and the part of the description appearing under the heading "The cassette").

The data storage system comprises a mounting rack 4 made of metal sections, which rack is

closed at the top by cover plates 5. On each of the sides two side plates 6 and 7 and a rear side-door 8 are disposed. Each rack 4 can accommodate three modules arranged above each other. The modules may comprise recorder modules 9 (see Figure 8), storage modules 10 (see Figure 4), control modules 11 (see Figure 3) and any further kinds of modules.

At the front each mounting rack 4 is closed by two front doors 12A of different widths. The wider door covers the access openings of the storage modules, so that the narrower door can remain closed when manually inserting or removing a cassette. Rear doors 12B are provided at the rear. The data storage system is thus entirely closed a satisfactory accessibility being obtained by the use of doors. Inside the enclosure at the back of the modules an external transport device 13 is arranged for the transport of cassettes between the modules. The storage modules 10 and the recorder modules 9 are each provided with internal transport devices which will be described in more detail hereinafter.

The transport of cassettes 3 between storage modules and recorder modules is coordinated and controlled by means of, *inter alia*, the electronic control unit 11. The storage modules, recorder modules, control modules and any further modules may be arranged on top of and adjacent each other in any desired configuration to form modular systems with a data storage capacity adapted to specific needs. In the embodiment shown the system may be extended at option with mounting racks 4, cover plates, side plates and doors in order to form a modular data storage system of suitable capacity. The external transport device 13 is adapted to the number of mounting racks used and cooperates with all storage modules and recorder modules at the back. The data storage system is approximately 1.70 m high and 1.62 m deep. The width of a single mounting rack 4 is approximately 0.90 m.

The data storage system shown may for example be used as an electronic file for the storage of documents in coded form. In the case of A4-format documents a resolution of 8 lines per mm in the horizontal direction and 7.7 lines in the vertical direction is required in accordance with the standards for high-quality facsimile reproduction. This means that per A4-size page a maximum of 500 kbyte of binary information is necessary. This amount of information per page permits a high-quality reproduction of text, graphs and drawings. Each optical disc has a storage capacity of approximately 25,000 pages A4 using data compression method, which means a capacity of $1.5 \cdot 10^6$ pages per storage module. If exclusively printed text is to be stored, the alphanumeric data of each document being coded by means of codes such for example the ASCII—code, a capacity of substantially twenty times as high is attainable.

Each of the modules comprises a module frame. The module frame 14 of the control module 11 (Figure 3) comprises a plurality of suitably

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interconnected sections. These parts and the manner in which they are interconnected will not be described in more detail, because this is evident from the drawing. In the module frame 14 of the control module 11 a plurality of metal bins 15 are arranged in accordance with the 19-inch standard, which bins contain electronic circuits for controlling the data storage system. The storage module 10 has a similar module frame 16 and the recorder module 9 a similar module frame 17. If desired, further modules which are required, such as a power-supply module, may be equipped with a similar module frame of the same dimensions.

All modules are arranged in a rack 4 and are provided with four wheels 18 at the bottom on both sides. In the mounting rack the wheels 18 bear on the guide 19. The wheels 18 and the guides 19 together constitute guiding devices for the modules. Such guiding devices enable the modules to be moved between an operating position within the rack 4 and a maintenance position (see Figure 1) in which a storage module 10 is shown partly outside the rack 4. In view of the dimensions and the weight of the storage module use in made of a special maintenance frame 20, which is coupled to the mounting rack 4 and which comprises legs 21 which may be replaced by legs of different length. In order to enable the modules to be fixed firmly and without play in their operating positions in the mounting racks, all modules are provided with manually adjustable studs 22, which in the tightened condition bear on cross members 23 of the mounting rack:

The Cassette

The optical disc 1 (Figure 9) comprises two glass discs 113 and 114 which by means of three concentric ring shaped spacers 115 to 117 are combined to form a unit. Such an optical storage disc is described in United States Patent Specification 4,074,282 (PHA 20.742) (herewith incorporated by reference).

In the space between the spacers 115 and 116 the glass discs 113 and 114 are provided with a vacuum-deposited metal layer on their surfaces which face one another. By means of a laser beam local pits can be melted onto said layer. This produces areas of different light reflecting properties in the metal layer. The reflected light beam is modulated by the pattern of pits in the radiation-sensitive metal layer. By suitable optoelectronic means said modulation is converted into an electrical modulation, so that the pattern of pits in the metal layer is converted into bit patterns suitable for digital processing. The optical disc 1 has a central hole 118 in which centring caps 119 are arranged on both sides, which caps serve for centring the optical disc on the recorder.

The cassette 3 (see Figure 10) has already been described in the Applicant's NL-A-80.00381 (PHN 9671) (herewith incorporated by reference). The cassette mainly comprises the optical disc 1 and an enclosure constituted by two covers 120 of

square shape. At the corners the covers 120 are interconnected by elastic connecting members 121, which urge the covers 120 towards each other. In the narrow side of the cassette housing two recesses 49 are formed for cooperation with a sliding member 39 of the internal transport device 32 of the storage module.

The cassette housing has two openings 122 which make it possible to carry out an optical check of whether the cassettes are in the correct position in the storage rack of the storage module. The cassette has a circumferential slot 123, bounded by the edges 124 of the covers 120. The edges are locally provided with a projection 125 which serves to prevent incorrect insertion of a cassette into the recorder module, and projections 414 for latching the cassette in a slot 392 in the rack plate 31 of the storage module. Slots 208 in the covers 120 allow the passage of a laser beam to the optical disc.

The Storage Module (Figure 4).

For protection against dust and other contaminants the storage modules are each covered by a front wall 24 and a rear wall 25 at the front and the back respectively, which walls are detachably arranged on the mounting rack 4. Said front walls and rear walls have apertures 26 and 27 in the form of slots, which are adapted to the external dimensions of the cassettes 3. The aperture 26 in the front wall serves for the manual insertion or removal of a cassette 3. Behind the front wall 24 a second front wall 28 is secured to the module frame 16, which second front wall normally remains in place during maintenance activities. The aperture 26 continues in the second front wall 28. At the rear of the storage module a second rear wall 29 is located in which the aperture 27 continues.

Inside the module frame 16 a storage rack for the cassettes 3 is arranged, which comprises an upper slotted rack plate 30 and a lower slotted rack plate 31. In the storage position the cassettes 3 are vertically arranged in said storage rack, parallel to the front wall 24. The internal width of the storage module 10 is greater than twice the width of a cassette 3, so that adjacent the storage rack an internal transport space is available having a width greater than the width of a cassette 3. In said transport space an internal transport device 32 is movable. Said device substantially comprises three units (Figure 5) namely a sliding device 33, a gripping device 34, and a translation device 35. The sliding device 33 is intended for sliding a cassette 3 parallel to the front wall 24 into and out of the storage rack between the storage position (shown in Figure 4) and a slid-out position in the transport space. The gripping device 34 grips the cassette 3 in the transport space. The translation device 35 transfers the gripped cassette in the depth direction of the storage module between the slid-out position and a transfer position at the front or at the rear of the storage module. In a transfer position the cassette is located partly in the slot 26 at the front

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or in the slot 27 at the back.

The internal transport device 32 comprises a carriage 36, to which a transversely extending arm 37 of the sliding device 33 is rigidly secured, and the gripping device 34. In its upper side the arm 37 has a slot 38 in which a projecting member 39 can slide. This member is driven by a toothed belt 40, which passes round a toothed guide roller 41 at one end and a toothed drive roller 42 at the other end. The drive roller is driven by a motor 43, which drives the driver roller via two bevel gears 44 and 45, a shaft 46 and a slipping clutch 47 loaded by a compression spring 48. The motor 43 incorporates a tachogenerator and a Gray-code shaft-position indicator. The cassettes 3 are each formed with a recess 49 in which the sliding member 39 engages. By means of the sliding member 39 a cassette 3 can be drawn out of the storage rack, from the storage position into a slid-out position. The last-mentioned position is not shown in the drawing. In order to provide some lateral guidance for the cassettes 3 lateral guide lugs 50 are secured to the arm 37.

The gripping device 34 comprises two grippers 51 and four pins 52. In Figure 4 the grippers 51 and the pins 52 are shown in a vertical position. In this position the sliding member 39 can insert a cassette 3 between the pins 52 and the two grippers. In Figure 5 the grippers 51 and the pins 52 are shown in a horizontal position, pivoted through an angle of 90° for the horizontal transport of a cassette within the storage module. The grippers 51 comprise rings 53 with bevelled edges 54 for cooperation with a bevelled edge 55 of a central opening of the cassettes 3. Each ring 53 carries a number of short spokes 56 with pads 57 and is secured to a lever 58 which is movably mounted on the carriage 36.

On the carriage 36 a tilting device for the gripping device 34 is arranged. The tilting device comprises a motor 59 with a worm 60 and a worm wheel 61 driven by the worm 60. On the worm wheel two plates 62 and 63 are arranged, to which the two levers 58 are pivoted. The pivot of each lever is disposed the ring 53 at one end and a roller 64 at the other end. Between the rollers 64 a tension spring 65 urges the latter ends of the levers 58 towards each other against a cam 67. The plate 62 carries a motor 66, which is adapted to drive the cam 67 situated between the levers 58. The cam 67 has a non-circular shape, so that at a location near the rollers 64 the levers can be urged apart. As a result of this the levers 58 are urged towards each other at the end adjacent the rings 53 thus permitting a cassette to be gripped. The tilting device enables a cassette 3 to be tilted in the transport space of the storage module from the vertical position through an angle of 90° in a first direction or in a second direction, so that either the one side of the cassette or the other side of the cassette faces upward. Thus, the cassette can be moved into one of the apertures 26 and 27 in a first or a second tilted orientation.

In which of the two tilted orientations the cassette has been moved is determined by opto-

electronic means. On the worm wheel 61 a mirror 424 is arranged. Four opto-electronic devices 425-428 are equipped with a light source and a light-sensitive cell and are identical to a device 405, to be described hereinafter. They cooperate with the mirror 424 in order to generate a signal indicating whether the gripping device 34 is in the vertical position or in its first or second tilted position. They are further used for controlling the motor 59 which tilts the gripping device.

The translation device 35 of the internal transport device 32 comprises the carriage 36, a plurality of rollers 68 journaled on the carriage 36, a guide rail 69, a long toothed belt 70, a short toothed belt 71, and a drive motor 72 with a toothed pulley 73. The motor 72 comprises a built-in tachogenerator. A Gray-code shaft position indicator 391 is mounted against the motor.

The carriage 36 moves along the rail 69 and functions as an internal transport carriage, to which both the gripping device 34 and the sliding device 33 are secured. On each of the sides of said internal transport carriage there is arranged a substantially L-shaped sensing arm 75 and 76 respectively. The sensing arm 75 comprises a first horizontal limb 77 which extends in the direction of translation of the carriage towards the front 28 of the storage module. On the end 78 of the limb 77 which is remote from the carriage there is disposed a second limb 79, which extends in a horizontal direction transversely of the limb 77. On said second limb two signalling elements 80 and 81 are arranged for signalling the presence and a correct horizontal position of a cassette 3. In the present example these elements are two microswitches, which are arranged adjacent each other in such a way that one, namely the switch 80, is depressed when a cassette 3 is disposed in the gripping device 34 in the horizontal position, whilst the other, namely the switch 81, detects whether a recess 49 is disposed at the location of the switch. If this is the case, the switch 81 is not depressed. If it is not the case, the switch 81 is depressed. The two switches 80 and 81 therefore ascertain not only the presence of a cassette 3 but also the correct orientation of the cassette. The second limb 79 carries a stop 82 for the side edge of a cassette 3.

In an identical manner the sensing arm 76 on the other side of the carriage 36 comprises a first limb 83 having an end 84, a second limb 85, two sensing elements in the form of microswitches 86 and 87, and a stop 88. The limbs 77 and 83 of the respective sensing arms 75 and 76 are pivotable about a horizontal pin 89 and 90 respectively. Rollers 91 and 92 are arranged respectively near the end 78 of the sensing arm 75 and the end 84 of the sensing arm 76. To the second front wall 28 of the storage module 10 a run-on cam 93 is secured, having a curved sloping 94. A similar track run-on cam 95 having a curved sloping track 96 is secured to the second rear wall 29. Said cams are adapted to cooperate with the sensing arms 75 and 76. The roller 91 is movable along the curved track 94 and the roller 92 along the curved

track 96. Tension springs 97 and 98 urge the ends 78 and 84 of the respective sensing arms 75 and 76 downwards into the position shown in Figure 5, hereinafter referred to as the sensing position of the sensing arms. If one of the rollers 91 and 92 engages the sloping track of the associated run-on cam the sensing arms is pivoted from the sensing position to a pivoted position. In said position the sensing arm does not impede a cassette 3 which is passed through one of the apertures 26 and 27.

It may be desirable to block aperture by means of a blocking element, thereby preventing cassettes from being inserted into the storage module at an undesired moment. Figure 6 shows the area near the aperture 26 at the front of the storage module. On both sides of the aperture 26 guide blocks 99 and 100 are arranged. The guide block 99 carries six guide rollers 101 for guiding the upper and lower wall of a cassette. The guide block 100 carries two guide rollers 102. For guidance in the transverse direction the guide block 99 comprises two vertical rollers 103 and 104 on a spring-loaded pressure plate 74. When a cassette is inserted it is pressed against a vertical roller (not shown) of the guide block 100, because the cassette moves the pressure plate 74 against the spring-loading during insertion. Depression of the pressure plate can be prevented by means of a solenoid 105 in order to block the aperture 26. On the rear wall 29 (Figure 4) guide blocks 106 and 107 are arranged, which are provided with rollers 108 and 109 respectively for guiding the bottom and top of a cassette. The guide block 106 further comprises a pressure plate 429 for the vertical rollers 110 and 111. The pressure plate 429 can be blocked by the solenoid 112.

Near the free end of the arm 37 an opto-electronic locating device 390 (detail Figure 7) is arranged for accurately locating the position of a cassette within the storage rack by the precise alignment of the arm 37 relative to said desired position. On an L-shaped bracket 398 light source 399, a lens 400 and a light-sensitive twin diode 401A, B are arranged. A strip 402, which extends underneath the lower rack plate 31, has openings 403 which accurately correspond to the slots 392 for the cassette 3 in the rack plate 31. The two diodes 401A, B are located behind the strip, so that a light spot 404 can reach the diodes only if the arm 37 is disposed before an opening 403. Precise positioning is possible by moving the arm 37 until the two diodes supply signals of equal amplitudes.

A second opto-electronic device 405 detects the presence of a cassette at the relevant location. In each slot 392 of the rack plate 31 a tumbler 406 is located. A spring 407 pushes the tumbler upwards with moderate force. A cassette present in the slot urges the tumbler downwards by its weight. On the underside of the tumbler a light-reflecting surface 408 is disposed. A light source 410 arranged in a mount 409 emits a light beam 411 which is reflected to a light-sensitive cell 412 by the surface 408 only if the tumbler 408 is

depressed by a cassette.

In the slots 392 latching tumblers 413 are located which engage behind a projection 414 on the cassette in order to latch said cassette in the slots. A spring 415 urges the latching tumbler upwards. Pivoted to the arm 37 of the sliding device 33 is an unlatching bracket 393 (Figure 5) having a stop 415 which projects into a groove 416 of the latching tumbler. The unlatching bracket can be pivoted downwards by energizing a solenoid 417 on the side of the arm 37, so that the stop 415 pivots the latching tumbler downwards when a cassette is to be slid to the transport space by the sliding device.

Rollers 418 guide the free end of the arm 37 over a guide rod 419.

A light source 420 and a light-sensitive cell 421 detect the position of the cassettes in the storage rack via openings 122 in the cassettes (see Figure 4).

The Recorder Module

The recorder module is also protected against penetration of dust and contaminants by detachable walls arranged on the mounting rack 4. The rear wall is identical to the rear wall 25 of the storage modules and has an aperture 27 at the same location. The front wall 422 (see Figure 1) may be fully closed.

The recorder module (see Figure 11) comprises an internal transport device having a transport frame which mainly comprises two fixed side panels 126 and 127 which are interconnected at the rear by a transverse panel 128 and at the front by a transverse panel 423 and which is supported on a base plate 130 by means of legs 129. Said base plate is mounted in the frame 17 of the recorder module 9 by means of damping blocks 131 (see Figure 8).

In the transport frame an upper plate 132 and a lower plate 133 are mounted so as to be movable. Relative to the surrounding transport frame said plates can perform a limited vertical movement. For guiding the vertical movements short guide rails 134 are arranged at the corners of the transport frame, of which rails only a single one is visible in Figure 11. At each of its corners the top plate 132 carries a block 135 with guide rollers 136 and 137. At its corners the bottom plate 133 is provided with a block 138 with guide rollers 139 and 140. At the corners of the transport frame connecting plates 141 are disposed. Between the connecting plates 141 and the top plate 132 compression springs 142 are arranged. The top plate 132 and the bottom plate 133 have castellated edges 143 and 144 respectively extending along three sides. Said edges are arranged in such a way relative to each other that the projections of the one castellated edge engage the recesses of the other castellated edge. The edge 143 of the top plate 132 carries inwardly projecting pins 145 and the edge 144 of the bottom plate 133 carries identical pins 146. In the situation shown in Figure 11, in which the recorder module

contains no cassette, the pins 145 and 146 are arranged in line.

Nearer the side of the front panel 423, guide blocks 147 are provided at the left and right, which blocks contain a guide slot 148 for guiding a cassette. In the position shown in Figure 11 the guide blocks 147 and the top and bottom plates 132 and 133 respectively are in such relative positions that a cassette can be inserted into the recorder module between the plates 132 and 133. The pins 145 and 146 extend into the slot 123 between the edges 124 of the cassette and thus do not impede insertion of the cassette, unless it is in an incorrect position, the pins nearest the guide blocks 147 butting against the projection 125 in the slot 123. A motor 149 (see Figure 12) with a spindle 150 and a turntable 151 is mounted on the base plate 130 of the recorder module. The turntable is provided with a rubber drive ring 152 and a central recess 153. It has such dimensions that it can accommodate the centring cap 119 of the optical disc 7.

For moving an optical pick-up 155 (Figure 12) underneath the optical disc adjacent the motor 149 an actuating device 154 is arranged on the base plate 130. The base plate 130 further carries a helium-neon laser 156 and a stationary opto-electronic unit underneath a cover 157. A light beam 158 produced by the laser 156 is deflected through an angle of 90° by a mirror 159, passes through a shutter 160 and via an aperture 161 reaches the space underneath the cover 157. By means of a stationary prism 162 the light beam is again deflected through 90° , after which it passes through a lens system 163 which causes the diameter of the light beam to increase. Subsequently the light beam is split into two beams by a polarizing prism 164. One of said beams leaves the space underneath the cover 157 via a lens 165 and is incident on a light-sensitive cell 167 via an aperture 166. Slow intensity variations of the light beam are measured by means of said cell, so that the laser can be adjusted when a permissible minimum value is not reached. Furthermore, the cell signals whether the shutter 160 is open or closed and the signal is employed in a compensator for a tracking error signal (see further).

The other beam emerges through an aperture 168 in the cover 157 and is routed to a movable objective 172 via a stationary prism 169, a movable mirror 170 and a prism 171 belonging to the optical pick-up 155. The objective 172 resembles an objective type as known from United States Patent Specification 4,021,101 (PHN 7938) (herewith incorporated by reference). It mainly comprises a lens system arranged in a cylindrical mount, which by means of a cylindrical moving coil is electromagnetically movable in a vertical direction. In order to obtain an objective bearing-arrangement with an extremely low friction the present recorder module employs an air-bearing arrangement. Pressurized air for the bearing arrangement is supplied through an air tube 173. The stationary prism 169 and the movable mirror

170 are located on a support 174 with apertures 175 and 176 for the passage of the light beam. The movable mirror 170 may be of a type as known from United States Patent Specification 4,129,930 (PHN 8650) (herewith incorporated by reference).

The beam reflected by the underside of the disc 7 returns to the space underneath the cover 157 via the objective 172, the prism 179, the mirror 170 and the prism 169 through the aperture 168. For simplicity the quarterwave plates required in the optical path have been omitted, which plates cooperate with the polarizing prisms that are used. The part of the reflected beam transmitted by the polarizing prism 164 is split into three beams for three opto-electronic units 180, 181 and 182 by a second polarizing prism 167, a third polarizing prism 178 and a prism 179. These three units serve for converting the high-frequency beam modulation into an electrical modulation which contains the information present on the disc 7 and for generating a focusing-error signal and a tracking-error signal respectively. The focusing error signal is employed in a control circuit for correcting the focusing position of the objective 172. The tracking-error signal is employed for correcting the position of the movable mirror 170. For a further description of the optical and electronic details of optical disc players and digital optical recorders reference is made to the relevant literature, such as the previously mentioned article "An optical disc replaces 25 magnetic tapes" by G.C. Kenney et al. in IEEE Spectrum, Febr. 1979.

For the radial movement of the optical pick-up 155 the actuating device 154 (Figure 8) comprises a member 183 on which the optical pick-up is arranged. The member is slidable in a yoke 184 of a linear motor 185, which on both sides of the member comprises permanent magnets 186 and 187, and a linearly movable coil connected to the member 183. On both sides of the actuating device 154 stops 189 and 190 are provided, which limit the travel of the member 183.

The internal transport device of the recorder module 9 for transferring a cassette 3 between its loading position at the rear of the recorder module and the recorder operating position on the recorder module mainly comprises first means for horizontally shifting the cassette between the top plates 132 and 133 and second means which serve for moving the disc 7 vertically toward the turntable 151 and at the same slightly opening the cassette.

By means of the external transport device to be described hereinafter, a cassette, through an aperture 27 and via the slots 148 of the guide blocks 147 (Figure 11), is moved through some distance between the plates 132 and 133, a plurality of freely rotating guide rollers 191 in the bottom plate 133 contributing to a low resistance. On the top plate 132 a U-shaped bracket 192 is arranged, which pivots about two pins 193. In the bracket 192 a spindle 194 is journaled, which spindle drives drive rollers 195 on both sides of the bracket. Via gear wheels 196 and 197 the

spindle can be rotated by a motor 198 which is rigidly connected to the bracket 192. By means of two compression springs 199, which press against a stationary bar 200 on the upper side of the recorder frame, the bracket 192 is urged downward. By means of a solenoid 201, a right-angled lever 202, a cam 203 and a roller 204 connected to the bracket 192, the bracket 192 can be lifted slightly against the pressure of the springs 199. The bracket 192 is retained in the slightly lifted position during insertion of a cassette, so that the rollers 195 do not impede insertion. In the top plate 132 two light sources 430 and 431 are mounted. The first source cooperates with a light-sensitive cell 432 in the bottom plate 133 and the second source with an identical cell, not shown. The power supply to the solenoid 201 is not turned off and the rollers 195 are not urged against the upper side of the cassette by the springs 199 until a cassette has been moved past the rollers 195 between the top and bottom plates 132 and 133, which is signalled by the light-sensitive cell 432. By energization of the motor 198 the cassette can then be moved further between the plates 132 and 133 in a horizontal direction. Three microswitches 205, 206 and 207 cooperate with the edge of the inserted cassette, the switch 207 sensing the position of the recess 49 in the rear of the cassette in order to ascertain whether the cassette is correctly positioned in the recorder. By the use of two switches 205 and 206 oblique positioning of the cassette can be detected. In each of its covers the cassette has a slot 208, which in the recorder should face downwards to permit passage of the light beam from the laser. In Figures 4 and 10 the cassettes 3 are shown in a version in which the slot 208 is open. An embodiment of a cassette provided with means for closing the slot 208 is described in the Applicant's previous Application no. 80 04 378 (PHN 9808) (herewith incorporated by reference). At the rear of the transport frame a bracket 209 is arranged, which is adapted to cooperate with projecting portions of slides on the cassette, which slides serve to close the slot 208.

When the rollers 195 have moved the cassette the full distance between the plates 132 and 133, the opening 118 of the optical disc 1 is situated above the turntable 151 and underneath a disc hold-down device 210. By means of a pin 211 said disc hold-down device is mounted on a vertically movable traversing mechanism 212 which runs over the top plate 132. Between the disc hold-down device 210 and the traversing mechanism 212 a compression spring 213 is arranged which urges the disc hold-down device downwards. In the top plate 132 an aperture 214 is formed for the passage of the disc hold-down device.

The second part of the internal transport device of the recorder module, for vertically moving the optical disc 1 onto the turntable 151, comprises a motor 215 which drives a toothed cam 217 by means of a pinion 216. Said cam is rigidly connected to a rod 218 to which a similar cam 219 is rigidly secured on the other side of the recorder.

However, the cam 219 is not formed with teeth. The rod 218 is journaled in the side plates 126 and 127 of the transport frame, so that the cams 217 and 219 can perform a rotary movement. By means of pivots 220 the two cams are pivotally connected to left-hand and right-hand slides 221 respectively. Said pins each move in a slot in the corresponding slide. The slides are longitudinally movable on the side plates 126 and 127 of the transport frame and are guided by a plurality of guide rollers 222. The bottom plate 133 comprises laterally projecting pins 223, which engage in slots 224 in the slides 221. The traversing mechanism 212, on which the disc hold-down device 210 is arranged, comprises side plates 225 which are vertically movable on the side plates 126 and 127 of the transport frame and which are guided by guide rollers 226. The side plates 225 of the traversing mechanism 212 carry pins 436 which engage in slots 228 in the slides 221. As the spindle 218 rotates, the slides 221 are moved in the longitudinal direction. Owing to the shape of the slots 228 the traversing mechanism 212 is then moved downwards via the pins 227. At a later instant the pins 233 also move the bottom plate 133 downward. The top plate 132 follows the movement of the bottom plate 133 under the influence of the pressure exerted on the top plate 132 by the compression springs 142. At a specific instant the guide rollers 136 reach stops 227, which prevent the top plate 132 from moving further downwards. The pins 145, which project into the slot 123 of an inserted cassette, retain the upper cover 120, so that it cannot move further downwards. The bottom plate 133 is moved further downward and, via the pins 146, takes with it the cassette cover which is disposed nearer the turntable 151. During this downward movement the traversing mechanism 212 and thus the disc hold-down device 210 are moved further downward. At a certain instant the disc 1 is positioned on the turntable 151. The lower cover of the cassette is moved slightly further downwards by the pins 146 and the disc hold-down device 210 is pressed onto the upper cap 119 of the disc, so that the disc is centred and pressed in place on the turntable. The two covers 120 are now separated from each other in such a way that the disc 1 can be rotated inside the covers. During the stroke of the two slides 221 the end 434 of a spring 229 are arranged around the rod 218 is pressed against the cassette. This additional pressure, which is directed towards the switches 205—207 and the bracket 209, is necessary to overcome the counteracting pressure of the switches. Moreover, in the case of cassettes provided with slides for closing the slots 208, which slides can be opened by the bracket 209 there are provided springs for closing the slides. The spring force of said springs is also overcome by means of the spring 229, so that the cassette is urged into its correct final position between the plates 132 and 133. The rod 218 further carries an element 230 which moves with the rod 218. Said element ensures that the covers 120 of the cas-

sette remain sufficiently spaced from each other at the side of the cassette adjacent the rod 218. This is required in those cases in which the covers 120 are not entirely rigid and may therefore sag slightly. The pins 145 and 146 are disposed on three sides of the transport frame only, not on the side at which the rod 218 is located, with the result that at this side the covers 120 could sag and the distance between the covers become too small.

For controlling the movements of the two slides 221 there are provided two switches 231 and 232, of which the last-mentioned switch cooperates with the non-toothed cam 219 and the first-mentioned switch with a cam (not shown) which is located behind the cam 219 in Figure 11. The two final positions of the slides 221 are detected by means of these two switches.

Inside the module frame 17 (Figure 8) of the recorder module there are also located a plurality of bins 234 equipped with electronic circuits. Furthermore, there is provided a plate 235 on which a plurality of connectors 236 are mounted for the electrical connections of the recorder module.

The external transport device (Figure 13)

The external transport device comprises a cassette changer 237 which is movable inside the enclosure of the data-storage system along the back of all the recorder modules and storage modules in a horizontal and a vertical direction. On the rear of the data storage system there are disposed an upper horizontal gear rack 238 and a lower horizontal gear rack 239. There are further provided an upper horizontal guide rod 240 and a lower horizontal guide rod 241. The two horizontal guide rods 240 and 241 guide a carriage 242 which is horizontally movable along the back of the data storage system, which carriage can be moved horizontally along the two gear racks 238 and 239 by means of gear wheels 243 and 244.

The carriage 242 mainly comprises an upper part and a lower part, which are interconnected by four vertical guide rods 245, 246, 247 and 248. The upper part of the carriage 242 comprises a drive unit for the horizontal movement of the carriage and for the vertical movement of the cassette changer 237. The drive unit comprises a frame plate 249, two flange plates 250 and 251, side plates 252 and 253, a spacer rod 254, two guide blocks 255 and 256, two motors 257 and 258, a shaft 259 traversing the spacer rod 254, on which shaft toothed pulleys 260, 261 and 262 are mounted, a toothed drive pulley 263 on the spindle of the motor 258, a bevel gear 264 on the spindle of the motor 257, a bevel gear 265 and a drive shaft 266 on which the bevel gear 265 is mounted, and two gear wheels 243 and 244. The two motors 257 and 258 are each provided with a built-in tachogenerator and a Gray-code shaft-position indicator.

The lower part of the carriage 242 comprises two side plates 267 and 268 which are interconnected by means of a spacer rod 269. On said

spacer rod blocks 270 and 271 are arranged, which are connected to guide blocks 273 and 274 by means of leaf springs 272. Toothed guide pulleys 275 and 276 are mounted on the side plates 267 and 268 so as to be freely rotatable.

The motor 258 drives the two pulleys 260 and 261 via a toothed belt 277. The pulley 260 cooperates with a toothed belt 278, which at the lower end is guided round the pulley 275. The pulley 261 drives a toothed belt 279, which at the lower end is guided round the pulley 276.

The cassette changer 237 is accommodated in a carrier which comprises a side plate 280, a side plate 281 and a connecting plate 282. The side plates 280 and 281 of said carrier are connected to the toothed belts 278 and 279 respectively and can slide on the guide rods 246 by means of ball guide bushes 283 and 284. On the other side, two sets of ball bearings 285 A, B and 286 A, B run on the rod 248. In order to compensate for the weight of the cassette changer and the carrier there are provided counterweights 287 and 288, which are also connected to the respective toothed belts 278 and 279 and which are guided on the guide rods 245 and 247 respectively.

The cassette changer 237 (see Figure 14) mainly comprises a changer frame comprising two side plates 290 and 291 and intermediate plates 305 and 306, which are connected to each other by means of eight hollow spacers 292 to 299. Through the spacers threaded rods 300 extend onto which nuts 301 are fitted. Each of these spacers comprises a plurality of separate portions which are together arranged on a threaded rod. On both sides of the changer frame laterally projecting suspension pins 302 and 303 are located, by means of which the cassette changer is suspended in the carrier so as to be slightly pivotal. A limited pivotal range is of importance for the correct operation of the cassette changer in order to enable compensation for small positioning errors of the cassette changer relative to the slots 27. The side plates 280 and 281 of the carrier comprise rubber stops 304, which limit the pivotal movements of the cassette changer relative to the carrier.

The cassette changer is equipped with two retaining devices for two cassettes, so that two cassettes can be interchanged at the back of a module. In the cassette changer two compartments 307 and 308 are formed for the insertion of a cassette 3. Figure 14 shows a cassette 3 partly inserted in the compartment 307. The cassette changer is equipped with three motors 309, 310 and 311. The motors 309 and 310 are equipped with tachogenerators. Motor 309 drives a belt 313 via a pulley 312 mounted on its spindle. Said belt runs round a pulley 314 which is rigidly connected to a traversing shaft 315. Said shaft projects from the side plates 290 and 291 and carries pulleys 316 and 317 at the outer sides of said side plates. Via short belts 318 and 319 said pulleys drive two pulleys 320 and 321 respectively, which via short shafts 322 and 323 drive toothed pulleys 324 and 325 respectively, which are situated at the inner

sides of the side plates 290 and 291. A track chain 326 runs round the pulley 324 at one end and at the other end round a freely rotatable toothed pulley 327, which pulley is adjustable in order to tension the track chain. A track chain 328 runs round the pulley 325 and round a freely rotatable pulley 329, which is also adjustable. Thus, the two track chains 326 and 328 can be driven simultaneously and synchronously the motor 309. By means of the two track chains a cassette 3 can be fed into the compartment 308 of the cassette changer. For the insertion of a cassette into the compartment 307 there are provided two similar track chains 330 and 331. The motor 310 is provided with a pulley 332 which drives a belt 333 which runs round a pulley 334. Said pulley is rigidly connected to a traversing shaft 335 which extends in a lateral direction beyond the two intermediate plates 305 and 306. At one end of the track chains 330 and 331 pass round toothed pulleys 336 and 337 which are rigidly mounted on the shaft 335. At the other end the track chains 330 and 331 are guided round freely rotatable toothed pulleys 338 and 339 respectively, which are again adjustable.

In the compartments 307 and 308 of the cassette changer the cassettes are supported by the track chains. Thus, they can be moved in said compartments by means of the motors 309 and 310. In order to avoid slip between the cassettes and the track chains there are provided pressure rollers 340 to 343 for urging the cassettes against the track chains. The pressure rollers 340 and 341 urge a cassette against the track chains 326 and 328 in the upper compartment 308, the pressure rollers 342 and 343 urge a cassette against the track chains 330 and 331 in the lower compartment 307. In addition to said pressure rollers there are provided guide rollers 344 and 345 for a cassette in the upper compartment 308 and guide rollers 346 and 347 for a cassette in the lower compartment 307.

The pressure rollers should not impede entry of the cassettes into the cassette changer. Therefore, they are arranged on slightly pivotable levers 348 to 351, which during insertion of a cassette can be pivoted away slightly. Tension springs 352 pull the pressure rollers downwards by means of metal wires 353 which run over rollers 354 and which terminate in caps 355. For pivoting the levers cams 356 to 359 are provided, which are rigidly connected to the shafts 360 and 361. Said shafts can be rotated through a limited angle by the motor 311, which via toothed pulleys 362 to 365 and a toothed belt 435 drives the two shafts 360 and 361. On the pulley 433 cams 366 to 368 are arranged in order to detect and control the degree of rotation of the shafts 360 and 361 by means of two switches 369 and 379.

The orientation of the cams on the shaft 360 is opposed to that of the cams on the shaft 361. By having the motor 311 rotate anti-clockwise or clockwise, either the one set of pressure rollers or the other set of pressure rollers is lifted, but never both sets of pressure rollers at the same time.

In order to retain cassettes in the cassette changer there are provided the pressure rollers 340 to 343, which exert pressure on the upper side of a cassette. A plurality of rollers 371 is provided on the side plates 290 and 291 to exert lateral pressure on a cassette under the bias of leaf springs 372 if said cassette is slightly shifted in the lateral direction relative to the neutral position.

For sensing the presence and the position of a cassette in the cassette changer there is provided a plurality of switches 375 to 378 on two back plates 373 and 374. On a centre plate 380 four light sources 381 to 384 are arranged. Said sources emit light beams in the direction of light-sensitive cells 385 to 388 on the centre plate 389 and on the intermediate plate 305. By means of these light sources and light-sensitive cells the presence of a cassette in the cassette changer can be sensed at two locations, in order to control the motor 311 which actuates the pressure rollers and for duly braking the track chains when the end position is approached.

For the sake of clarity a number of details of the cassette changer which are shown in Figure 14 have been omitted in Figures 2 and 13.

Operation of the Data-storage System

The data-storage system is controlled by means of an external computer and with internal control computers in a control module. The internal computers never communicate directly with each other but only via the external computer. The recorder modules, the storage modules and the external transport device are equipped with separate microprocessors, which may be located in the control module, for controlling the internal functions and for communication with the outside computer. Since the control system is not part of the present invention, it will only be discussed when it is of importance for the description of the operation of the data-storage system in accordance with the invention.

The present description is based on an initial situation in which all cassettes are disposed at their locations in the storage modules and in which the system is inoperative. When the system is put into service the internal transport devices execute a locating routine in each storage module under control of its control computer, which routine serves for accurately locating the cassette positions. The motor 72 (Figure 4) moves the carriage 36 from the beginning to the end of the guide rail 69, the optical device 390 generating position signals as it passes the openings in the strip 402, the maximum values of the signals corresponding to the positions of the cassette slots 392 in the lower rack plate 31. The signals from the optical device 390 are related to the position code of the carriage 36 of the translation device 35 signalled by the rotating Gray-code shaft-position indicator 391. Thus, each cassette location is periodically stored in Gray code in a memory. The resolution of this method of locating the cassettes is 0.2 to 0.3 mm. An internal

transport device without backlash is essential in this respect. If desired, said locating routine may be repeated at regular intervals, for example daily. In the memory of the external computer two addresses are assigned to each cassette, one for each side of the optical disc. Each address contains a code number of the storage module and a code number of the location of the cassette in the storage rack within the storage module.

Requests for reproduction or storage of data are applied to the control computer of the storage module by the external computer in the form of addresses. After it has been ascertained which cassette is to be removed from a storage module the external computer feeds a signal to the relevant storage module in which the desired cassette is located. The internal transport device of said storage module moves towards the cassette, which is disposed at the specified location, under control of the Gray-code shaft-position indicator 391. The internal transport device 32 is then moved in the longitudinal direction of the storage module by the motor 72. The sliding member 39 is in such a position that it can move underneath the cassettes through the recesses 49 in the cassettes.

The rings of the gripping device 34 are in the vertical position, as is shown in Figure 4. When the specified cassette location is reached the unlatching bracket 393 (Figure 3) is energized, so that the latching tumbler 413 (fig. 7) is pivoted away and the relevant cassette can be pulled forward by the sliding member 39. The motor 43 is energized and the sliding member 39 moves in the direction of the carriage 36, the position of the sliding member being detected by a Gray-code shaft-position indicator 395 on the motor 43. When the cassette is being pulled out of the storage rack the cassette is slightly guided by the two guide lugs 50 on the arm 37. Furthermore, the cassette, when it is slightly further pulled out, is supported by the pins 52 between which the cassette is moved. The gripping device 34 is open, so that the rings 53 do not impede the movement of the cassette out of the storage rack. The end position of the cassette is detected by optoelectronic means, not shown. Subsequently the motor 43 is de-energized and the motor 66 is energized, so that the cam 67 is rotated and the levers 58 are moved, causing the rings 53 to move towards each other. The bevelled edges 54 of said rings ensure that the bevelled, circular edge 55 of the central opening of the cassette is centred relative to the gripping device 34 whilst in addition a small vertical displacement (approximately 1.5 mm) is produced, so that the cassette comes clear of the arm 37. The pads 57 are in contact with the cassette in order to prevent a rotation of the cassette. Via the address the external computer has specified which side of the optical disc is to be used. The motor 59 is energized and rotates in a direction such that the gear wheel 61 tilts the gripping device 34 in the correct direction. Tilting is terminated when the opto-electronic device 425 or 428 detects the selected horizontal position of

the cassette. Subsequently, the motor 72 of the horizontal transport device is switched on again and the cassette is moved to the rear aperture 27. If possible, tilting and internal transport are effected simultaneously. This depends on the starting position of the carriage 36 and thus on the address of the selected cassette. When the back of the storage module is reached the roller 92 rolls up the track 96 of the run-on cam 95, so that the sensing arm 76 is pivoted upward. The carriage 36 is advanced until the cassette is disposed in a transfer position in the slot 27, through which the cassette projects partly from the storage module.

In the meantime the external transport device, under command of its control computer, has positioned the cassette changer 237 before the aperture 27 of the relevant storage module. The motor 257 then drives the carriage 242 via the gear wheel 243 in a horizontal direction along the back of the module, the position being signalled by a Gray-code shaft-position indicator 396 on the motor 257. The motor 258, which via the pulleys 260 to 263 and the toothed belts 278 and 279 drives the carrier for the cassette changer 237, is also equipped with a Gray-code shaft-position indicator 397. The internal control computer thus constantly receives information as to the horizontal and vertical position of the cassette changer and by energization of the motors 257 and 258 can send the cassette changer to any point at the back of the data storage system covered by the external transport device, the position of each point defined by a horizontal and a vertical coordinate. For a fast and effective movement of the cassette changer along the back of the data-storage system the control computer may be programmed in such a way that the horizontal and vertical movements can be performed simultaneously whenever possible.

Obviously, it should be avoided that a cassette changer moves towards an aperture 27 at the back of a module at the instant that a cassette is located in this aperture in the loading position, because in that case damage to the cassette and the data storage system is not unlikely. This situation is precluded by the external computer ensuring that the cassette changer 237 is first moved to its ultimate position in front of the aperture before the internal transport device of the storage module is allowed to move the cassette through the aperture into the loading position.

The internal transport device of the storage module moves the cassette outwards through the aperture 27 so far that the cassette is transferred to one of the compartments 307 and 308 of the cassette changer, above the track chains which are disposed at the bottom of the relevant compartment and beneath the pressure rollers which have been pivoted away from the cassette by means of the motor 311. Assuming that the cassette is disposed in the lower compartment 307 of the cassette changer, the cassette, as is shown in Figure 14, will be disposed on the track

(22)

chains 330 and 331 and underneath the pressure roller 342 and 343, which is detected by the light-sensitive cells 383 and 387. The cassette, in the loading position, can now be taken over by the cassette changer. By means of the motor 311 the pressure rollers 342 and 343 are swung down, so that said rollers bear on the top of the cassette under the influence of the tension springs 352 and urge the cassette onto the track chains 330 and 331. In the storage module the motor 59 is energized, so that the gripping device 34 is opened, as a result of which the rings 53 no longer retain the cassette and do not impede a further outward displacement of the cassette. The motor 310 of the cassette changer is started and the track chains 330 and 331 pull the cassette further into the cassette changer to an end position which is detected by the end switches 378 and 379. The light-sensitive cells 384, 388 supply a signal for braking the motor 310 slightly before the said end position.

The external transport device now positions the cassette changer in front of the aperture of the recorder module. Subsequently the cassette is moved in the reverse direction by the cassette changer and via the guide slots 148 it is inserted between the plates 132 and 133 of the recorder module (Figure 11). The solenoid 201 is energized, so that the rollers 195 do not impede the indention of the cassette into the recorder module. The cassette changer moves the cassette in the recorder module into a transfer position in which the cassette is located underneath the rollers 195, which is detected by the light-sensitive cell 432. A further displacement of the cassette can now be effected by the internal transport device of the recorder module. By means of the motor 311 the pressure rollers 342 and 343 are lifted off the cassette. The power supply to the solenoid 201 is switched off and the rollers 195 are pressed against the top of the cassette by the springs 199. The motor 198 of the recorder module is switched on and the cassette is conveyed over the rollers 191 in the bottom plate 132 into an end position, which is detected by the end switches 205 to 207. When the end position of the cassette is reached this also provides a signal for the control computer of the external transport device. Via the external computer said control computer acknowledges that the cassette changer is allowed to move again.

In the recorder module the motor 215 is now energized, so that the slides 221 are slid out of their positions shown in Figure 11. The traversing mechanism 212 is lowered and the optical disc is centred by the disc hold-down device 210. Then the two plates 130 and 132 also begin to move downward, so that the cassette bodily moves in the direction of the turntable 151. At a certain instant the rollers 136 of the top plate 132 reach the stops 227, after which the top plate can no longer move further downwards. The pins 145 of the top plate 132 now retain the upper cover of the cassette, whilst the lower cover is moved further downward by the pins 146 as a result of

the continuing movement of the bottom plate 133, so that the two cassette covers are moved apart against the force of the resilient connecting members 121 of the cassette. The optical disc reaches the turntable 151 and is centred thereon and retained by the disc hold-down device 210. The bottom plate 133 moves slightly further, so that the lower cover of the cassette no longer makes contact with the optical disc. The end position of the slides 221 is signalled by one of the switches 231 and 232, after which the motor 215 is switched off. Before the guide rollers 136 have reached the stops 227 the covers of the cassette are pressed towards the switches 205—207 by the end 434 of the spring 229. In the end position the cassette covers are separated from each other by the element 230 on the rod 218. Closing elements, if provided, for the slot 208 of the cassette are opened by the bracket 209 before the switches 205 and 207 are changed over. The optical pick-up 155 can now focus the laser beam on the optical disc, which is freely rotatable inside the cassette by the motor 149, through the slot 208. The actuating device 154 moves the pick-up 155 to a position on the optical disc which is derived from the address data received from the external computer by the control computer of the recorder module. The desired data is now, for example, read and electronically processed in order to be applied to suitable output units such as a display terminal, an external buffer memory, a facsimile apparatus, or a printer. Obviously, it is alternatively possible to record data on to the optical disc instead of reading data present on the optical disc.

While an optical disc is being located on the turntable in the recorder module and while data is subsequently being read from or recorded on the disc, the external transport device moves the cassette changer to a different storage module in order to fetch the next cassette. The cassette is transferred from the storage module to the cassette changer in the manner described in the foregoing and the cassette changer is returned to the recorder module. When it is assumed that the new cassette is again located in the compartment 307 of the cassette changer, the cassette changer is positioned in such a way in front of the recorder module that the empty compartment 308 of the changer is disposed opposite the aperture 27 of the recorder. Upon termination of the read or write operation the internal transport device of the recorder module performs the previously described transport operations in the reverse sequence, so that the drive rollers move the cassette out of the recorder module through the aperture 27 via the guide slots 148 into a transfer position in which the cassette is located underneath the pressure rollers 340 and 341 of the cassette changer and above the track chains 326 and 328. The solenoid 201 is energized and the pressure rollers 195 are lifted off the upper cassette cover. The pressure rollers 340 and 341 of the cassette changer are swung down and the cassette can be pulled into the cassette changer

by the track chains 326 and 328. The end position of the cassette is detected by the two switches 375 and 376. Subsequently the cassette changer is moved over a small distance in the vertical direction by the control computer of the transport device in such a way that the cassette which is now in the compartment 307 is located in front of the aperture of the recorder module and thus in front of the guide slots 148. This cassette can now be inserted into the recorder module, where it is taken over by the internal transport device of the recorder module. Thus, the cassettes at the back of the recorder module are rapidly interchanged and no time is lost in returning the cassette just taken from the recorder module and in fetching a new cassette to be delivered to the recorder module.

In the foregoing the operation of data storage system in accordance with the invention has been explained by means of a single example. It is alternatively possible to employ a plurality of recorder modules in a data storage system, so that the cassette changer is to be moved by the external transport device between a plurality of storage modules and a plurality of recorder modules. Furthermore, it is alternatively possible in the case of larger data-storage systems in accordance with the invention to divide the external transport device into a plurality of sections each with a separate cassette changer.

If a cassette is to be manually placed into or removed from a storage module the control computer of the storage module ensures that no undesired situations can arise. The internal transport device of the relevant storage module is moved to the front of the storage module under command of its control computer, the sensing arm 75 being swung up by the run-on cam 93. By means of the solenoid 105 the blocking element 104 is released, so that a cassette can be inserted through an aperture 26. In the mean time the gripping device 34 has been moved into a horizontal position. The cassette, guided by the guide rollers 101 and 102, can be inserted between the rings 53 of the gripping device. Insertion of the cassette should be continued until the switches 86 and 87 have detected the end position and the correct position of the cassette. At this instant the gripping device is closed and the cassette can be moved inwards by the translation device 35. By means of the solenoid 105 the blocking element 104 is again set to its blocked position. In the case of manual removal of a cassette from the storage module the operations proceed in the reverse sequence. In general it will be desirable that the storage modules are provided with separate control panels, so that a manual control mode of the storage module is possible. Such control panels are not present in the data storage system shown in the drawing, but may be added if desired.

Claims

1. A modular data storage system comprising:
 - a plurality of identical data carriers having a

recording layer in which data can be recorded in coded form and from which said data can be read

- at least one recorder apparatus provided with supporting means for supporting a data carrier in a recorder operating position and provided with recording and/or read means for recording and/or reading data on and/or from a data carrier which is in the recorder operating position,

- at least one storage module for storing a plurality of said data carriers closely adjacent each other, which storage module comprises a module frame,

- an internal transport device accommodated within the module frame of the storage module for the transport of data carriers between a storage position and a transfer position at the back of the storage module,

- an external transport device, which cooperates with the storage module at the back, for the transport of data carriers between said transfer position at the back of the storage module and a loading position near a recorder apparatus,

- an enclosure for the external transport device located at the back of the storage module, and

- at least one electronic control unit for coordinating and controlling the transport of the data carriers between their storage positions in the storage modules and the loading positions near the recorder apparatus, the storage modules being capable of being arranged on top of and adjacent each other in optional configurations to form enclosed modular systems adapted to specific storage-capacity requirements, the external transport device cooperating with each storage module at the back and the enclosure of the external transport device being adapted to the resulting external dimensions of said configuration of combined storage modules,

characterized in that

- the recorder apparatuses are constituted by recorder modules having a module frame, which together with the storage modules can be arranged on top of and adjacent each other in optional configurations to suit specific requirements,

- said loading positions of the data carriers are located at the backs of the recorder modules,

- the external transport device cooperates with the backs of the storage modules and recorder modules,

- the enclosure of the external transport device is adapted to the resulting external dimensions of said configuration of storage and recorder modules, and

- each of the recorder modules comprises an internal transport device for the transport of a data carrier between said loading position at the back of the recorder module and said recorder operating position inside the recorder module.

2. A modular data storage system as claimed in Claim 1, characterized in that further units belonging to the system, such as the said electronic control unit, a power supply unit etc., are constituted by control modules, power-supply modules

by the track chains 326 and 328. The end position of the cassette is detected by the two switches 375 and 376. Subsequently the cassette changer is moved over a small distance in the vertical direction by the control computer of the transport device in such a way that the cassette which is now in the compartment 307 is located in front of the aperture of the recorder module and thus in front of the guide slots 148. This cassette can now be inserted into the recorder module, where it is taken over by the internal transport device of the recorder module. Thus, the cassettes at the back of the recorder module are rapidly interchanged and no time is lost in returning the cassette just taken from the recorder module and in fetching a new cassette to be delivered to the recorder module.

In the foregoing the operation of data storage system in accordance with the invention has been explained by means of a single example. It is alternatively possible to employ a plurality of recorder modules in a data storage system, so that the cassette changer is to be moved by the external transport device between a plurality of storage modules and a plurality of recorder modules. Furthermore, it is alternatively possible in the case of larger data-storage systems in accordance with the invention to divide the external transport device into a plurality of sections each with a separate cassette changer.

If a cassette is to be manually placed into or removed from a storage module the control computer of the storage module ensures that no undesired situations can arise. The internal transport device of the relevant storage module is moved to the front of the storage module under command of its control computer, the sensing arm 75 being swung up by the run-on cam 93. By means of the solenoid 105 the blocking element 104 is released, so that a cassette can be inserted through an aperture 26. In the mean time the gripping device 34 has been moved into a horizontal position. The cassette, guided by the guide rollers 101 and 102, can be inserted between the rings 53 of the gripping device. Insertion of the cassette should be continued until the switches 86 and 87 have detected the end position and the correct position of the cassette. At this instant the gripping device is closed and the cassette can be moved inwards by the translation device 35. By means of the solenoid 105 the blocking element 104 is again set to its blocked position. In the case of manual removal of a cassette from the storage module the operations proceed in the reverse sequence. In general it will be desirable that the storage modules are provided with separate control panels, so that a manual control mode of the storage module is possible. Such control panels are not present in the data storage system shown in the drawing, but may be added if desired.

Claims

1. A modular data storage system comprising:
 - a plurality of identical data carriers having a

recording layer in which data can be recorded in coded form and from which said data can be read

- at least one recorder apparatus provided with supporting means for supporting a data carrier in a recorder operating position and provided with recording and/or read means for recording and/or reading data on and/or from a data carrier which is in the recorder operating position,

- at least one storage module for storing a plurality of said data carriers closely adjacent each other, which storage module comprises a module frame,

- an internal transport device accommodated within the module frame of the storage module for the transport of data carriers between a storage position and a transfer position at the back of the storage module,

- an external transport device, which cooperates with the storage module at the back, for the transport of data carriers between said transfer position at the back of the storage module and a loading position near a recorder apparatus,

- an enclosure for the external transport device located at the back of the storage module, and

- at least one electronic control unit for coordinating and controlling the transport of the data carriers between their storage positions in the storage modules and the loading positions near the recorder apparatus, the storage modules being capable of being arranged on top of and adjacent each other in optional configurations to form enclosed modular systems adapted to specific storage-capacity requirements, the external transport device cooperating with each storage module at the back and the enclosure of the external transport device being adapted to the resulting external dimensions of said configuration of combined storage modules,

characterized in that

- the recorder apparatuses are constituted by recorder modules having a module frame, which together with the storage modules can be arranged on top of and adjacent each other in optional configurations to suit specific requirements,

- said loading positions of the data carriers are located at the backs of the recorder modules,

- the external transport device cooperates with the backs of the storage modules and recorder modules,

- the enclosure of the external transport device is adapted to the resulting external dimensions of said configuration of storage and recorder modules, and

- each of the recorder modules comprises an internal transport device for the transport of a data carrier between said loading position at the back of the recorder module and said recorder operating position inside the recorder module.

2. A modular data storage system as claimed in Claim 1, characterized in that further units belonging to the system, such as the said electronic control unit, a power supply unit etc., are constituted by control modules, power-supply modules



etc., each having a module frame, which modules may all be arranged on top of or adjacent each other in a specific configuration so as to form a modular system.

3. A modular data storage system as claimed in Claim 1 and 2, characterized in that:

- the modules are arranged in a mounting rack,
- the module frame of each module is movable relative to the rack by means of a guiding device and

- by means of the guiding device each of the movable module frames is movable between an operating position inside the rack and a maintenance position at least partly outside the rack.

4. A modular data storage system as claimed in Claim 1, each storage module having a front wall at the front, characterized in that:

- in the front wall of at least one of the storage modules an aperture is formed, which is adapted to the external dimensions of a data carrier, for the manual insertion or removal of a data carrier into or from the storage module,

- in the storage module there are provided signalling means for signalling the presence of a data carrier in the aperture, and

- by means of the internal transport device the data carriers are movable in the storage module between the storage position and a transfer position in the aperture at the front of the storage module.

5. A modular data storage device as claimed in Claim 4, characterized in that the aperture in the front wall of the storage module can be blocked by means of a movable blocking element.

6. A modular data storage system as claimed in Claim 3, in which:

- the data carriers are arranged vertically in the storage position in a storage rack in a storage module parallel to the front wall thereof,

- each storage module has an internal width which is greater than twice the width of a data carrier, so that adjacent the storage rack an internal transport space is formed having a width greater than the width of a data carrier,

- the internal transport device of the storage module comprises a sliding device for sliding a data carrier parallel to the front wall of the storage module into and out of the storage rack, between the storage position and a slid-out position within the transport space,

- said internal transport device comprises a gripping device for gripping the data carrier in the transport space, and

- said internal transport device comprises a translation device for the transport of a gripped data carrier in the depth direction of the storage module between the slid-out position and a transfer position.

characterized in that

- the data carriers comprise discs having a first recording layer on a first side and a second recording layer on the second side, and

- said internal transport device comprises a tilting device which is pivotable in two directions

for tilting a disc in the transport space through 90° in a first direction or through 90° in an opposite second direction in order to transfer the disc in the transfer position in a first or in a second tilted orientation.

7. A modular data storage system as claimed in Claim 6, said translation device in the storage module comprising an internal transport carriage, characterized in that

- the tilting device is located on the internal carriage and tilts the data carriers into a horizontal position,

- on said carriage a substantially L-shaped sensing arm is arranged having a first limb connected to said carriage, which limb extends horizontally in the direction of translation of said carriage towards the front of the storage module and has an end which is remote from said carriage, and having a second limb connected to said end, which second limb extends transversely of the first limb, and

- the second limb carries signalling elements for signalling the correct horizontal position of a data carrier,

8. A modular data storage system as claimed in Claim 7, in combination with Claim 4, characterized in that

- on said internal carriage there is provided a second substantially L-shaped sensing arm having a first limb connected to the carriage, which limb extends horizontally in the direction of translation of the carriage towards the rear of the storage module and has an end which is remote from the carriage, and having a second limb connected to said end, which second limb extends transversely of the first limb,

- the second limb carries signalling elements for signalling the correct horizontal position of a data carrier,

- of each of the substantially L-shaped sensing arms at least a portion of the first limb which portion is situated nearer the second limb, is pivotable between a sensing position and a pivotable position, in which position a data carrier can be moved in a horizontal direction without being impeded by the sensing arm, and

- near the front of the storage module there is arranged a front run-on cam and at the rear of the storage module a rear run-on cam, which cams during the movement of the carriage of the storage module to the front or to the rear respectively cooperate with the pivotal portion of the substantially L-shaped sensing arm which faces the relevant side in order to move said arm from the sensing position to the pivoted position.

9. A modular data storage system as claimed in Claim 1, the external transport device comprising a vertical guiding device at the rear of a plurality of stacked modules and a changer which is movable in a vertical direction along the guiding device, which changer is provided with a retaining device for a data carrier, characterized in that

- in the case of a plurality of modules arranged adjacent each other the external transport device comprises a horizontal guiding device at the rear



of the configuration of modules which are arranged on top of and adjacent each other, and
 — the entire vertical guiding device is horizontally movable along the horizontal guiding device, so that the changer is both horizontally and vertically movable along the back of the configuration of modules.

10. A modular data storage device as claimed in Claim 1, the external transport device comprising a changer which is movable along the back of a plurality of modules, which changer comprises a retaining device for a data carrier, characterized in that the changer is provided with two retaining devices for two data carriers, in order to enable two data carriers to be interchanged at the back of a module.

Patentansprüche

1. Modulare Datenspeichervorrichtung mit

— einer Anzahl gleichförmiger Datenträger mit einer Aufzeichnungsschicht, in der die Daten kodiert aufgezeichnet und daraus ausgelesen werden können,

— mit zumindest einer Rekordervorrichtung mit Unterstützungsmitteln zum Unterstützen eines Datenträgers in einer Rekorderstellung und mit Aufzeichnungs- und/oder Lesemitteln zum Aufzeichnen und/oder Lesen der Daten auf bzw. aus einem in der Rekorderstellung befindlichen Datenträger,

— mit zumindest einem Speichermodul indem eine Anzahl der Datenträger nahe beieinander untergebracht werden, und wobei der Speichermodul ein Modulgestell enthält,

— mit einer im Modulgestell des Speichermoduls vorgesehenen inneren Transportvorrichtung zum Befördern von Datenträgern zwischen einer Speicherstellung und einer Durchgangsstellung an der Rückseite des Speichermoduls,

— mit einer an der Rückseite mit dem Speichermodul zusammenarbeitenden externen Transportvorrichtung zum Befördern von Datenträgern zwischen der Durchgangsstellung an der Rückseite des Speichermoduls und einer Ladestellung bei einer Rekordervorrichtung,

— mit einem an der Rückseite des Speichermoduls vorgesehenen Umbau für die externe Transportvorrichtung sowie

— zumindest einer elektronischen Steuereinheit zum Koordinieren und Steuern des Transports der Datenträger zwischen ihren Speicherstellungen in den vorhandenen Speichermodulen und den Ladestellungen beim Rekorder, wobei die Speichermodulen zur Bildung eingebauter modularer Vorrichtungen mit einem an den Bedarf angepassten Datenspeicherkapazität auf und nebeneinander in gewünschten Konfigurationen zusammengefügt werden können, wobei die externe Transportvorrichtung mit jedem Speichermodul an der Rückseite zusammenarbeitet und der Umbau der externen Transportvorrichtung an die sich ergebende Aussenabmessung der erwähnten Konfiguration zusammengefügt Speicher-

modulen angepasst ist, dadurch gekennzeichnet,

— dass die vorgesehenen Rekordervorrichtungen durch Rekordermodulen mit einem Modulgestell gebildet werden, die mit den Speichermodulen auf und nebeneinander in gewünschter, an den Bedarf angepasster Konfigurationen zusammengefügt werden können,

— dass sich die Ladestellungen der Datenträger an den Rückseiten der vorgesehenen Rekordermodulen befinden,

— dass die externe Transportvorrichtung mit den Rückseiten der vorgesehenen Speichermodulen und Rekordermodulen zusammenarbeitet,

— dass der Umbau der externen Transportvorrichtung an die sich ergebenden Aussenabmessungen der Konfiguration von Speicher und Rekordermodulen angepasst ist, und

— dass jeder der vorgesehenen Rekordermodulen eine innere Transportvorrichtung zum Befördern eines Datenträgers (3) zwischen der Ladestellung an der Rückseite des Speichermoduls und der Rekorderstellung im Rekordermodul besitzt.

2. Modulare Datenspeichervorrichtung nach Anspruch 1, dadurch gekennzeichnet, dass auch andere zur Vorrichtung gehörende Einheiten, wie z.B. die elektronische Steuereinheit, eine Speiseeinheit usw. durch Steuermodulen, Speichermodulen usw., mit je einem Modulgestell gebildet werden, wobei alle Modulen auf und/oder nebeneinander in einer bestimmten Konfiguration zur Bildung einer modularen Vorrichtung zusammenfügbar sind.

3. Modulare Datenspeichervorrichtung nach Anspruch 1 und 2, dadurch gekennzeichnet,

— dass die Modulen in einem Trärgestell (4) angebracht sind,

— dass das Modulgestell jedes Moduls mit Hilfe einer Führungsvorrichtung in bezug auf das Trärgestell bewegbar ist, und

— dass jedes der bewegbaren Modulgestelle mit Hilfe der Führungsvorrichtung zwischen einer Betriebsstellung im Trärgestell und einer Wartungsstellung wenigstens teilweise ausserhalb des Trärgestells bewegbar ist.

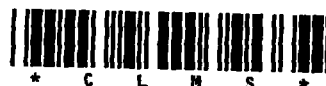
4. Modulare Datenspeichervorrichtung nach Anspruch 1, bei der jeder Speichermodul eine Vorderwand an der Vorderseite besitzt, dadurch gekennzeichnet,

— dass in der Vorderwand zumindest eines Speichermoduls eine an die Aussenabmessungen eines Datenträgers angepasste Durchgangsöffnung zum handbetätigten Ein- oder Ausführen eines Datenträgers in bzw. aus dem Speichermodul vorgesehen ist,

— dass Signalisierungsmittel im Speichermodul zum Signalisieren eines Datenträgers in der Durchgangsöffnung vorgesehen sind,

— dass die Datenträger von der inneren Transportvorrichtung im Speichermodul zwischen ihrer Speicherstellung und einer Durchgangsstellung an der Vorderseite des Speichermoduls in der Durchgangsöffnung transportierbar sind.

5. Modulare Datenspeichervorrichtung nach Anspruch 4, dadurch gekennzeichnet, dass die



Durchgangsöffnung in der Vorderwand des Speichermoduls mit einem bewegbaren Blockierungselement blockierbar ist 6. Modulare Datenspeichervorrichtung nach Anspruch 3, bei der

— die Datenträger in der Speicherstellung vertikal in einem Aufbewahrungsrahmen in einem Speichermodul parallel zur vorderen Wand des Speichermoduls angeordnet sind

— jeder Speichermodul eine innere Breite besitzt, die grösser als die zweifache Breite eines Datenträgers ist, wodurch neben dem Aufbewahrungsrahmen ein innerer Transportraum mit einer Breite grösser als die Breite eines Datenträgers vorgesehen ist,

— die innere Transportvorrichtung des Speichermoduls eine Schiebevorrichtung zum Verschieben eines Datenträgers parallel zur Vorderwand des Speichermoduls in den Aufbewahrungsrahmen hinein oder daraus heraus zwischen der Speicherstellung und einer im Transportraum liegenden vorgeschobenen Stellung enthält,

— die innere Transportvorrichtung eine Greifervorrichtung zum Festgreifen des Datenträgers im Transportraum besitzt, und

— die innere Transportvorrichtung eine Umsetzungsvorrichtung zum Befördern eines festgegriffenen Datenträgers in der Tiefenrichtung des Speichermoduls zwischen der vorgeschobenen Stellung und einer Durchgangstellung,

dadurch gekennzeichnet,

— dass die Datenträger-Platten mit einer ersten Aufzeichnungsschicht an einer ersten Seite und einer zweiten Aufzeichnungsschicht an einer zweiten Seite enthalten, und

— dass die innere Transportvorrichtung eine in zwei Richtungen drehbare Kippvorrichtung zum Kippen einer Platte im Transportraum über 90° in einer ersten Richtung oder über 90° in einer entgegengesetzten zweiten Richtung besitzt und so die Platte in die Durchgangstellung in einer ersten oder einer zweiten gekippten Orientierung weiterleitet.

7. Modulare Datenspeichervorrichtung nach Anspruch 6, bei der die Umsetzungsvorrichtung im Speichermodul einen inneren Transportwagen enthält, dadurch gekennzeichnet,

— dass sich die Kippvorrichtung auf dem inneren Transportwagen befindet und die Datenträger in eine waagerechte Stellung kippt,

— dass auf dem Transportwagen ein im wesentlichen L-förmiger Fühler mit einem ersten mit dem Transportwagen verbundenen Schenkel, der sich waagerecht in der Umsetzungsrichtung des Transportwagens nach der Vorderseite des Speichermoduls erstreckt und ein vom Transportwagen abgewandtes Ende besitzt, sowie mit einem zweiten mit diesem Ende verbundenen zweiten Schenkel (79) vorgesehen ist, der sich senkrecht zum ersten Schenkel erstreckt, und

— dass der zweite Schenkel signalisierungselemente zum Signalisieren der richtigen horizontalen Stellung eines Datenträgers (3) trägt.

8. Modulare Datenspeichervorrichtung nach

Anspruch 7 in Kombination mit dem Anspruch 4, dadurch gekennzeichnet,

— dass auf dem inneren Transportwagen ein zweiter im wesentlichen L-förmiger Fühler vorgesehen ist, der einen ersten mit dem Transportwagen verbundenen Schenkel, der sich waagerecht in der Umsetzungsrichtung des Transportwagens nach der Rückseite des Speichermoduls erstreckt und vom Transportwagen angewandtes Ende besitzt, sowie mit einem Ende verbundene zweiten Schenkel besitzt, der sich senkrecht zum ersten Schenkel erstreckt,

— dass der zweite Schenkel Signalisierungselemente zum Signalisieren der richtigen horizontalen Stellung eines Datenträgers trägt,

— dass wenigstens ein näher beim zweiten Schenkel liegender Teil des ersten Schenkels jedes im wesentlichen L-förmigen Fühlers zwischen einer Fühlerstellung und einer geschwenkten Stellung schwenkbar ist, in der ein Datenträger in horizontaler Richtung verschoben werden kann, ohne dass der Fühler dabei ein Hindernis bildet, und

— dass sich nahe bei der Vorderseite des Speichermoduls ein vorderer Auflaufnocken und an der Rückseite des Speichermoduls ein hinterer Auflaufnocken befinden, die beim Bewegen des Transportwagens des Speichermoduls nach der Vorderseite bzw. nach der Rückseite mit dem gelenkigen Teil des der betreffenden Seite zugewandten, im wesentlichen L-förmigen Fühlers zum Verschieben dieses gelenkigen Teils aus der Fühlerstellung in die Schwenkstellung zusammenarbeiten.

9. Modulare Datenspeichervorrichtung nach Anspruch 1, bei der die externe Transportvorrichtung eine vertikale Führungsvorrichtung an der Rückseite einiger übereinander angeordneter Moduln und ein entlang der Führungsvorrichtung in vertikaler Richtung bewegbarer Wechsler mit einer Festhaltevorrichtung für einen Datenträger enthält, dadurch gekennzeichnet,

— dass beim Vorhandensein einiger nebeneinander angeordneter Moduln die externe Transportvorrichtung eine horizontale Führungsvorrichtung an der Rückseite der Konfiguration von über- und nebeneinander angeordneten Moduln besitzt, und

— dass die vertikale Führungsvorrichtung horizontal entlang der horizontalen Führungsvorrichtung bewegbar ist, so dass der Wechsler sowohl in horizontaler als auch in vertikaler Richtung längs der Rückseite der Konfiguration von Moduln bewegbar ist.

10. Modulare Datenspeichervorrichtung nach Anspruch 1, bei der die externe Transportvorrichtung einen längs der Rückseite einiger Moduln bewegbaren Wechsler mit einer Festhaltevorrichtung für einen Datenträger enthält, dadurch gekennzeichnet, dass der Wechsler mit zwei Festhaltevorrichtungen für zwei Datenträger versehen ist, mit welchen Festhaltevorrichtungen an der Rückseite eines Moduls zwei Datenträger austauschbar sind.



Revendications

1. Système modulaire de stockage de données comprenant:

— plusieurs supports de données identiques comportant une couche d'enregistrement dans laquelle des données peuvent être enregistrées sous une forme codée et de laquelle les données peuvent être lues,

— au moins un appareil enregistreur pourvu de moyens de support pour supporter un support de données dans une position de fonctionnement de l'enregistreur et pourvu de moyens d'enregistrement et/ou de lecture pour enregistrer et/ou lire des données sur un/à partir d'un support de données qui se trouve dans la position de fonctionnement de l'enregistreur,

— au moins un module de stockage pour stocker plusieurs supports de données les uns tout près des autres, ce module de stockage comprenant un châssis de module,

— un dispositif de transport interne logé dans le châssis de module du module de stockage pour transporter des supports de données entre une position de stockage et une position de transfert au dos du module de stockage,

— un dispositif de transport externe qui coopère avec le module de stockage au dos de celui-ci pour transporter des supports de données entre la position de transfert au dos du module de stockage et une position de chargement près d'un appareil enregistreur,

— une enceinte pour le dispositif de transport externe installée au dos du module de stockage, et

— au moins une unité de commande électronique pour coordonner et commander le transport des supports de données entre leurs positions de stockage dans les modules de stockage et les positions de chargement près de l'appareil enregistreur, les modules de stockage pouvant être disposés les uns au-dessus des autres et les uns près des autres selon des configurations choisies pour former des systèmes modulaires clos adaptés à des exigences de capacité de stockage spécifiques, le dispositif de transport externe coopérant avec chaque module de stockage à l'arrière et l'enceinte du dispositif de transport externe étant adaptée aux dimensions externes résultantes de la dite configuration de modules de stockage combinés,

caractérisé en ce que:

— les appareils enregistreurs sont constitués de modules enregistreurs comportant un châssis de module qui, avec les modules de stockage, peuvent être disposés les uns au-dessus des autres et les uns près des autres selon des configurations choisies conformément à des exigences spécifiques,

— les positions de chargement des supports de données sont disposées aux dos des modules enregistreurs,

— le dispositif de transport externe coopère avec les dos des modules de stockage et des modules enregistreurs,

— l'enceinte du dispositif de transport externe est adaptée aux dimensions externes résultantes de la configuration de modules de stockage et enregistreur, et

— chaque module enregistreur comprend un dispositif de transport interne pour le transport d'un support de données entre la position de chargement située au dos du module enregistreur et la position de fonctionnement de l'enregistreur située à l'intérieur du module enregistreur.

2. Système modulaire de stockage de données suivant la revendication 1, caractérisé en ce que d'autres unités appartenant au système, telles que l'unité électronique de commande, une unité d'alimentation de courant, etc., sont constituées par des modules de commande, des modules d'alimentation de courant, etc., comportant chacun un châssis de module, ces modules pouvant tous être disposés les uns audessus des autres ou les uns près des autres selon une configuration spécifique de manière à former un système modulaire.

3. Système modulaire de stockage de données suivant les revendications 1 et 2, caractérise en ce que:

— les modules sont disposés dans un bâti de montage,

— le châssis de module de chaque module est mobile par rapport au bâti de montage à l'intervention d'un dispositif de guidage, et

— au moyen du dispositif de guidage, chaque châssis de module mobile peut être déplacé entre une position de fonctionnement à l'intérieur du bâti et une position d'entretien au moins partiellement à l'extérieur du bâti.

4. Système modulaire de stockage de données suivant la revendication 1, chaque module de stockage comportant une paroi antérieure à l'avant, caractérisé en ce que:

— dans la paroi antérieure d'au moins un des modules de stockage est ménagée une ouverture qui est adaptée aux dimensions externes d'un support de données et qui est destinée à l'introduction manuelle d'un support de données dans le module de stockage ou à son enlèvement de celui-ci.

— des moyens de signalisation sont prévus dans le module de stockage pour signaler la présence d'un support de données dans l'ouverture, et

— au moyen du dispositif de transport interne, les supports de données sont mobiles dans le module de stockage entre la position de stockage et une position de transfert dans l'ouverture prévue à l'avant du module de stockage.

5. Dispositif modulaire de stockage de données suivant la revendication 4, caractérisé en ce que l'ouverture de la paroi antérieure du module de stockage peut être bloquée au moyen d'un élément de blocage mobile.

6. Système modulaire de stockage de données suivant la revendication 3, dans lequel:

— les supports de données sont disposés verticalement dans la position de stockage dans un magasin dans un module de stockage parallèle-



ment à sa paroi antérieure,

— chaque module de stockage présente une largeur interne qui est supérieure au double de la largeur d'un support de données de sorte qu'un espace de transport interne est formé près du magasin et a une largeur supérieure à celle d'un support de données,

— le dispositif de transport interne du module de stockage comprend un dispositif coulissant destiné à faire coulisser un support de données parallèlement à la paroi antérieure du module de stockage dans le magasin et hors de celui-ci entre la position de stockage et une position d'extraction située dans l'espace de transport,

— le dispositif de transport interne comprend un dispositif de préhension destiné à saisir le support de données dans l'espace de transport, et

— le dispositif de transport interne comprend un dispositif de translation destiné à déplacer un support de données saisi dans le sens de la profondeur du module de stockage entre la position d'extraction et une position de transfert, caractérisé en ce que:

— les supports de données sont des disques comportant une première couche d'enregistrement sur une première face et une seconde couche d'enregistrement sur une seconde face, et

— le dispositif de transport interne comprend un dispositif d'inclinaison qui peut pivoter dans deux directions pour incliner un disque dans l'espace de transport de 90° dans un premier sens ou de 90° dans un second sens opposé au premier, afin de transférer le disque dans la position de transfert dans une première ou dans une seconde orientation inclinée.

7. Système modulaire de stockage de données suivant la revendication 6, le dispositif de translation dans le module de stockage comprenant un chariot de transport interne, caractérisé en ce que:

— le dispositif d'inclinaison est monté sur le chariot interne et incline les supports de données dans une position horizontale,

— sur le chariot, un bras détecteur en substance en L est monté et comporte une première branche reliée au chariot, cette branche s'étendant horizontalement dans la direction du mouvement de translation du chariot vers l'avant du module de stockage et comportant une extrémité qui est éloignée du chariot, et une seconde branche reliée à la dite extrémité, cette seconde branche s'étendant transversalement à la première, et

— la seconde branche porte des éléments de signalisation destinés à signaler la position horizontale correcte d'un support de données.

8. Système modulaire de stockage de données suivant la revendication 7, en combinaison avec la revendication 4, caractérisé en ce que:

— sur le chariot interne est prévu un second

bras détecteur en substance en L comportant une première branche reliée au chariot, cette branche s'étendant horizontalement dans le sens du mouvement de translation du chariot vers l'arrière du module de stockage et comportant une extrémité qui est éloignée du chariot, et une seconde branche reliée à la dite extrémité, cette seconde branche s'étendant transversalement à la première,

— la seconde branche porte des éléments de signalisation destinés à signaler la position horizontale correcte d'un support de données,

— pour chacun des bras détecteurs en substance en L, au moins une partie de la première branche, qui est située plus près de la seconde branche, peut pivoter entre une position de détection et une position décalée dans laquelle un support de données peut être déplacé horizontalement sans être gêné par le bras détecteur, et

— près de l'avant du module de stockage est disposée une came antérieure et, à l'arrière du module de stockage, une came postérieure qui, pendant le déplacement du chariot du module de stockage vers l'avant ou vers l'arrière, respectivement coopèrent avec la partie pivotante du bras détecteur en substance en L qui est dirigée vers le côté en question afin de faire passer le bras de la position de détection à la position décalée.

9. Système modulaire de stockage de données suivant la revendication 1, le dispositif de transport externe comprenant un dispositif de guidage vertical à l'arrière de plusieurs modules empilés et un changeur qui est mobile dans un sens vertical le long du dispositif de guidage, ce changeur étant pourvu d'un dispositif de retenue pour un support de données, caractérisé en ce que:

— dans le cas de plusieurs modules disposés les uns près des autres, les dispositifs de transport externe comprennent un dispositif de guidage horizontal à l'arrière de la configuration de modules disposés les uns au-dessus des autres et les uns près des autres, et

— le dispositif de guidage vertical entier est mobile horizontalement le long du dispositif de guidage horizontal, de sorte que le changeur est à la fois mobile horizontalement et verticalement le long du dos de la configuration de modules.

10. Dispositif modulaire de stockage de données suivant la revendication 1, le dispositif de transport externe comprenant un chargeur qui est mobile le long du dos de plusieurs modules, ce chargeur comprenant un dispositif de retenue pour un support de données, caractérisé en ce que le changeur est pourvu de deux dispositifs de retenue pour deux supports de données, afin de permettre la permutation de deux supports de données au dos d'un module.

