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(54) Control system for illumination devices

(57) The invention relates to a control system and method for a lighting device (1) adapted to be controlled by means of control signals in compliance with a high-speed transmission protocol. The system according to the invention comprises a central control unit (2) adapted to transmit control signals (s1) in compliance with said high speed transmission protocol, a plurality of peripheral control units (3) adapted to activate said lighting devices.

The invention is characterised in that said system comprises first means (4) adapted to convert said control signals (s1) transmitted by said central unit in one or more low-speed data flows (s2) and second means (5) adapted to transmit said low-speed data flow (s2) on at least one supply line (6) adapted to supply electrical power to said lighting devices.

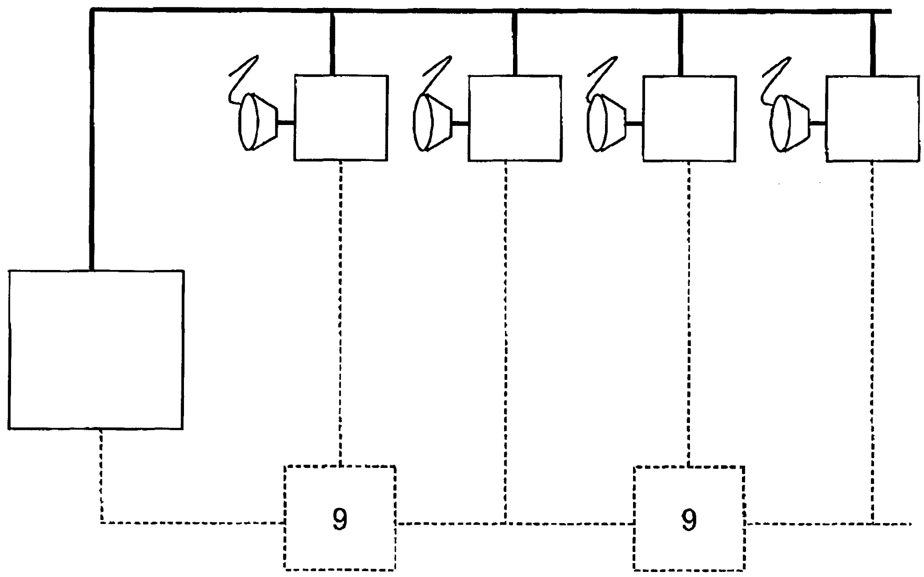

Fig. 1

EP 1 631 126 A2

Description

[0001] The invention relates to a control method for lighting devices according to the preamble of claim 1.

[0002] Current lighting installations tend to use an increasing number of lighting devices based on Light Emitting Diodes (LED); in fact these are efficient at energetic level, virtually they do not produce heat, and have a very long operating life.

[0003] These devices are suited to a very efficient digital type control; for this reason well-known computerised lighting systems exist which use LED diodes.

[0004] The US patent US 5,420,482 describes a system which uses various coloured LED diodes to generate a selectable colour, mainly for application on a display.

[0005] The American patent US 4,845,481 describes a variable colour display comprising a plurality of visualisation areas arranged in 7 segments. Each of the visualisation areas is composed of at least two LED diodes, of different primary colours, the light of which is combined to obtain a compound colour. The diodes are activated selectively in a manner to obtain the required characters. The colour control system regulates the duration of the activating impulses of the diodes this controlling the compound colour.

[0006] The American patent US 5,184,114 describes a LED visualisation system, and, again, patent US 5,134,387 describes a display with LED matrixes.

[0007] Lighting systems wherein a lighting installation, or in other words, a network of lights, is controlled by a central control unit, that can possibly be operable through video screen interfacing from a PC.

[0008] Said type of lighting system can also be applied in theatre lighting systems and these are typically based on high speed communication protocols, such as protocol DMX-512 (250 Kbit/s) for example, that permit the supply of sufficient data for the entering of all the parameters (dimming, angle slant, etc) of the lighting devices.

[0009] A significant problem of current lighting systems is that they require special cables and wiring.

[0010] In particular, one set of cables is necessary for electrical power, while a second set is needed for data, such as the protocol data DMX-512, for example. As a result, the owner of an existing light installation will have to make considerable efforts to rewire the whole installation in order to obtain a controlled digital luminous environment.

[0011] A second significant problem is linked with the need to modify the lighting installation, adding or moving lighting devices of various types. This need sometimes results from the fact that different lighting applications can require different types of lights; for example, LED based lights are appropriate for certain applications, in particular for illumination of buildings, while incandescent lamps or halogen lighting can be more appropriate for other applications, especially where high power is required.

[0012] A user who wishes to modify his own digital controlled lighting installation is therefore forced to reposition different cables according to the new positions.

[0013] In known state of the art, cabling problems, particularly in computer networks for offices, have been resolved through radiofrequency data transmission or through the supply network by means of conveyed wave communication protocols.

[0014] These solutions pose serious problems and do not have a large-scale application in lighting systems for various reasons, for example, radio frequency transmission is subject to interference problems, while conveyed wave transmission is limited to the data transfer speed of current modems, of about 2.4-4.8 Kbit/s; a speed that does not allow to operate the more modern lighting devices that require much faster data transfer speed.

[0015] The aim of the present invention is therefore to solve the aforesaid problems and to realise a lighting installation that allows the use of different types of digital controlled lights, and that are also easily modified.

[0016] These aims are achieved by means of a control system and method for lighting installations according to the appended claims that are considered as an integrated part of the present description.

[0017] Further aims and advantages will be made more apparent from the following detailed description and the annexed drawings, provided simply as a non-limiting example wherein:

FIG. 1 shows a known system for the control of lighting devices, in particular LED devices, through DMX-512 (or 256) control signals.
FIG. 2 shows a known system for the control of lighting devices by means of a conveyed wave communication protocol.
FIG. 3 shows an embodiment of a control system for lighting devices according to the invention.
FIG. 4 shows a second embodiment of a control system for lighting devices according to the invention.
FIG. 5 shows a third embodiment of a control system for lighting devices according to the invention.
FIG. 6 shows a circuit block diagram of a compression circuit (4).
FIG. 7 shows a circuit block diagram of a decompression circuit (8).

[0018] In the following description, the term: "LED device" refers to any device that integrates LED diodes, able to receive an electric signal and produce a coloured light in response to said signal. The term "LED device" therefore refers to all types of emitting diodes, polymers that emit light, semiconductors that produce light in response to a current load, organic LEDs, electro-luminescent strips, or other similar systems. In one form, a "LED device" can refer to a single diode that has multiple matrixes with individually controlled semiconductors.

[0019] The term " lighting source" refers to any kind of lighting source: filament lamps, pyro-luminescent sources such as flames, candle luminescent sources, short arc lamps, photoluminescent sources, that comprise gas discharge lamps, fluoro-luminescent sources, phosphorescent sources, laser, electroluminescent sources, such as electro-luminescent lamps, LED, and cathodic luminescence sources that use electronic saturation, as well as mixed light sources that also comprise galvano-luminescent, crystal-luminescent, kyno-luminescent, thermo-luminescent, triboluminescent, sonoluminescent, and radioluminescent. These lighting sources can also include luminous polymers able to produce primary colours.

[0020] Further on, the term "to light" will be used to refer to the generation of a radiation with any type of frequency; this signifies that the term "a colour", as it will be used in this context must be understood as including frequencies, not only in the visible spectrum, but also frequencies in infrared and ultraviolet areas and other areas of the electromagnetic spectrum.

[0021] Fig. 1 shows a known system for the control of lighting installations comprising lighting devices, including LED devices and more generally, lighting sources, adapted to be controlled by means of control signals in compliance with high speed transmission protocols. In particular, the system shown in Fig. 1 uses a coding protocol for DMX-512 (or 256) data.

[0022] The DMX-512 USITT protocol was developed to provide a data flow from a theatre console to a range of theatre projectors.

[0023] To be more precise, the DMX-512 protocol was originally created to standardize the controlling of light dimmers from the theatre console.

[0024] The DMX-512 protocol is a multiple digital lighting protocol with a signal for controlling 512 devices, such as the devices that include a dimmer, scroller, non-dim relays, parameters for mobile lights or a graphic light in a computerised virtual set.

[0025] The DMX-512 protocol uses digital coded signals.

[0026] When a central control unit, such as a console for lights for example, sends digital codes, a receiving device such as a dimmer, transforms these codes according to a command, such as the dim at a specified level.

[0027] The advantage of digital control lies in the fact that, in comparison to analogic control, the completeness of the signal is less compromised in the case of very long sections.

[0028] When a coded string of characters 0 and I is transmitted and received, the device performs the requested function.

[0029] In terms of hardware, the data of the DMX-512 protocol is transferred among the devices through metal cables using RS-485 protocol hardware. This foresees the use of two cables, known as twisted pair. The first cable is identified as "data +" cable, and the second is identified as "data —" cable. The voltage used on the line is typically a positive voltage +5V. As an example, in order to transmit a logic one, the "data +" cable is brought to +5V and the "data —" cable to zero volts. To transmit a logic zero, the "data +"cable will be sent to zero volts, and the "data —" cable to +5V. This is somewhat different when compared to common RS-232 interfacing, where a cable is always maintained at zero volts. With the RS-232, logic one is transmitted by placing on the line a positive signal between six and twelve volts, while a logic zero is transmitted by placing on the line a negative voltage between -6V and -12V.

[0030] The RS-485 is generally considered as the best solution for data transmission compared to RS-232. In fact, with the RS-232 the receiver must measure whether the input voltage is positive or negative. With the RS-485, the receiver must only measure a voltage differential to determine which of the two cables has the higher voltage.

[0031] The two cables on which the RS-485 is transmitted are preferably twisted. "Twisting" has the meaning that the disturbances will be present on both lines, more or less in the same measure, so that the line voltages tend to oscillate, but their difference will remain exactly the same. The result is that the disturbance is eliminated from the circuit.

[0032] Moreover, the RS-485 can connect devices that are hundreds of times more distant from each other that it would be possible using the RS-232.

[0033] The RS-485 also increases the maximum data transfer speed, in other words, the maximum amount of data that can be transmitted on the line each second.

[0034] The communication between the devices through the RS-232 is normally approximately nine thousand six hundred baud (bits per second). Faster communication is possible but the distances that the data can be transmitted are considerably reduced when the communication is accelerated.

[0035] In comparison, the DMX-512 (with a RS-485) allows data to be transmitted at two hundred and fifty thousand baud (two hundred and fifty thousand bits per second) at distances of hundreds of metres without any problems.

[0036] Each transmitted byte has a start bit that is used to warn the receiver that the following character, eight data bits, is about to begin (this provides up to two hundred and fifty-six different levels) and two stop bits, that are used to communicate to the receiver that the end of the character has been reached.

[0037] This results in the fact that each byte is transmitted as a string of eleven bits; each one having duration of 4 microseconds (period corresponding to a transmission speed of two hundred and fifty thousand baud) and therefore the length of each byte is forty-four microseconds.

[0038] The device according to standard RS-485 receives two signals in input on a pair of inputs, thus measuring a differential signal, which corresponds to a sequence of logic 0 and 1, that will be then read and decoded.

[0039] If any kind of interference is accidentally transmitted on the line, this will not generate any response as long as the interference is identical on both lines. With regards to this point, it should be noted that the proximity of the two lines helps to ensure that the distribution of the interference is identical on both cables.

[0040] In the case of theatre system consoles, in compliance with DMX-512 standard, a central control unit sends five hundred and twelve device codes in a practically continuous data flow.

[0041] The receiving device is addressed with a number between one and five hundred and twelve, and therefore it will respond only to the data, which corresponds with the assigned address.

[0042] Generally, at the end of a DMX data line, a device termination resistor is installed, that reduces the possibility of a signal reflection that can create errors in the DMX signal. The ohmic value of the resistor is determined in a manner known by the type of cable used.

[0043] Some devices allow self-termination at the end of the line. Further multiple DMX data lines can be distributed through an optical repeater; This device creates a physical interruption on the line transforming the electric signals in light that crosses a section, that is then reconverted in electrical signals. This protects the devices from high voltage damage that can accidentally travel along the network. The optical repeater will also regenerate the original DMX data towards the various output lines. The input data is recreated at output, eliminating any distortion. The signal leaves the optical repeater with the same energy with which it left the console.

[0044] Each DMX message is preceded by an interruption, which is the signal for the receiver that the previous message is finished and that the following message is about to begin. The length of the pause signal (equivalent to a logic zero on the line) must be eighty-eight microseconds according to the DMX standard; even though it should be also noted that said pause signal can last longer than eighty-eight microseconds.

[0045] At the end of the pause signal, there is a period during which the signal is at a level of one logic. This fact is known as "Mark" or "Mark after break" (MAB). This time lapse is generally at least eight microseconds.

[0046] After the MAB, the first character or byte arrives, which is defmed as the "start" character. This character is defined in a rather approximate manner, and is generally established on a zero value (this can vary between zero and two hundred and fifty five).

[0047] This start character can be used to specify special messages. For example, it is possible to have five hundred and twelve dimmers that respond to messages that start with the zero character, and another five hundred and twelve dimmers that respond to messages with a one start character. In this manner, if the start character is fixed at zero for the first five hundred and twelve dimmers, and at one for the second five hundred and twelve dimmers, it is possible to control one thousand and twenty four dimmers (or more, when wanting to use the same technique).

[0048] The disadvantage lies in the reduction of the number of messages sent to each dimmer group, in the example just described above, by a factor of two.

[0049] After the "start", the message characters follow (between one and five hundred and twelve characters), that generally correspond with the channels controlled through the DMX central control unit.

[0050] Using 8 bit characters, each of these characters can have a value between zero (for the switched off signal, zero percent of the power) and two hundred and fifty five (for the completely switched on signal, 100 percent of the power).

[0051] After the last character, a further delay can occur (at one logic level) before the following pause begins.

[0052] The number of messages that are transmitted each second depend on all the parameters described above.

[0053] In the case of a pause signal of eighty-eight micro seconds, of an eight microsecond MAB, and of five hundred and twelve characters of forty-four microseconds each, 44 messages will be transmitted each second.

[0054] Many DMX control units and other sources transmit less than five hundred and twelve channels, they use a longer pause and MAB and can have a refresh rate of seventy or eighty messages per second.

[0055] Some devices are able to use sixteen-bit DMX. Normal messages with eight bit characters permit two hundred and fifty-six positions, which is inadequate for positioning mirrors and other mechanical devices.

[0056] When sixteen bit per channel are available, this quantity is increased as far as sixty-five thousand five hundred and thirty six positions, which removes the limitation of the standard DMX.

[0057] In fig. 1, a DMX central control unit (2A) transmits synthesized commands through the DMX-512 (or 256) protocol described above, using a 2-cable dedicated data line in a manner in compliance with RS-485 standards; the control signals generated in this manner are received by the peripheral control units (3A), also adapted to receive DMX signals and to operate the relative lighting devices (1), particularly LED devices.

[0058] The peripheral control units (3A) interpret the control signals, received from a dedicated data line to control the final stage of the LED device, for example, adjusting the luminous intensity, the mechanical slant of the spotlight, stroboscopic effects, non-dimmerable relays etc...

[0059] Both the DMX central control unit (2A), and the peripheral control units (3A), are fed by a supply line (for example, 220V AC, or 110V AC, or 12/14V AC/DC) through distribution boxes (9); generally the supply line is physically composed of three wires, the two phase wires and earth wire respectively. In the aforesaid system therefore, two separate cables are needed for supply and for DMX control signal transmission.

[0060] In many cases, additional cabling for high speed DMX signal transfer is not possible, or it is difficult due to lack of space, moreover this additional cabling requires special connectors and cables which increase the cost.

[0061] To prevent the problem of additional cabling, it is possible to transfer control signals through the supply line, using conveyed wave modems (5) as shown in fig. 2.

[0062] The central control unit (2B) generates signals according to a low-speed communication protocol and transmits them to a conveyed wave modem (5) through one or more data cables.

[0063] The signals transmitted from the central control unit are used for the modulation carrier frequency in the conveyed wave modem (5); this provides a complex data signal, supply and data that is placed at the modem output and directed to a conveyed wave modem receiver (7), connected to a peripheral control unit (3B) adapted to operate the lighting device (1).

[0064] In the conveyed wave modem receiver (7) the complex signal is divided into supply and data signals: the supply signal is supplied to the corresponding control unit (3B), to supply the LED device, while the data signal extracted from the supply line is also transmitted to the peripheral control unit (3B) to control the lighting device functions.

[0065] According to this known solution, only the supply network cable is used to transfer both the supply and the data signal to the lighting device, and therefore no additional cabling is necessary, and the pre-existent supply line installation is easily adapted to the connection with the controlled lighting devices.

[0066] The disadvantage of these systems is the low-speed of the data signal transfer (generally between 2.4 and 4.8 kbit/second); these systems cannot therefore be used for the control of the majority of LED devices, which normally require a standard transmission speed of 250 kbits/sec.

[0067] Figure 3 shows a control system for lighting devices that provides an advantageous embodiment for control signal transfer through a supply line.

[0068] Figure 3 shows an efficient multicolour lighting installation, with very high performance levels, both in colour range and change of colours, thanks to digital control of the various lighting sources, especially LED devices or other lighting devices.

[0069] In a preferred embodiment, said lighting devices are compliant with RS-485 standards, in other words, they are equipped with a pair of inputs through which the device reads a differential signal corresponding to one zero status or one logic.

[0070] According to the invention, the control system for lighting devices (in particular LED devices) adapted to be controlled by means of control signals compliant with a high speed transmission protocol, comprises:

- a central control unit adapted to transmit control signals, said control signals being compliant with said high-speed transmission protocol,
- a plurality of peripheral control units adapted to operate said lighting devices.

[0071] The control system according to the invention is characterised in that the system comprises first means adapted to convert said control signals transmitted from said central control unit in one or more low-speed data flows, and second means adapted to transmit said low-speed data flows on at least one supply line adapted to supply electrical power to said lighting devices.

[0072] According to the embodiment of the invention shown in figure 3, a central control unit (2) generates digital control signals (s1) compliant with DMX-512 protocol; said central control unit (2) is then connected to a compression circuit (4) where the control signals (s1) are present in the form of a high speed data flow that is then converted to a low-speed data flow for controlling a reduced number of channels, selected between the available 512 (or 256 in the case of DMX 256) .

[0073] Figure 6 shows the block diagram of a preferred embodiment of the compression circuit (4).

[0074] The DMX (4) compression circuit comprises an input stage that receives the full DMX-512 signal from the DMX (2) central control unit , and loads it in serial mode in a long shift register (10).

[0075] After having selected the necessary bits (channels), the limited number of channels (11) is transferred in parallel mode to the following output register (12) and in low frequency (equal to the bit rate of the conveyed wave modem) it is transmitted to a transmission device downstream of the compression circuit, through a suitable final stage comprising a buffer (14) (14) and an output interface (15).

[0076] Therefore, with this compression circuit solution, the information selected by said control signals, in particular the selected channels, can be transmitted by suitable means adapted to transmit data on a supply line (6) used for the electrical supply of the lighting devices (1).

[0077] Said data transmission can occur in a particular manner according to a conveyed wave communication protocol; therefore in this case, the transmission means on the aforesaid supply line will coincide with a conveyed wave modem (5).

[0078] The transmission means on the supply line, in particular a conveyed wave modem (5), use the low-speed data flow (s2) generated by the compression circuit, located upstream, to modulate a carrier frequency and to generate a second control signal (s3).

[0079] Said second control signal (s3) is composed of an electric signal which can be used to supply power to the lighting devices connected to the supply line (6) and provides information adapted to control said lighting devices.

[0080] The control signal (s3) transmitted in this way on the supply line, is received by suitable means adapted to receive this type of signals through a supply line; these means are then adapted to divide up the received signal into a supply signal and a low-speed digital data signal.

[0081] The choice of the aforesaid reception means must be coherent with the choice of the data transmission means on the supply line; therefore, by choosing to transmit information through a conveyed wave communication protocol, this reception means will consist of a conveyed wave modem (7).

[0082] Hereafter, reference will always be made to information transfer on the supply line by means of conveyed wave communication protocol, however, it is understood that any other known equivalent communication protocol can be used for the purposes of the present invention.

[0083] The transmission and/or reception means will therefore be adapted to transmit and/or receive signals on the supply line by means of the selected protocol.

[0084] According to a preferred embodiment, each conveyed wave modem receiver for the data signals sent on the supply line, is connected to a decompression circuit (8) adapted to convert to low-speed digital data signals in compliance with the high speed transmission protocol of the central control unit, and in this specific case, the DMX-512 (or 256) protocol.

[0085] The control signal transmitted on the line, a complex signal composed of supply and data, is received by the conveyed wave modem (7) and divided into two distinct signals: the supply signal and a low-speed data signal (s4) which corresponds with the low-speed data flow (s2) originally produced by the compression circuit. (4).

[0086] While the supply is directed to the peripheral control unit (3) to provide power for the lighting device (1), the data signal is directed to the decompression circuit (8).

[0087] Figure 7 shows the block diagram of said decompression circuit (8).

[0088] The decompression circuit (8) loads in serial mode, a low-speed input register (16), and transfers the contents in parallel mode (17) to the following high speed output register (18).

[0089] The high speed output register (18) is therefore loaded with dummy bits (empty, dummy channels) wherever it is not loaded in parallel mode with the low-speed input register bits; following this, the contents of the output register is transferred at high speed (19), through the output buffer (20) and interfacing (21), to the standard DMX-512 data flow containing some used bits and others set on zero.

[0090] The DMX-512 output signal created in this manner is then directed as an input signal to a peripheral control unit of a lighting device (1), in particular a LED device, to control its operation.

[0091] In this manner, 64 DMX channels, of the DMX 512 channel flow, are made available for a previously existent lighting system without the need for new cabling and installation of the supply system.

[0092] According to a preferred embodiment, an additional filtering system (22) is applied to the supply source and to each energy consumer element, such as the DMX (2) central control unit and the peripheral control units (3), in order to separate the short circuit path for the carrier of conveyed wave modem, and also to isolate any electromagnetic disturbance generated by connected units, especially if equipped with SMPS systems (Switched Mode Power Supplies) and incorrect PFC supply systems.

[0093] In this way, the modulated carrier is transmitted through the supply line, isolated by low pass filters (22) from any type of undesired noise or load signal.

[0094] Figure 4 shows a lighting device control system (1) that permits the use and transmission of all the 512 DMX channels through a plurality of means adapted to transmit low-speed data flow on the same number of supply lines; preferably these transmission means will be composed of a conveyed wave modem (5).

[0095] The DMX (2) central control unit transmits control DMX-512 (s1) signals on a common transmission line to a plurality of compression circuits (4); the DMX-512 data flow generated from the central control unit (2) is divided by the compression circuits (4), so that each circuit picks up part of the information contained in the control signal generated by the central control unit; this information is preferably composed of a limited number of high speed flow channels.

[0096] In other words, each compression circuit selects a different part of the control signal (s1) generated by said central control unit. (2).

[0097] The channels picked up in this manner are transferred to respective conveyed wave modems (5) that transfer them at low-speed to different groups of lighting devices (1) connected to different supply lines (6).

[0098] Each compression circuit (4) is connected to a conveyed wave modem (5), and each modem transmits on a different supply line — the supply lines can be isolated by low pass filters (22); in this manner groups of peripheral control units (3) are formed which adhere to the same supply line and use a limited number of channels.

[0099] Each group of peripheral control units corresponds with a supply line with a conveyed wave modem (5) at the beginning of the line, and upstream of the modem, a compression circuit (4).

[0100] In this manner, if the first group of the control units of the LED devices uses the channels from 0 to 63, the following group will use the following channels from 64 to 127, and so on, as far as the last group that will use the last part of the available channels, thus providing the complete transfer of all the 512 DMX channels.

[0101] The disadvantage of the aforesaid system is the need for supply separated lines isolated with different low pass filters (22).

[0102] This disadvantage is overcome by means of a system as shown in figure 5, that permits the transmission of all the 512 DMX channels using a single supply line.

[0103] The system shown in figure 5 comprises a plurality of pairs of means adapted to convert high speed signals to low-speed signals, and means adapted to transmit said low-speed signals on a supply line.

[0104] In a preferred embodiment, said conversion means will be composed of compression circuits (4) of the type described in figure 6, while the transmission means will be composed of a conveyed wave modem (5).

[0105] The compression circuits (4) select different information from the control signals (s1) generated by the central control unit (2) and transfer it to the corresponding conveyed wave modem (4), which uses it to modulate different carrier frequencies and to generate different control signals (s3) for low-speed transmission on the supply line.

[0106] Therefore N different conveyed wave modems (5), are therefore connected to a common supply line; the modems use N different carrier frequencies to obtain a number of transmitted channels N times greater than those normally transmitted by a single conveyed wave modem (5); In this way it is possible to transmit the entire DMX-512 data flow.

[0107] In the system shown in figure 5, each peripheral control unit is associated with means adapted to receive at least one of the control signals transmitted on said supply line.

[0108] In the preferred case of signal transmission on the supply line using a conveyed wave protocol, each peripheral control unit (3) will be associated with a conveyed wave modem (5) adapted to demodulate one of the carrier frequencies transmitted on the supply line.

[0109] Naturally, it is obvious that many variations can be applied by a person skilled in the art while remaining within the context of the invention as illustrated in the present description, the drawings and annexed claims.

[0110] In particular, according to a preferred embodiment, the lighting device comprises a housing realised in a heat conducting material for the lighting equipment adapted to dissipate heat.

[0111] Said housing contains a supply module and a light module substantially composed of two electronic cards.

[0112] The light module comprises a LED card connected thermically to a separate heat dissipater, through a heat conductor polymer and relative coupling means. In this configuration it should be considered substantially equivalent to a LED card with metal in the centre.

[0113] The light module is adapted to be conveniently interchangeable with other light modules that have a supply, and therefore programmable lighting intensity.

[0114] Other said light modules could include organic LEDS, electroluminescent strips, conventional LED diodes and other types of module.

[0115] The supply module then comprises means adapted to receiving the low-speed signal transmitted on the supply line; as described previously, said means can be composed of a conveyed wave modem

[0116] The conveyed wave modem equipped on the supply module, divides the complex data signal transmitted on the supply line into a supply signal adapted to provide power to the lighting device, and into a low-speed control signal.

[0117] The supply module then comprises a decompression circuit (8) adapted to convert the low-speed control signal (s4) to a control signal (s5) compliant with the high-speed transmission protocol used by the central control unit.

[0118] The decompression circuit is then adapted to transfer the high-speed control signal (s5) to the peripheral control unit (3) located in the light module.

[0119] Therefore in this configuration the lighting device is a system that integrates both a system for receiving signals from a supply line, as well as a decompression circuit device (8) able to convert the low-speed data flow to a DMX control signal, which can be processed by the peripheral control unit, and used to operate the lighting device, in particular a LED device.

[0120] According to the previous description, it is apparent that the invention is not limited to a simple control system for lighting devices, but also to a control method.

[0121] As is clearly apparent from the description and the drawings, in fact, the invention also relates to a control method for lighting devices adapted to be controlled through control signals in compliance with a high speed transmission protocol, said method comprising the following stages:

- Transmission of control signals through a central control unit, said control signals being compliant with said high speed transmission protocol,
- Reception of control signals through a plurality of peripheral control units adapted to operate said lighting devices.

[0122] The invention is characterised in that said control signals transmitted from said central control unit are converted into one or more low-speed data flows that are transmitted on at least one supply line adapted to provide the power supply to said lighting devices.

[0123] As has been described above, said high-speed transmission protocol is preferably a DMX protocol, in particular reduced DMX-512 or DMX-512 or DMX-256.

[0124] Quite apart from the type of protocol, the basic idea of the invention relates to a control system and method for devices that require data flow with a pre-determined speed, higher than that which can be transmitted on the supply line with current systems and communication protocols, such as a conveyed wave modem, for example.

[0125] The control method according to the invention, advantageously foresees that the control signals transmitted from the central control unit are converted to a plurality of low-speed data flows that are transmitted on multiple individual supply lines.

[0126] In another advantageous embodiment, that permits the transmission of the entire flow of DMX-512 channels, the method according to the invention foresees that the control signals transmitted from the central control unit are converted into a plurality of low-speed data flows; these are then transmitted on a single supply line by means of a plurality of conveyed wave modems that generate signals with different carrier frequencies.

Claims

1. Control system for lighting devices (1) adapted to be controlled through control signals in compliance with a high speed transmission protocol, comprising:

    - a central control unit (2) adapted to transmit control signals (s1) in compliance with said high-speed transmission protocol,
    - a plurality of peripheral control units (3) adapted to operate said lighting devices,

    characterised in that said system comprises first means (4) adapted to convert said control signals (s1) transmitted from said central control unit in one or more low-speed data flows (s2) and second means (5) adapted to transmit said low-speed data flows (s2) on at least one supply line (6) adapted to provide electrical power to said lighting devices.

2. Control system for lighting devices according to claim 1, **characterised in that** said first means (4) comprise at least a compression circuit adapted to select information from said control signals (s1), to generate a corresponding low-speed data flow (s2), and to transfer said flow to said second means (5).

3. Control system for lighting devices according to claim 2, **characterised in that** said second means (5) uses said low-speed data flow (s2) to modulate a carrier frequency and to generate a second control signal (s3).

4. Control system for lighting devices according to claim 3, **characterised in that** said second control signal (s3) is made of an electric signal that can be used to provide power for the lighting devices connected to the supply line and also provide the information adapted to control said lighting devices.

5. Control system for lighting devices according to claim 3, **characterised in that** said second control signal (s3) is received by third means (7) adapted to receive said second control signals (s3) through a supply line and adapted to divide said second control signals (s3) into a supply signal and a low-speed data signal (s4) that corresponds with the low-speed data flow (s2) originally produced by the compression circuit (4).

6. Control system for lighting devices according to claim 5, **characterised in that** said control system comprises a decompression circuit (8) adapted to convert said low-speed digital data signal (s4) into a third control signal (s5) in compliance with said high speed transmission protocol.

7. Control system for lighting devices according to claim 6, **characterised in that** said decompression circuit (8) comprises an input register (10) with a length equal to the number of bits making up said low-speed digital data signal (s4), and an output register (12) with a length equal to the number of bits making up said third control signal.

8. Control system for lighting devices according to claim 7, **characterised in that** said decompression circuit (8) transfers in serial mode the bits of the low-speed digital data signal (s4) in the input register (16) until it is loaded.

9. Control system for lighting devices according to claim 8, **characterised in that** said decompression circuit (8), after having loaded said input register (16), transfers in parallel mode the input register bits (16) to the output register (18).

10. Control system for lighting devices according to claim 9, **characterised in that** said decompression circuit (8) completes the filling of all the positions on the output register (18) with dummy bits.

11. Control system for lighting devices according to claim 9, **characterised in that** said dummy bits are set at zero logic value.

12. Control system for lighting devices according to one of the previous claims, **characterised in that** said second signals are transmitted using a conveyed wave communication protocol.

13. Control system for lighting devices according to claim 12, **characterised in that** said second and third means are conveyed wave modems.

14. Control system for lighting devices according to claim 5, **characterised in that** said lighting device comprises a supply module and a light module.

15. Control system for lighting devices according to claim 14, **characterised in that** said supply module comprises said third means.

16. Control system for lighting devices according to claim 14, **characterised in that** said supply module comprises a decompression circuit (8) adapted to convert said low-speed digital data signal (s4) into a third control signal (s5) compliant with said high speed transmission protocol, and adapted to transfer said third control signal (s5) to said peripheral control unit (2) positioned in the light module.

17. Control system for lighting devices according to one

of the previous claims, **characterised in that** said control system comprises a plurality of independent supply lines.

18. Control system for lighting devices according to claim 17, **characterised in that** said first means are composed of a plurality of compression circuits and that said second means are composed of a plurality of transmission devices, in particular conveyed wave modems, associated with said independent supply lines.

19. Control system for lighting devices according to claim 18, **characterised in that** said central control unit (2) transmits said control signals (s1) on a transmission line common to all said compression circuits.

20. Control system for lighting devices according to claim 19, **characterised in that** each compression circuit selects a different part of the control signal (s1) generated by said central control unit (2).

21. Control system for lighting devices according to claim 2, **characterised in that** said control system comprises a single supply line (6), and a plurality of pairs of first and second means.

22. Control system for lighting devices according to claim 21, **characterised in that** said first means select different information from said control signal (s1) and transfer them to the corresponding second means.

23. Control system for lighting devices according to claim 22, **characterised in that** said second means use the different information received from the respective first means to modulate different carrier frequencies and generate different second control signals (s3).

24. Control system for lighting devices according to claim 23, **characterised in that** each peripheral control unit (3) is associated with third means adated to receive at least one of said different second control signals (s3) transmitted on said supply line.

25. Control system for lighting devices according to one of the previous claims, **characterised in that** said first control signals (s1) transmitted from said central control unit are signals compliant with reduced DMX-512 or DMX-512 or DMX-256 protocols.

26. Control system for lighting devices according to one of the previous claims, **characterised in that** said lighting device is a device in compliance with RS-485 standards.

27. Control method for lighting devices adapted to be controlled by means of control signals in compliance with a high speed transmission protocol, said method comprising the following stages:

- transmission of control signals (s1) through a central control unit (2), said control signals being compliant with a said high speed transmission protocol,
- reception of control signals through a plurality of peripheral control units (3) adapted to operate said lighting devices,

characterised in that said control signals (s1) transmitted from said central control unit (2) are converted into one or more low-speed data flows (s2) that are transmitted on at least one supply line (6) adapted to provide electrical power to said lighting devices.

28. Control method for lighting devices according to claim 27, **characterised in that** said low-speed data flow (s2) is transmitted on said supply line by means of a conveyed wave communication protocol.

29. Control method for lighting devices according to the claims 27 or 28, **characterised in that** said control signals (s1) transmitted from said central control unit (2) are converted to a plurality of low-speed data flows (s2) that are transmitted on multiple individual supply lines.

30. Control method for lighting devices according to claim 29, **characterised in that** said control signals (s1) transmitted from said central control unit (2) are converted to a plurality of low-speed data flows (s2) that are transmitted on a single supply line (6) through a plurality of conveyed wave modems (5) that generate signals with different carrier frequencies.

31. Control method for lighting devices according to any one of the claims from 29 to 30, **characterised in that** said high-speed transmission protocol is the DMX-512 protocol or the reduced DMX-512 or DMX-256 protocol.

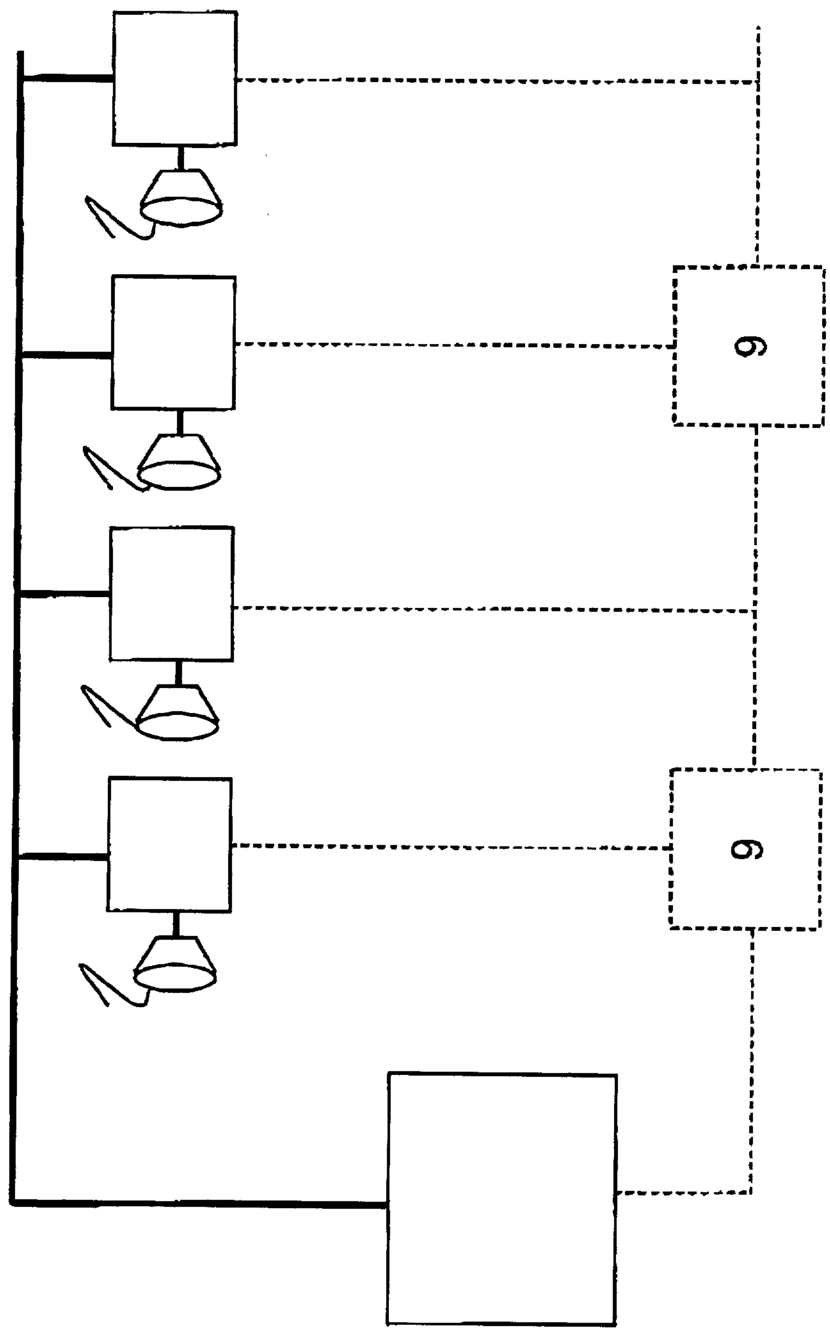

Fig. 1

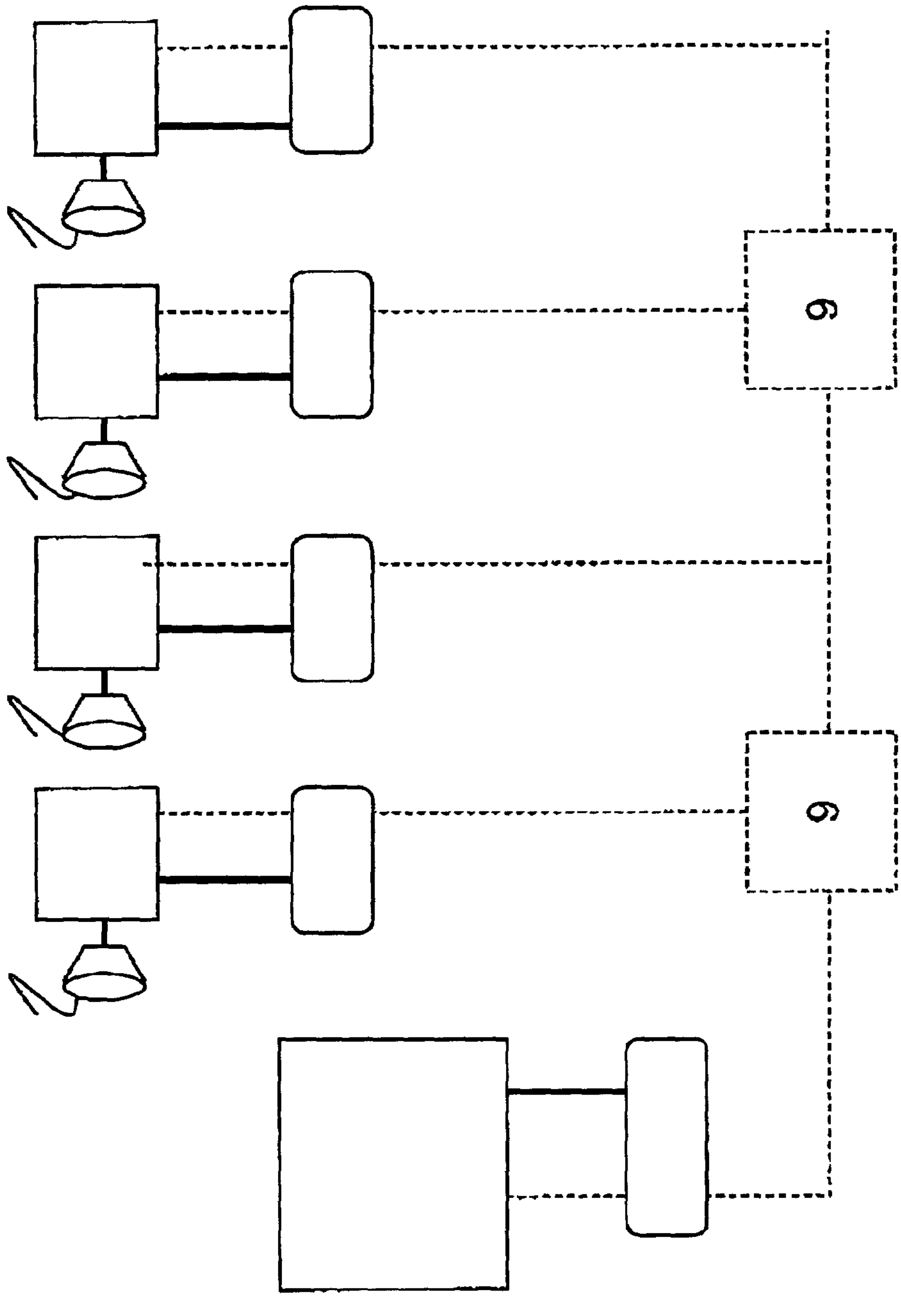

Fig. 2

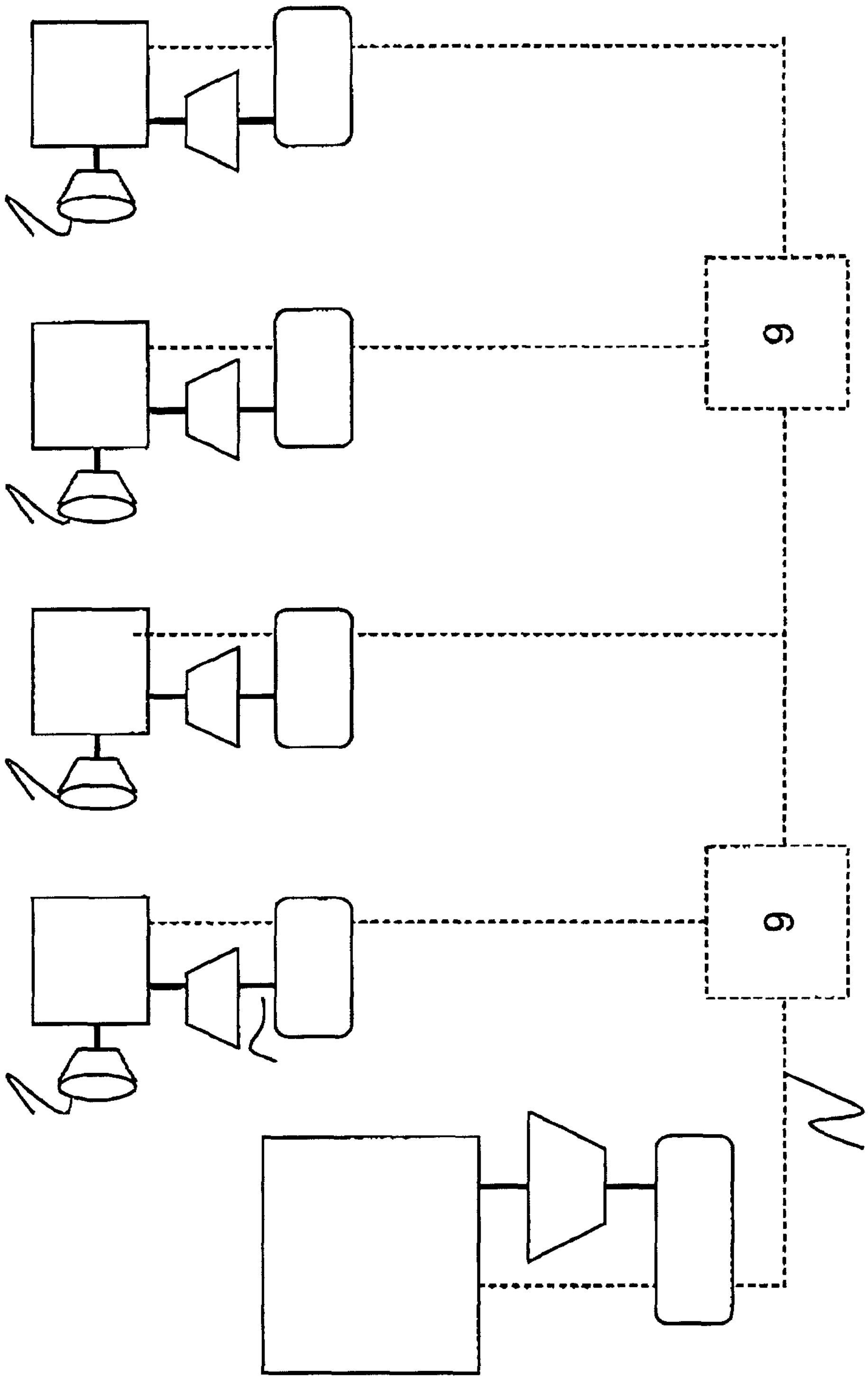

Fig. 3

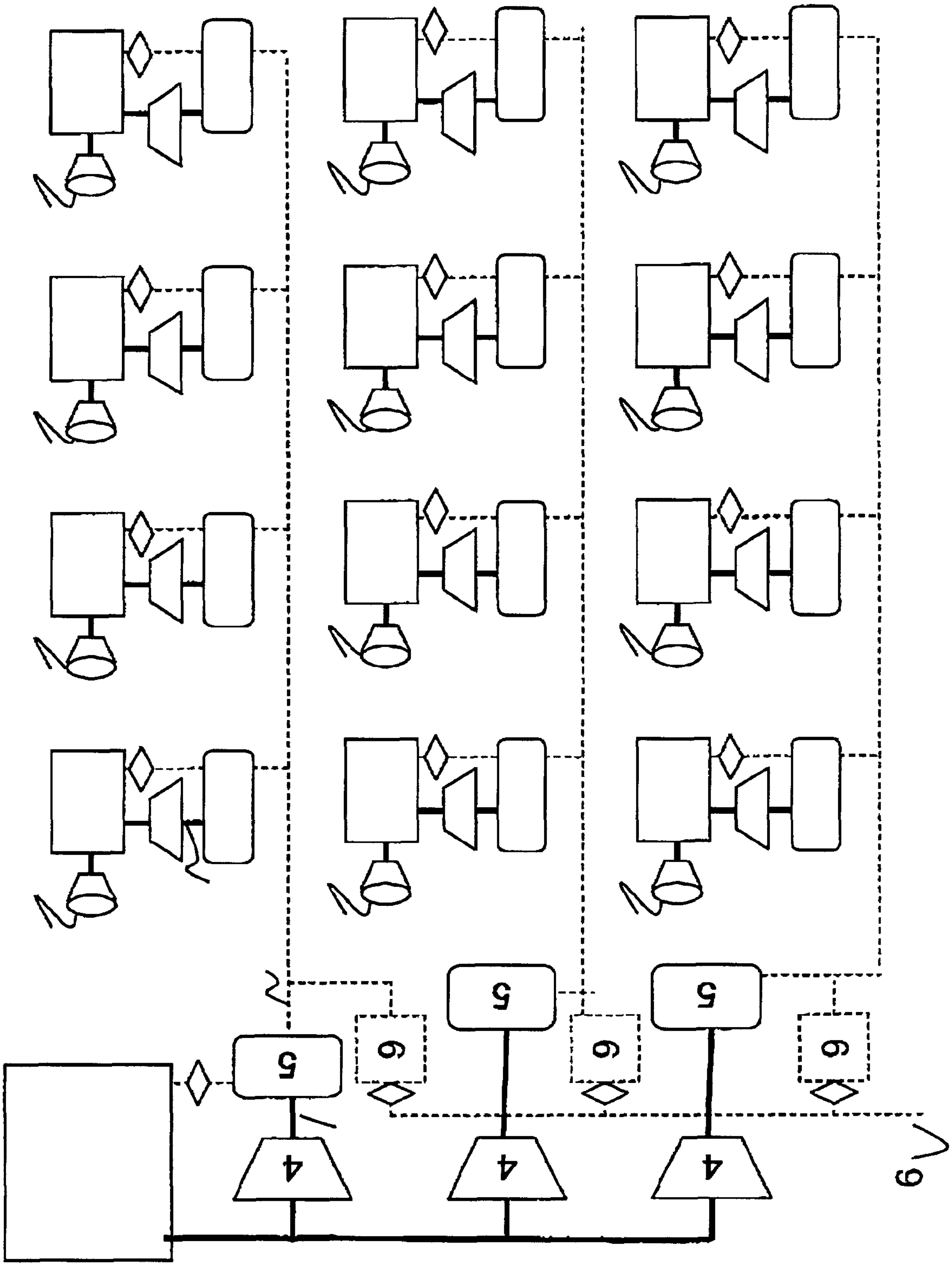

Fig. 4

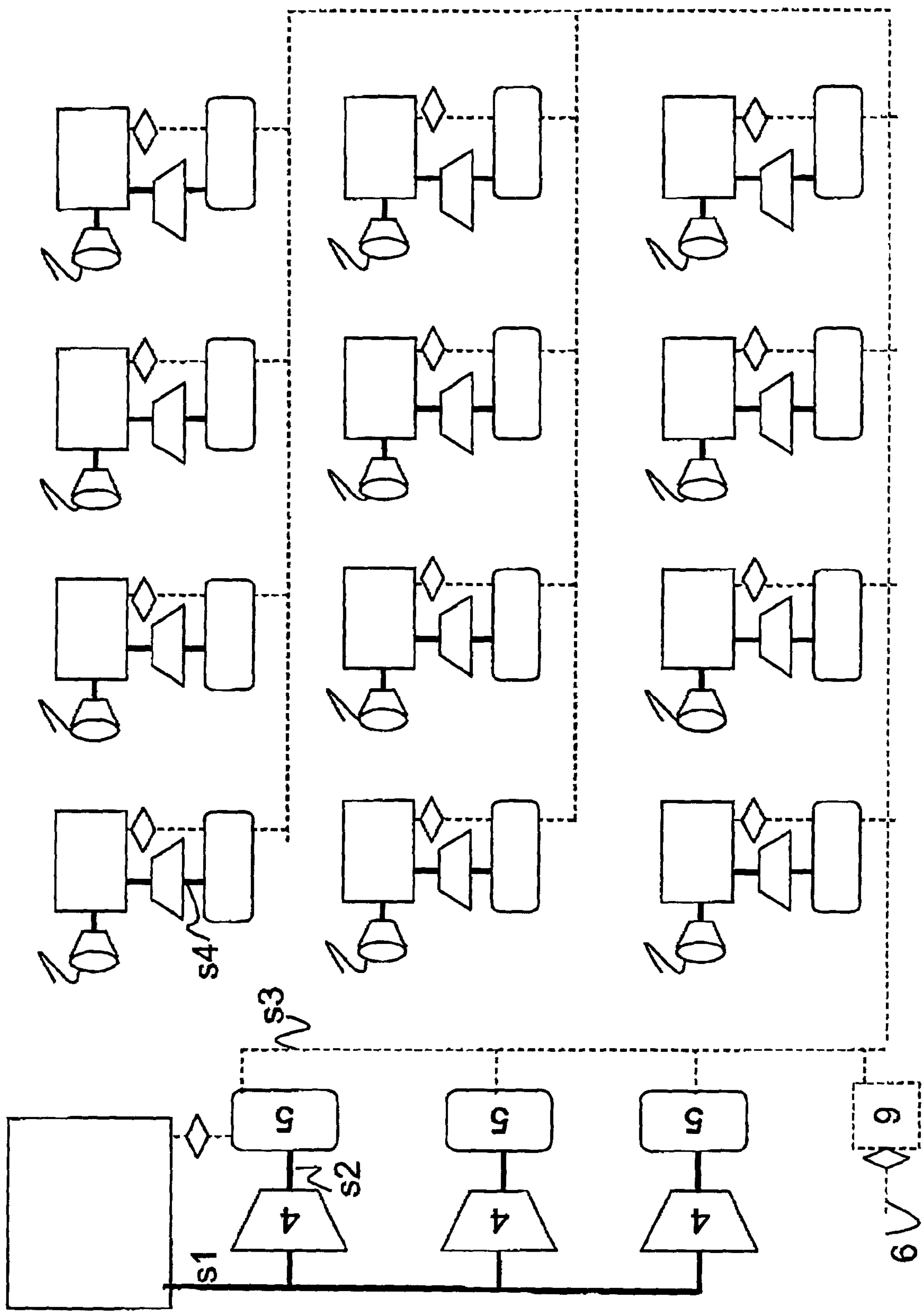

Fig. 5

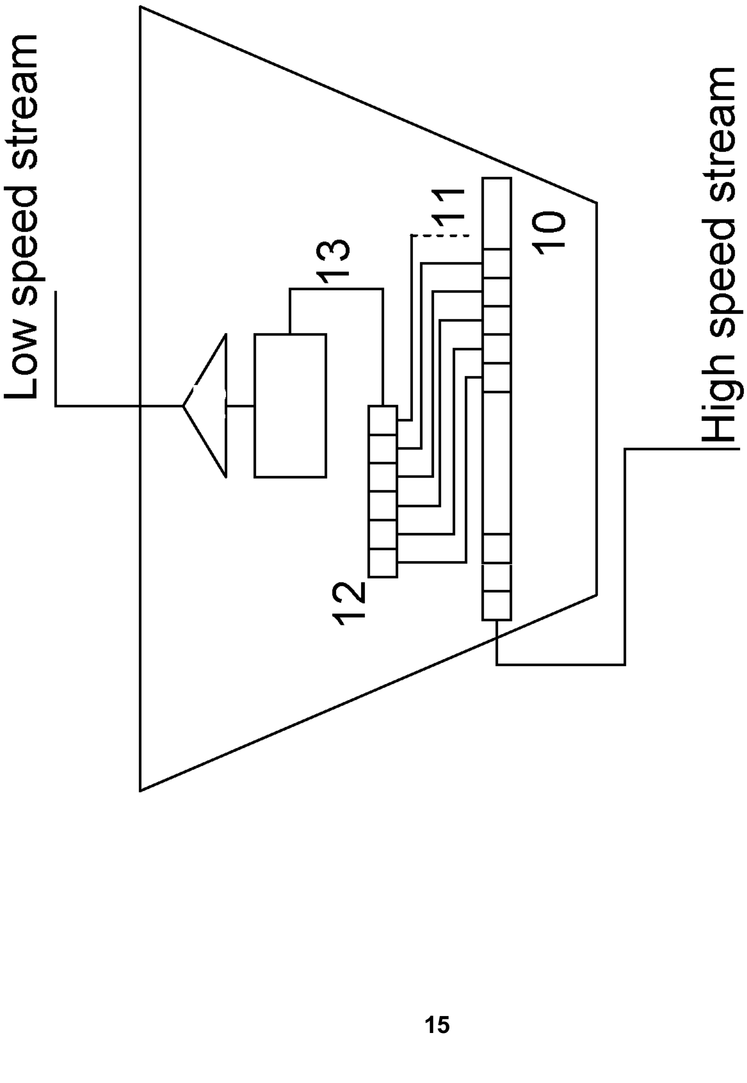
Low speed stream
13
11
10
12
High speed stream

Fig. 6

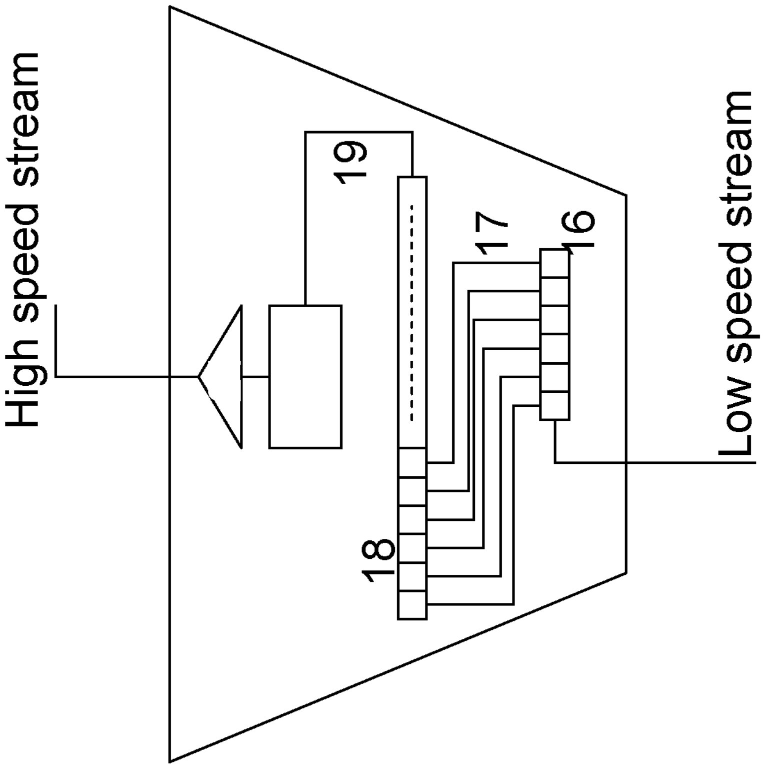
High speed stream
19
17
16
18
Low speed stream

Fig. 7