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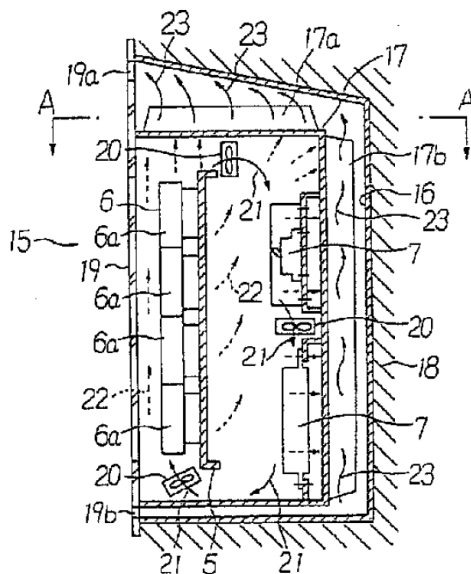
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(54) (TITLE OF THE INVENTION) LED DISPLAY DEVICE

(57) (ABSTRACT)

(OBJECTIVE) Provide the inner housing with a waterproof and dust-proof structure so as to eliminate the need for cleaning and maintenance of the air filter and IC substrate, thereby reducing running cost.

(CONFIGURATION) A housing is given a dual structure comprising an outer housing 16 and an inner housing 17, and fins 17a, b, c are provided along the outer surface of the inner housing 17. The cooling fins 17a, b, c are positioned within a space formed between the inner housing 17 and the outer housing 16, and this space is made contiguous with the exterior. By this means, heat generated by the light-emitting diode 6a and the electrical member for control 7 is transmitted to the cooling fins 17a, b, c provided along the span of the outer surface of the inner housing 17, and is then radiated into the space between the inner housing 17 and the outer housing 16. The heat radiated into this space is then discharged to the exterior, thereby suppressing temperature increase in the inner housing 17.



(SCOPE OF PATENT CLAIMS)

(CLAIM 1) LED display device comprising: an inner housing, which has an opening on the front side that is covered by a screen, within which are provided a display panel, which has a plurality of light-emitting diodes, and which faces toward the aforesaid screen, as well as electrical members for control, which are provided behind the aforesaid display panel in the interior of the aforesaid inner housing, and which serve to control the plurality of light-emitting diodes, and ventilation ports, which are provided on the left and right sides, top and bottom sides, and back side of the aforesaid inner housing, and which serve to ventilate the interior of the aforesaid inner housing; an outer housing that houses the aforesaid inner housing; and cooling fins provided within a space formed between the aforesaid inner housing and the aforesaid outer housing, which communicates to the exterior.

(CLAIM 2) LED display device set forth in claim 1, characterized in that the opening in the aforesaid inner housing is covered by the aforesaid screen in such a way as to form a hermetic seal.

(CLAIM 3) LED display device set forth in claim 1, wherein heat circulating fans are provided within the aforesaid inner housing in order to forcibly circulate the air within the aforesaid inner housing.

(CLAIM 4) LED display device set forth in claim 1, wherein a heat exchanger is provided near the top within the interior of the aforesaid inner housing in order to naturally circulate the air within the aforesaid inner housing by cooling the air contained within the aforesaid inner housing and exhausting it downward.

(CLAIM 5) LED display device set forth in claim 1, further furnished with a duct provided within the interior of the aforesaid inner housing, the interior of which communicates with the space between the aforesaid inner housing and the aforesaid outer housing, and cooling fins provided within the interior of this duct.

(CLAIM 6) LED display device set forth in claim 1, characterized in that the top surface of the aforesaid outer housing is formed in such a way as to taper upward toward the opening therein.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD OF THE INVENTION) The present invention relates to an LED display device, and in particular relates to an LED display device in which a screen is provided on the front of the housing, and a plurality of light-emitting diodes and electrical members for control are provided within the housing.

(0002)

(PRIOR ART) In FIG. 6, an LED display device indicated by 1 has a housing 2, and the housing 2 is embedded in a wall 3 or the like of a building. A screen 4 is provided on the surface of the housing 2 in such a way as to close off the housing 2, and a display panel 5 is provided within the housing 2 parallel to the screen 4. An LED module 6, on which a plurality of light-emitting diodes (hereinafter referred to as "LED") are provided in parallel, is attached to the front-facing side of the display panel 5. Electrical parts for control 7, 7 are attached to the rear surface of the housing 2 within the interior thereof.

(0003) The LED module 6 and each electrical part for control has its own operating temperature range (for example, 0-30 °C), for which reason the LED module 6 and the electrical parts for control 7, 7 cannot be used for extended periods of time at a temperature beyond their operating temperature range. Consequently, in order to cool the LED module 6 and the electrical parts for control 7, it is necessary to provide intake/exhaust ports on the housing 2 so that air within the

housing 2 can be exhausted to the exterior via intake/exhaust ports while also allowing outside air to be taken into the housing 2.

(0004) However, if, as stated above, the LED display device 1 is embedded in a wall 3 or the like of a building, it will not be possible to form intake/exhaust ports on the top, bottom, left, right, and rear sides of the housing 2, and consequently, it will not be possible to reduce the temperature in the housing 2 by exhausting air within the housing 2 to the exterior of the housing 2 via the intake/exhaust ports while also allowing outside air to be taken into the housing 2. The resulting problem is that the heat emitted by the LED module 6 and the electrical parts for control 7, 7 will cause the temperature in the housing 2 to increase beyond the operating temperature range for the LED module 6 and the electrical parts for control 7.

(0005) To solve this problem, an exhaust port 8 was formed at the top of the screen 4 provided on the front side of the housing 2, and an exhaust fan 9 was provided on the interior side of this exhaust port 8. Additionally, an intake port 10 was formed at the bottom of the screen 4, and an air filter 11 was provided on the intake port 10. By then rotating the exhaust fan 9 so as to forcibly exhaust air in the housing 2 through the exhaust port 8, clean outside air was introduced into the housing 2 through the intake port 10 and the air filter 11. By this means, heat flow 12 was produced within the housing 2, cooling the LED module 6 and the electrical parts for control 7, 7.

(0006)

(PROBLEM TO BE SOLVED BY THE INVENTION) However, a problem with this prior-art cooling method, in which an exhaust fan 9 is provided on the exhaust port 8 formed on the screen 4 so as to forcibly exhaust air in the housing 2, and an air filter 11 is provided on the intake port 10 formed on the screen 4 to ensure that only clean air is brought into the housing 2, is that it does not provide the interior of the housing 2 with a waterproof and dust-proof structure.

(0007) Additionally, in order to prevent clogging of the air filter 11, it was necessary to periodically clean the air filter 11. Furthermore, in order to prevent dust from collecting on the LED module 6 and the substrate and relays and so on of the electrical parts for control 7, 7, which could potentially cause electrical shorts, it was necessary to periodically perform maintenance and clean the IC substrate, relays, etc. contained within the interior of the housing 2 at night while the LED display device 1 was turned off. This resulted in the problem of high running cost. Additionally, in order to facilitate viewing, the LED display device 1 is typically installed in a location higher than an average person's height. The resulting problem is that it was necessary to use a workbench or scaffolding in order to perform cleaning or maintenance of the LED display device 1, which made these cleaning and maintenance duties more hazardous.

(0008) Hence, in order to solve the aforesaid problems with the prior art, the objective of the present invention is to provide an LED display device whose housing has a waterproof and dust-proof structure, thereby reducing running costs.

(0009)

(MEANS FOR SOLVING THE PROBLEM) To achieve the aforesaid objective, the present invention comprises: an inner housing, which has an opening on the front side that is covered by a screen, and within which are provided a display panel, which has a plurality of light-emitting diodes, and which faces toward the aforesaid screen, as well as electrical members for control, which are provided behind the aforesaid display panel in the interior of the aforesaid inner housing, and which serve to control the plurality of light-emitting diodes, and ventilation ports, which are provided on the left and right sides, top and

bottom sides, and back side of the aforesaid inner housing, and which serve to ventilate the interior of the aforesaid inner housing; an outer housing that houses the aforesaid inner housing; and cooling fins provided within a space formed between the aforesaid inner housing and the aforesaid outer housing, which communicates to the exterior.

(0010)

(ACTION) According to the present invention, the housing is given a dual structure comprising an outer housing and an inner, and cooling fins are provided along the exterior of the inner housing. Additionally, the cooling fins are positioned within a space formed between the inner housing and the outer housing, and this space is made to communicate with the exterior. Consequently, heat generated by the light-emitting diodes and the electrical members for control is conveyed to the cooling fins provided along the exterior of the inner housing, and the heat that has been conveyed to the cooling fins is radiated into the space between the inner housing and the outer housing. The heat radiated into the space between the inner housing and the outer housing is then discharged to the exterior, thereby suppressing increase in temperature within the interior of the inner housing.

(0011)

(EMBODIMENT EXAMPLES)

Embodiment example 1

Embodiment examples of the LED display device according to the present invention will be described below with reference to the drawings. Note that components in FIG. 1 similar or identical to those in FIG. 6 are indicated using the same symbol, and these components will not be described. In FIG. 1, the LED display device, indicated as a whole with symbol 15, is furnished with an outer housing 16, inner housing 17, etc. The outer housing 16 is formed into a box shape, and the top side thereof is formed in such a way as to taper upward toward the front side. The outer housing 16 is embedded into a wall 18 or the like of a building. Like the outer housing 16, the inner housing 17 is also formed into a box shape, and is housed within the outer housing 16.

(0012) The outer housing 16 and the inner housing 17 are arranged in such a way that their front sides are flush with one another, and a screen 19 is provided on the front side of the outer housing 16 and the inner housing 17. An exhaust port 19a is formed at the top end of the screen 19 between the outer housing 16 and the inner housing 17, and an intake port 19b is formed at the bottom end of the screen 19 between the outer housing 16 and the inner housing 17. By this means, the space between the outer housing 16 and the inner housing 17 is made to communicate with the exterior via the exhaust port 19a and the intake port 19b, and the inner housing 17 is hermetically sealed by the screen 19.

(0013) Fins 17a, 17a, etc. are welded in parallel on the top side of the inner housing 17, and fins 17b, 17b, etc. are welded in parallel on the rear side of the inner housing 17. Additionally, fins 17c, 17c, etc. are welded in parallel on the left and right sides of the inner housing 17. The fins 17a, etc., 17b, etc., and 17c, etc. are situated in the space between the outer housing 16 and the inner housing 17. These fins 17a, etc., 17b, etc., and 17c, etc. are made of aluminum, which has a good heat transfer coefficient. Welding fins 17a, etc., 17b, etc., and 17c, etc.

around the inner housing 17 in this way increases the radiation surface area, which improves cooling efficiency.

(0014) A display panel 5 is arranged within the inner housing 17 in a position parallel to the screen 19, and an LED module 6 with rows of LED 6a, 6a, etc. is attached to the front-facing side of the display panel 5. Electrical parts for control 7, 7 are attached to the rear side of the inner housing 17 in the interior thereof. Furthermore, heat circulating fans 20, 20, 20 are disposed at designated locations within the inner housing 17, such that the heat circulating fans 20, 20, 20 forcibly circulate the air within the inner housing 17 in the direction indicated by the arrows 21. The action of the LED display device in embodiment example 1 configured in the manner described above will now be described. First, the heat circulating fans 20, 20, 20 activate, after which the LED module 6 illuminates, displaying the desired characters, etc. on the LED display device 1. After the LED module 6 has illuminated, the LED module 6 and the electrical parts for control 7, 7 generate heat, which raises the temperature of the air in the inner housing 17.

(0015) In this case, the warmed air attempts to rise in the direction indicated by the arrow 22, but the heat circulating fans 20, 20, 20 activate, forcibly circulating the air in the inner housing 17 in the direction of the arrow 21, causing the warmed air to be roughly uniformly dispersed within the inner housing 17. Consequently, the interior temperature in the inner housing 17 is maintained roughly uniform. By thus maintaining the interior temperature in the inner housing 17 roughly uniform, the heat in the inner housing 17 is transmitted roughly uniformly over the entire span of the inner surface of the inner housing 17. This means that the heat-receiving area, which spans the interior surface of the inner housing 17, is roughly the same as the heat-emitting area, which spans the exterior surface of the inner housing 17, thereby improving cooling efficiency.

(0016) Heat received by the interior surface of the inner housing 17 is then transmitted onward to the exterior surface of the inner housing 17 and thereby to the fins 17a, etc., 17b, etc., and 17c, etc. welded over the span of the exterior surface of the inner housing 17. Because the fins 17a, etc., 17b, etc., and 17c, etc. are made of aluminum, heat is efficiently transmitted over the entire area of the fins 17a, etc., 17b, etc., and 17c, etc. The heat transmitted to the fins 17a, etc., 17b, etc., and 17c, etc. is dissipated into the space between the outer housing 16 and the inner housing 17, where it ascends through the space between the outer housing 16 and the inner housing 17, as indicated by the arrow 23. After having ascended through the space between the outer housing 16 and the inner housing 17, the air is guided along the tapered top side of the outer housing 16 to the exhaust port 19a, and is discharged to the outside through the exhaust port 19a.

(0017) In this case, because the fins 17a, etc., 17b, etc., and 17c, etc. are welded along the span of the exterior surface of the inner housing 17, the heat emission area is increased, which improves cooling efficiency. In contrast, outside air is introduced from the outside into the space between the outer housing 16 and the inner housing 17 through the intake port 19b at the bottom edge of the screen 19. By thus transmitting heat in the inner housing 17 to the fins 17a, etc., 17b, etc., and 17c, etc., and then discharging the heat transmitted to the fins

17a, etc., 17b, etc., and 17c, etc. to the outside from the exhaust port 19a, it is possible to suppress increase in temperature in the inner housing 17. Consequently, this makes it possible to operate the LED module 6 and the electrical parts for control 7, 7 at a temperature within their operating temperature range.

(0018) Embodiment example 2

Although embodiment example 1 was described by way of an example in which air was circulated within the inner housing 17 by means of heat circulating fans 20, etc. provided within the inner housing 17, the present invention is not exclusive thereto, and a heat exchanger 25 may be provided in the inner housing 17 in place of heat circulating fans 20, etc., as in the case of embodiment example 2 in FIG. 3. Embodiment example 2 will be described below with reference to FIG. 3. Note that components in FIG. 3 similar or identical to those in embodiment example 1 in FIG. 1 will be indicated using the same symbols, and will not be described. The heat exchanger 25 is provided on the top surface of the inner housing 17 in the interior thereof. This heat exchanger 25 captures warm air rising within the inner housing 17 in the direction of the arrow 22, and discharges the captured air downward within the inner housing 17 in the form of cold air 26. Discharging cold air 26 downward in this way produces natural convection, whereby cool air descends and warm air ascends through the inner housing 17. By this means, air within the inner housing 17 that has been warmed by the heat generated by the LED module 6 and the electrical parts for control 7, 7 is dispersed in a roughly uniform manner throughout the inner housing 17, as in the case of embodiment example 1.

(0019) Here, although it would be conceivable to provide a heat circulating fan 20 to forcibly circulate the air in the inner housing 17, as in the case of embodiment example 1, forcibly circulating the air in the inner housing 17 with a heat circulating fan 20 would block the flow of cool air 26 discharged from the heat exchanger 25, creating high-temperature areas and low-temperature areas within the inner housing 17. Hence, more uniform dispersal of the air in the inner housing 17 that has been warmed by the LED module 6 and the electrical parts for control 7, 7 can be achieved by using natural convection, as described above, rather than using forced circulation with a heat circulating fan 20.

(0020) Additionally, in some instances, such as when numerous LED modules 6 are installed, the LED modules 6 and the electrical parts for control 7, 7 may produce a greater amount of heat, as a result of which it may not be possible to achieve adequate suppression of temperature increase in the inner housing 17 solely with the fins 17a, etc., 17b, etc., and 17c, etc., as in the case of embodiment example 1. In such instances, temperature increase in the inner housing 17 can be suppressed by using a heat exchanger 25 to magnify the cooling effect.

(0021) Embodiment example 3

Embodiment example 3 in FIG. 4 and FIG. 5 is the same as embodiment example 1, except that a duct 28 has been added in the inner housing 17. Embodiment example 3 will be described below with reference to FIG. 4 and FIG. 5. Note that components in FIG. 4 and FIG. 5 similar or identical to those in embodiment example 1 in FIG. 1 and FIG. 2 will be indicated using the same symbols, and will not be described. The duct 28 is provided in parallel on the left and right edge of the inner housing 17. The duct 28 is formed into a tube that has a rectangular shape when viewed in transverse cross-section, and the top ends and bottom ends of the duct 28 open into the

space between the outer housing 16 and the inner housing 17. Consequently, the space within the duct 28 communicates with the space between the outer housing 16 and the inner housing 17. A plurality of fins 28a, etc. are provided in parallel within the duct 28. The duct 28 and the fins 28a, etc. are made of aluminum, which has a good heat transfer coefficient.

(0022) The action of the LED display device in embodiment example 3 configured as set forth above will now be described. First, the heat circulating fans 20, etc. activate, after which the LED module 6 illuminates. As a result, the LED module 6 and the electrical parts for control 7, 7 produce heat, raising the temperature of the air in the inner housing 17. The warmed air is then forcibly circulated in the direction of the arrow 21 within the inner housing 17 by the heat circulating fans 20, etc., uniformly dispersing the warmed air throughout the inner housing 17. By this means, the heat within the inner housing 17 is transmitted roughly uniformly over the entire span of the inner surface of the inner housing 17 and the entire span of the outer surface of the ducts 28, 28.

(0023) Upon attaining the inner surface of the inner housing 17 and the outer surface of the duct 28, the heat is then transmitted to the fins 17a, etc., 17b, etc., and 17c, etc. of the inner housing 17 and the fins 28a, etc. of the duct 28. Upon being transmitted to the fins 17a, etc., 17b, etc., and 17c, etc., the heat then ascends through the space between the outer housing 16 and the inner housing 17, as shown by the arrow 23, and is discharged to the outside through the exhaust port 19a at the top end of the screen 19. Heat that has been transmitted to the fins 28a, etc. meanwhile ascends through the interior of the duct 28, and is guided into the space between the outer housing 16 and the inner housing 17, whereupon it is discharged to the outside through the exhaust port 19a. By thus providing a duct 28 on the left and right edges of the inner housing 17 and providing fins 28a, etc. in the duct 28, it is possible to increase the heat-emitting surface area, which makes it possible to achieve superior suppression of temperature increase within the inner housing 17 in comparison with embodiment example 1.

(0024)

(EFFECT OF THE INVENTION) As indicated by the preceding description, according to the LED display device of the present invention, heat generated by light-emitting diodes and electrical members for control is transmitted to cooling fins provided along the outer surface of an inner housing, and the heat that has attained the cooling fins is then radiated into the space between an inner housing and an outer housing. Upon being radiated into the space between the inner housing and the outer housing, the heat is then discharged to the exterior, thereby suppressing temperature increase within the inner housing. By thus transmitting heat generated within the inner housing to cooling fins on the outer surface of the inner housing, and then radiating this heat into a space between the inner housing and the outer housing, it is possible to adopt a structure that is waterproof and dust-proof by keeping the inner housing hermetically sealed. Additionally, because no air filter is used, there is no need to periodically clean the air filter. Furthermore, because the inner housing is given a structure that is both waterproof and dust-proof, there is no risk of contamination of the inner housing by dust or the like. Consequently, there is no need to perform cleaning or maintenance to prevent shorting of the IC substrate or relays or the like due to adhesion of dust. This helps to reduce the running cost. Since there is no need to perform cleaning or maintenance to prevent shorting of the IC substrate, relay, etc.

due to dust adhesion, this in turn eliminates the hazards associated with the use of a workbench or scaffolding.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(FIG. 1) Longitudinal cross-section showing the LED display device in embodiment 1 of the present invention.

(FIG. 2) A-A cross section, showing a cross-section along line A-A in FIG. 1.

(FIG. 3) Longitudinal cross-section showing the LED display device in embodiment 2 of the present invention.

(FIG. 4) Longitudinal cross-section showing the LED display device in embodiment 3 of the present invention.

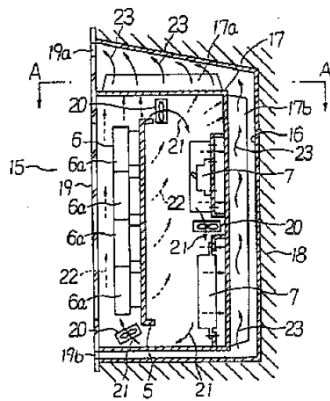
(FIG. 5) B-B cross section, showing a cross-section along line B-B in FIG. 1.

(FIG. 6) Longitudinal cross-section showing a prior-art LED display device.

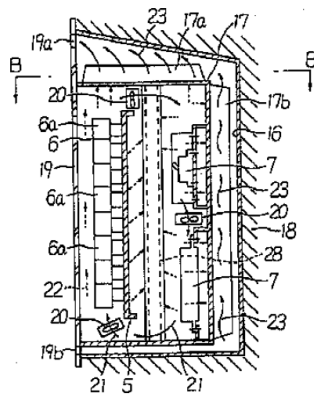
(DESCRIPTION OF THE SYMBOLS)

- 5: Display panel
- 6: LED module
- 6a: LED (light-emitting diode)
- 7: Electrical part for control
- 15: LED display device
- 16: Outer housing
- 17: Inner housing
- 17a, b, c, 28a: Fin
- 19: Screen
- 20: Heat circulating fan
- 25: Heat exchanger
- 28: Duct

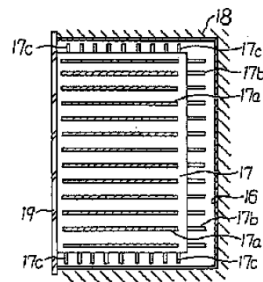
(FIG. 1)



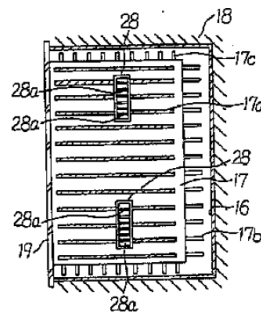
(FIG. 4)



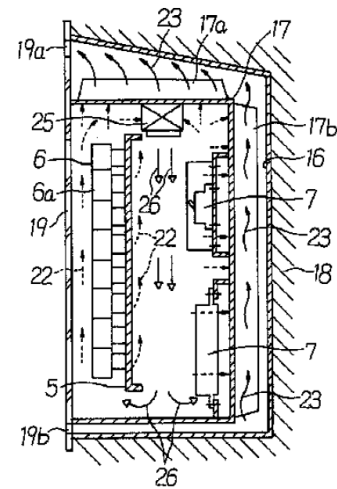
(FIG. 2)



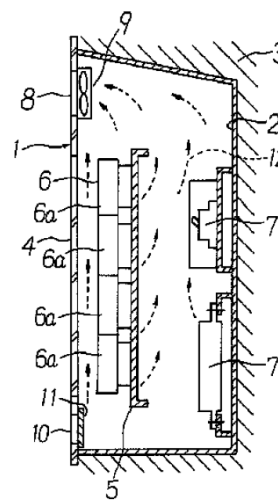
(FIG. 5)



(FIG. 3)



(FIG. 6)



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CERTIFICATE OF TRANSLATION

I, Dan McCourt, hereby certify that the document identified below, translated from Japanese into English, is true and accurate, to the best of my knowledge and belief.

Reference: JP平08-054834

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Dan McCourt

Sworn to before me this
12th December 2022



Signature, Notary Public



Stamp, Notary Public