

“FGG160DCY” General-Purpose Goods Vending Machine

ABE, Junichi*

ABSTRACT

In the retail market that uses vending machines in Southeast Asia, consumer purchasing requirements has become increasingly diversified. In response to this trend, Fuji Electric has developed a new general-purpose goods vending machine, the “FGG160DCY.” Equipped with the storage that has been greatly expanded in capacity, its product storage equipment (rack) and elevator mechanism stably dispense large and small, various products, such as food, beverages, and pharmaceuticals. In terms of cooling performance, strengthening the internal insulation structure inside and adopting a blow-down airflow structure have enabled all products to be kept uniformly cool in the temperature range of 1°C to 8°C. In addition, the housing structure has been strengthened to withstand the shocks during transportation outside Japan.

1. Introduction

In recent years, consumers have diversified their purchasing behavior worldwide, and there is a growing need for vending machines to sell products 24 hours a day without face-to-face interaction. Outside Japan, particularly in Southeast Asia, there has been a growing trend to install vending machines for food products such as confectionery and instant noodles, daily necessities, and pharmaceuticals on the premises of offices and commercial facilities. In response to this trend, Fuji Electric has developed a general-purpose goods vending machine, the “FGG160DCY.”

2. Needs for Vending Machines in Southeast Asia

2.1 Market trends

The vending machine market in Southeast Asia (Thailand, Malaysia, Singapore, Indonesia, etc.) has conventionally been dominated by small and medium-sized operators mostly selling canned and plastic bottled beverages. In recent years, convenience store chains have also entered this business, and demand has increased for various food products such as snacks, rice, and desserts, in addition to beverages, resulting in the installation of more than 10,000 food vending machines. On the other hand, constant traffic congestion in urban areas makes access to vending machine locations cumbersome. Operators are increasingly demanding larger capacity to reduce the frequency of replenishment of products, as well as a greater variety of products in order to avoid missing out on buying opportunities.

At the same time, hospitals in Taiwan are currently experimenting with new vending machines for non-food uses. In particular, they are studying methods of automatically dispensing pharmaceuticals from vending machines in order to reduce human error of mixing drugs up in dispensing work by pharmacists because this kind of issue occurred.

As described above, in overseas markets mainly in Southeast Asia, demand for vending machines with high capacity is increasing to accommodate a wide variety of products.

2.2 Challenges

Typical food vending machines (general-purpose machines) have had the following features: transparent glass doors, shelf-type product storage racks, an elevator mechanism for product conveyance, and a cooling unit for the entire interior of the storage compartment. This design is advantageous in that users can directly see the products displayed on the shelf, and loading products is as easy as placing them in a column (sales spaces on the racks). A glass door is also suitable for hospital use, as it is important to visually check the pharmaceuticals that are actually dispensed from the display racks. At the same time, however, this design also has the following challenges.

(1) Ability to store various products

(a) Storage of large products

The capacity of plastic bottled beverages distributed in Japan is usually 500 ml, but many beverages outside of Japan are 600 ml in size and longer in overall length than those distributed in Japan. Therefore, it is necessary not only to expand the capacity of the racks, but also to create a storage structure that allows flexible shelf positioning to adapt to various products, such as large products in overseas markets.

* Food & Beverage Distribution Business Group, Fuji Electric Co., Ltd.

(b) Conveyance of products

Racks of general-purpose machines are equipped with an elevator at the front of the racks to dispense products even from high positions, allowing products to be conveyed vertically to the dispensing outlet. However, conventional elevators sometimes have problems in the process of vertically conveying a wide variety of products. For example, some products might stick out and come into contact with other shelves and products. In addition, when heavy products are loaded on the elevator, its braking force could become ineffective, preventing it from stopping properly at specified positions. In addition, some products can become unsaleable because of content deformation and container damage due to shaking during conveyance or by the action of receiving products at the dispensing outlet. Therefore, the challenge is to ensure reliable and stable conveyance of large, heavy, fragile, and delicate products.

(c) Uniform internal cooling

An internal temperature of less than 8°C is required for pharmaceutical applications in Taiwan. This is the temperature specified by drug manufacturers for storing pharmaceutical products. General-purpose machines are designed to cool the entire interior of the storage compartment by supplying cold air to each shelf position. However, this does not comply with the requirement because their rated internal temperature ranges from 0°C to 10°C. In contrast, our new general-purpose goods vending machine comes standard with a new internal structure that is capable of keeping general foods, beverages, and pharmaceuticals uniformly cool within the same temperature range.

(2) High thermal insulation

Since heat dissipation increases with larger storage capacity, there is concern that larger cooling loads will increase power consumption. In order to improve the cooling performance of the storage compartment, it is necessary to strengthen the heat insulation of its housing and door beyond that of general-purpose machines.

(3) Reinforced structure that supports transportation

This product is designed to be manufactured in Japan and exported overseas. Unlike distribution conditions in Japan, delivering a product overseas can damage the product housing, due to shocks and vibrations during transport by cargo ship or by truck on unpaved roads and during unloading. To prevent this, it is necessary to ensure the strength of the product's housing and packaging. During container transportation, vending machines are subjected to impact forces up to 16 G (gravitational acceleration) and need to have structure to withstand these forces.

3. Features of the General-Purpose Goods Vending Machine

3.1 Overview

Figure 1 shows the external appearance of the "FGG160DCY," Fig. 2 shows the internal structure, and Table 1 shows the specifications compared with the general-purpose machine "FGG136MCY."

It has a bi-parting door, consisting of a dispensing door for the inside of the storage compartment and an operation door for the outside where the payment equipment and other devices are located. The benefit of using the bi-parting door that separate the inside and outside of the storage compartment is that the inside does not need to be opened when performing tasks, such as collecting money or changing sales settings. This reduces cooling loss and intrusion of warm outside air and insects while performing these tasks.



Fig.1 "FGG160DCY"

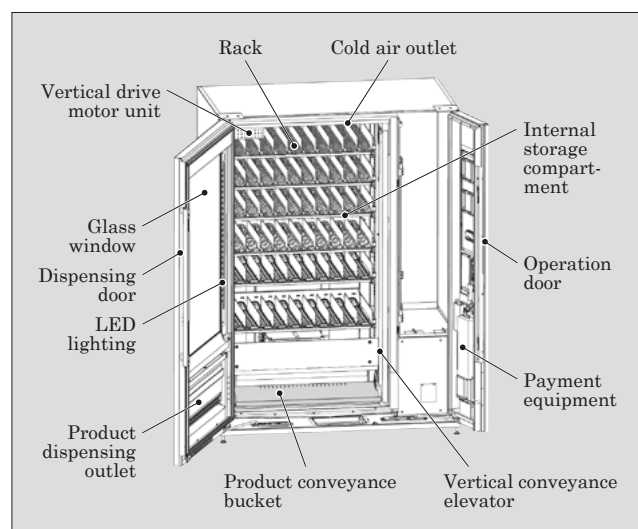


Fig.2 Internal structure of "FGG160DCY"

Table 1 Specifications compared with a general-purpose machine

Item	General-purpose machine	This product
Model	FGG136MCY	FGG160DCY
Dimensions	W882 × D840 × H1,834 (mm)	W1,435 × D890 × H1,934 (mm)
Selection	6 columns × 6 shelves 36 selections	10 columns × 6 shelves 60 selections
Product capacity	Max. 540 products	Max. 900 products
Sales assistance	Vertical conveyance elevator	Vertical conveyance elevator
Cooling system	High cooling (0°C to 10°C)	High cooling (1°C to 8°C)
Door	Single door	Bi-parting door

3.2 Features

The main features of the product are as follows:

(1) Racks for large items

Figure 3 shows the overall structure of the racks. The racks can be pulled out for product replenishment, equipped with sales modules with spiral or belt conveyor mechanisms. The product has 10 columns per shelf and supports up to 6 levels of shelves, allowing for a maximum of 60 selections of products to be stored. This capacity is 1.67 times larger than that of general-purpose machines, which accommodate 36 selections. In addition, in order to accommodate a variety of overseas products, the overall rack height and internal height have been extended by 100 mm compared with general-purpose machines, and the vertical height position of each shelf can be freely set in increments of 20 mm. By supporting a combination of up to 6 levels of shelves, operators can effectively configure the height between shelves from 163 to 258 mm. With this product, even long-length items such as bottles can be sold by adjusting the pitch between the corresponding upper and lower shelves. Moreover, the upper first and second shelves have a sloping drawer

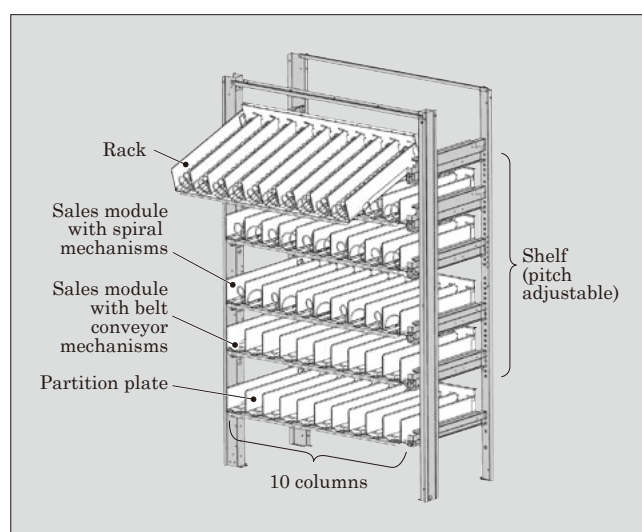


Fig.3 Overall structure of the racks

structure to facilitate replenishing work even for high-mounted shelves.

(2) Vertical conveyance elevator that reduces product shaking

Figure 4 shows the product receiver mechanism of the vertical conveyance elevator. The product conveyance bucket of the vertical conveyance elevator normally waits at the bottom of the storage compartment. At the time of delivery, it rises to the height of the rack containing the product to be sold and stops. After this, it uses a product detection sensor at the entrance of the product conveyance bucket to detect the passage of the product and confirms that the product has been transferred from the rack to the product conveyance bucket. Finally, it quietly moves the product to the position of the door's product dispensing outlet while maintaining a horizontal posture, and then directly unloads the product on the bucket in a way that ensures the safe dispensing of even fragile products.

The vertical drive motor has a higher torque, enabling it to transport twice the mass of similar machines in Japan. Even though the transport distance of the product conveyance bucket is longer due to the lower standby position and the 100-mm increase in the inner storage compartment height as mentioned above, the time required for the required series of operations (ascending from the standby position and stopping at the uppermost shelf ⇒ receiving the product from the rack ⇒ descending and stopping at the standby position) is the same as that of general-purpose machines. The depth of the product conveyance bucket has been increased by approximately 50 mm in comparison with that of conventional buckets, allowing it to reliably receive various types of products, both large and small. In addition, both ends of the product conveyance bucket are supported in a well-balanced manner by a four-wheel roller and conveying belt. This enables the product to be transported with hardly any shaking, even for larger products. We confirmed that the high-torque drive and stable dispensing operation of

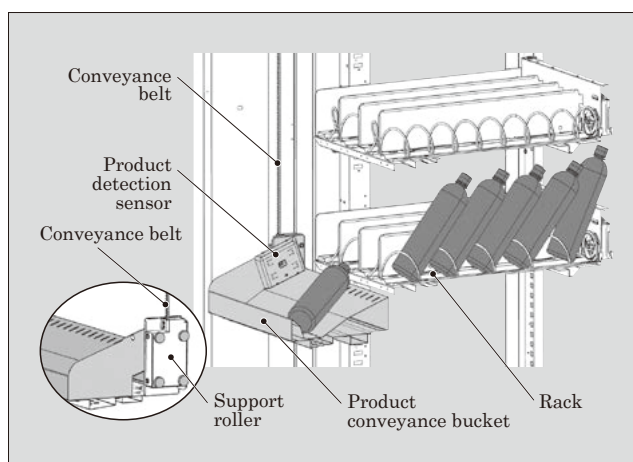


Fig.4 Product receiver mechanism of the vertical conveyance elevator

the product conveyance bucket in a horizontal posture enable conveyance of heavy plastic bottles and glass bottles such as drug ampoules without any problems.

(3) Equalization of internal temperature using a ceiling duct structure

The FGG160DCY incorporates ceiling ducts for the pathway of cold air that cools the inside of the storage compartment. Figure 5 shows the structure. This structure allows for ducts to be connected to the back of the storage compartment and the ceiling to provide ventilation paths and blow cold air down from the front part of the ceiling. The cold air is pushed up through the back ducts by the ventilation fan and down through the ceiling outlet via the ceiling ducts. It provides efficient internal airflow using natural convection and fan-assisted circulation, as well as uniform product cooling, allowing it to achieve a target controlled temperature of 1°C to 8°C. There was some concern that heat loss would occur when circulating cold air to the ceiling, but this was resolved through efforts to improve the cooling performance, as described below.

(4) High insulated structure

Table 2 shows a comparison of the structure and thermal insulation performance between this product and a general-purpose machine. Although the internal volume of the unit is 58% larger than that of a medium-sized general-purpose machine, it utilizes a thicker overall heat insulation material to suppress heat leakage and improve its cooling performance. For the main unit and the door, all walls facing the inner storage compartment are covered with urethane foam, and the volume of the overall insulation material is 1.5 times greater than that of general-purpose machines. In particular, it uses thicker insulation material in the ceiling to reduce heat transmittance. When the performance is compared with that of general-purpose machines,

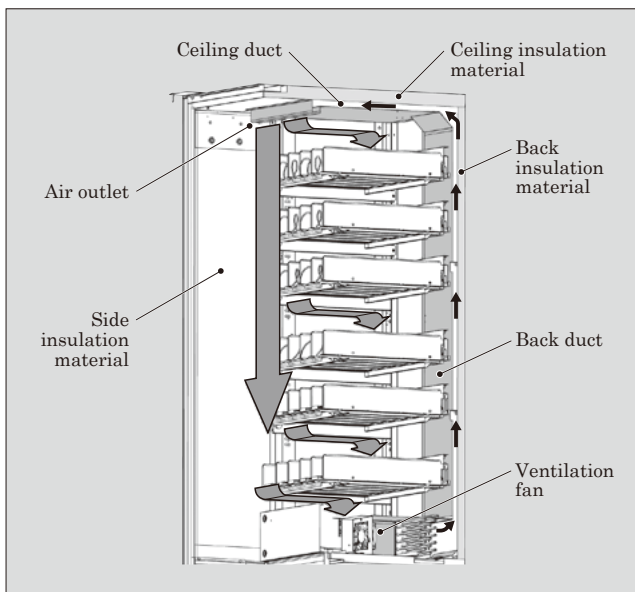


Fig.5 Ceiling duct structure (storage compartment cross-sectional view)

Table 2 Comparison of the structure and thermal insulation performance between this product and a general-purpose machine

Item	General-purpose machine	This product
Internal storage volume (m ³)	0.685	1.08
Internal insulation volume (m ³)	0.17	0.27
Ceiling insulation thickness (mm)	25	45
Ceiling insulation heat transmittance (W/m ² ·K)	0.99	0.55
Theoretical heat leakage (W)	184	262
Theoretical heat leak (internal storage volume ratio)(W/m ³)	269	243
Power consumption (internal storage volume ratio) (kWh/y·m ³)	2,920	2,530

it reduces heat leakage by approximately 10% per real unit volume, resulting in improved thermal insulation. The synergistic effect of the aforementioned cooling structure has also achieved a 13% reduction in power consumption for the inner storage compartment.

(5) Highly rigid housing

In order to ensure that products are not damaged when transported outside of Japan, we have established the standards for product drop tests and vibration tests using sine waves and random waves in accordance with the U.S. transportation packaging test standard “ASTM*1 D 4169.” The housing, which has been enlarged, is made with thicker sheet metal and beams with higher cross-sectional coefficient. Figure 6 shows the housing rigidity analysis and vibration test using an actual vending machine. Figure 6(a) shows the rigid stress analysis of mounting base of the housing. It has installation legs at the four corners of the mounting base, and even if the load is unevenly distributed to one leg, it exhibits no stress concentration that causes deformation. In addition to the structure

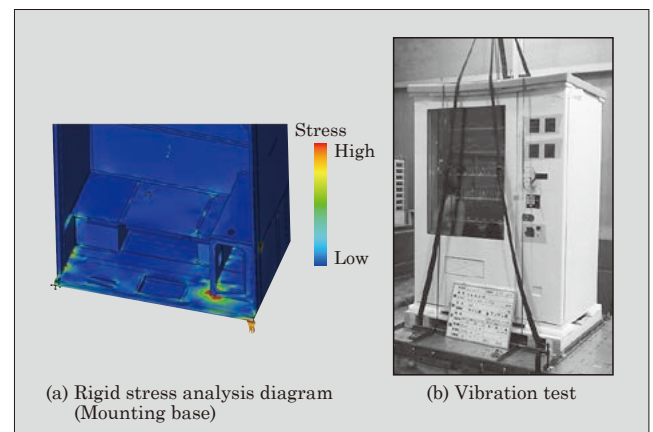


Fig.6 Housing rigidity analysis and vibration test using an actual vending machine

*1: ASTM refers to the international standards for industrial materials and testing methods developed and published by ASTM International of the United States.

of the vending machine, we have examined packaging specifications. A wooden pallet is used for the base of product packaging, and a resin foam cushioning material is incorporated between the pallet and the product body. We selected the cushioning material by calculating the required cushioning capacity based on the product load and assumed impact value and evaluated the vibration in this packaging condition. Figure 6(b) shows an example of the vibration test. During this test, neither the inside or outside was damaged, and we confirmed that the impact absorption of the packaging material was functioning normally.

4. Postscript

In this paper, we described the “FGG160DCY”

general-purpose goods vending machine. This development enabled us to create a standard model for products to be exported mainly to Southeast Asia. Its ability to handle large products and certain pharmaceuticals has expanded the range of vending machine applications from general food products to a variety of other goods. However, market needs differ from country to country. For this reason, it includes an electronic payment function, support for communication protocols, signage, and other features.

In the future, we intend to use this product as a platform to meet further market needs by providing flexible customization and a variety of models.





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