

Small-sized, Hot and Cold Cup Vending Machine

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1. Introduction

Since developing the “combination cup” vending machine in 1981, Fuji Electric has continued to develop new types of machines and new mechanisms in response to the changing needs of the marketplace.

Recently, as the outdoor installation of vending machines has almost reached saturation level, most vending machine operators are attempting to create new demand in schools, business complexes, etc., by installing indoor-type vending machines there.

In response to these changed market conditions, Fuji Electric has developed a new type, small-sized hot and cold cup vending machine requiring only a small installation space.

An overview of this type of vending machine is presented below.

2. Background and Objectives of Development

2.1 Background of development

In the last few years, expansion of the cup vending machine installed base has slowed due to decreasing sales profit per machine. Moreover, the market is beginning to show signs of a shift from large- and medium-sized machines to small-sized machines. This shift is probably caused by the following factors:

- (1) decrease in sales due to prolonged economic stagnation,
- (2) entrance of can vending machines into the indoor installation market and
- (3) diversification of consumers' taste, leading to increased purchases of canned beverages.

In light of these circumstances, Fuji Electric has worked to develop the “FBR151,” a small-sized, hot and cold cup vending machine that aims to invigorate the market for cup vending machines by increasing beverage sales from cup vending machines and creating demand for replacing existing hot cup vending machines with this model due to the savings of installation space.

2.2 Development objectives

- (1) Smallest width of any machine in the industry

that can vend syrup beverages and is equipped with hot and cold functions

- (2) Low price that enables installation in small-scale locations and provides profitability to operators easily
- (3) Good handling performance and easiness to clean to facilitate route service
- (4) Cheerful door design to attract customers

3. Special Features

This newly developed, small-sized, hot and cold cup vending machine realizes the above-mentioned objectives as well as many other functions that satisfy new market demands.

Principal characteristics are as follows:

- (1) Space-saving machine that is only 765 mm wide, the smallest in the industry, with no reduction in the varieties of beverages to vend due to improved construction of the cooling bath and hot water tank.
- (2) Water supply by cartridge tank system requiring no city water system. This is advantageous for installations in small-scale locations where large sales are not expected.
- (3) Syrups are supplied by a BIB (bag in box) system that facilitates syrup replacement operation and improves sanitation.
- (4) Power consumption is reduced compared with the former type of machine due to a newly developed small-sized cooling tank and hot water tank. Moreover, this machine is equipped with a “smart energy saving” function that learns the time intervals when sales increase and controls the operation of the equipment accordingly.
- (5) Machine is equipped with single cup, direct-drop mechanism that can accommodate 500 cups.
- (6) The door contains a coin mechanism cover structure that can be opened through one-touch operation so as to collect money easily and it has a structure that enables a non-kit bill validator to be attached without using parts such as a cosmetic frame.

4. Specifications

A summary of specifications of this type of machine is listed in Table 1.

5. Structure

5.1 Appearance and inner structure

Figure 1 shows the appearance of this small-sized hot and cold cup vending machine. The machine's layout allows easy selection of commodities and the

Table 1 Specifications of the hot and cold cup vending machine

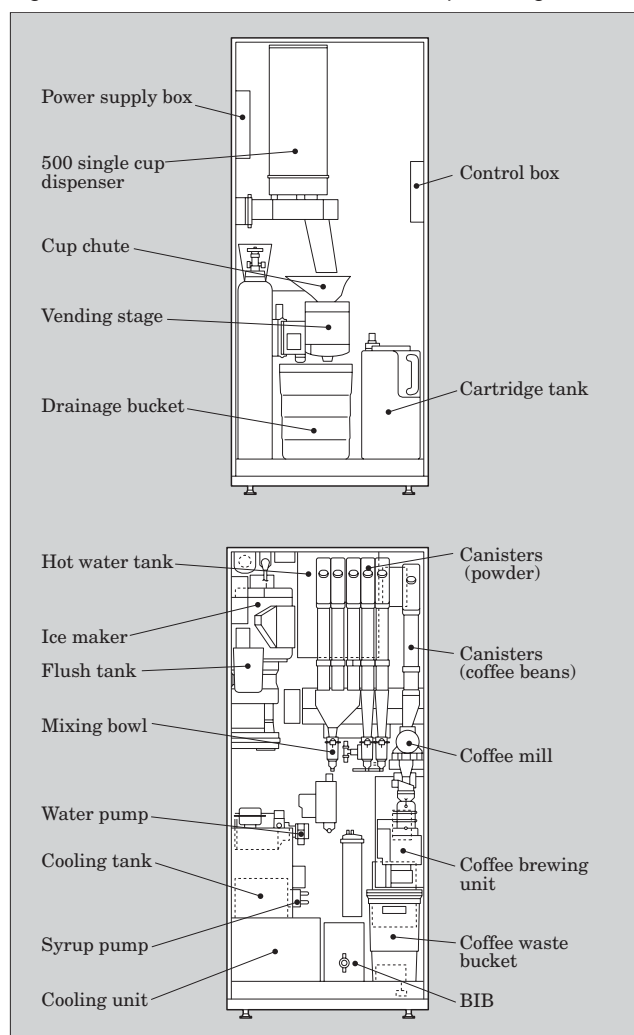
Model	FRB151 (M)	
Outer dimensions	Width 765 mm×depth 749 mm×height 1,830 mm	
Mass	240 kg	
Power supply	Single phase 100 V, 50/60 Hz, 15 A	
Beverages to be vended	71 kinds/24 buttons	
	Syrup	1 kind
	Powder	1 kind (instant coffee)
		2 kinds (cocoa, juice e.g.)
	Regular	1 kind (regular coffee)
Function button	Increase/decrease buttons for sugar, cream, coffee Buttons for without sugar, without cream Buttons for with/without ice	
Materials holding capacity	Syrup	2.5 gallons
	Coffee beans	4.6 L (1.6 kg)
	Cream	3.6 L (1.8 kg)
	Sugar	3.6 L (3.2 kg)
	Instant coffee	3.6 L (0.7 kg)
	Cocoa, juice	2×3.6 L (3.0 kg)
Materials taking-out system	Syrup	Variable pump system + BIB
	Powder	Screw taking-out
	Coffee beans	Screw taking-out + mill
Hot water tank	Tank capacity: 6 L Heater capacity: 950 W	
Cooling system	Power: 175 W, Refrigerant: R134a Mass of refrigerant encapsulated: 170 g Compressor: rotary compressor (common to ice maker and water bath)	
Cooling tank	11 L	
Ice maker	Ice capacity: 2.1 kg	
Coffee brewing unit	Air agitation, air press, paper filter	
Cup dispenser	500 single cup dispenser up to 500 cups×9-oz cup	
Water supply system	City water system or cartridge tank system (19 L)	
Display and monitoring	LCD display, monitoring for various operations, sell-out, fault detection	
Sanitary functions	Sanitation of hot drink system: cold water, hot water rinsing Automatic rinsing: once a day (can be set up for every day) or for preset number of cups vended Automatic rinsing of brewer: once a day (can be set up for every day)	

handling performance is well suited for use in a wide range of installations, from offices to general-use locations. The illuminated sign has an integral

Fig.1 Appearance of the hot and cold cup vending machine



Fig.2 Inner structure of the hot and cold cup vending machine



construction, which gives a sense of sophistication. Attractiveness and cheerfulness are the basis of our design.

The inner structure, shown in Fig. 2, is designed to have a layout that facilitates the routine replenishment of beverage materials and cups, and enables maintenance inspections to be performed easily. Thus, handling performance is improved.

5.2 Downsizing of mechanisms

Each mechanism has been downsized to develop a small-sized hot and cold cup vending machine requiring about 10 % less installation space than the former type vending machine.

Major improvements are as described below.

5.2.1 Water cooling unit

In order to realize the appropriate width of a machine equipped with hot and cold functions that support with syrup beverage vending, it was important to reduce the volume of the water cooling tank by 30 % compared to former machines.

Additionally, it was necessary to comply with beverage regulations concerning beverage temperature, number of cups continuously vendible, etc., without altering significantly other performance characteristics such as preparation time for cooling (pull-down time) as compared to former machines.

Accordingly, it was necessary to develop a water cooling tank and a cooling unit having performance suitable for use in small-scale locations.

Therefore, the following items were calculated to obtain the required cooling capacity of a motor-driven compressor (which serves to take in the vaporized refrigerant and compress it to raise vapor pressure of the refrigerant so as to facilitate liquefaction in the condenser).

- (1) Heat quantity required to lower the temperature of water in the water cooling tank from 32°C to 0°C
- (2) Heat quantity that must be stored for continuous vending (heat required to generate ice bank)
- (3) Heat input from outside (heat loss)

As a result, downsizing was realized by developing a new 175 W motor-driven compressor instead of the former 300 W compressor, a 3-row 7-stage small-sized condenser in place of the former 3-row 8-stage small-sized condenser (which functions to perform liquefaction by releasing heat obtained by the evaporator and the compressor), a 16-stage 100 mm square water tank evaporator in place of the former 16-stage 135 mm square water tank evaporator (which functions to remove heat from surrounding matter to be cooled using low pressure refrigerant). Figure 3 shows the outer dimensions of this newly developed water cooling device together with those of the former cooling device.

5.2.2 Hot water tank

The hot water tank, shown in Fig. 4, has 40 % less volume than former machines in order to secure the

Fig.3 Water cooling tank of the hot and cold cup vending machine

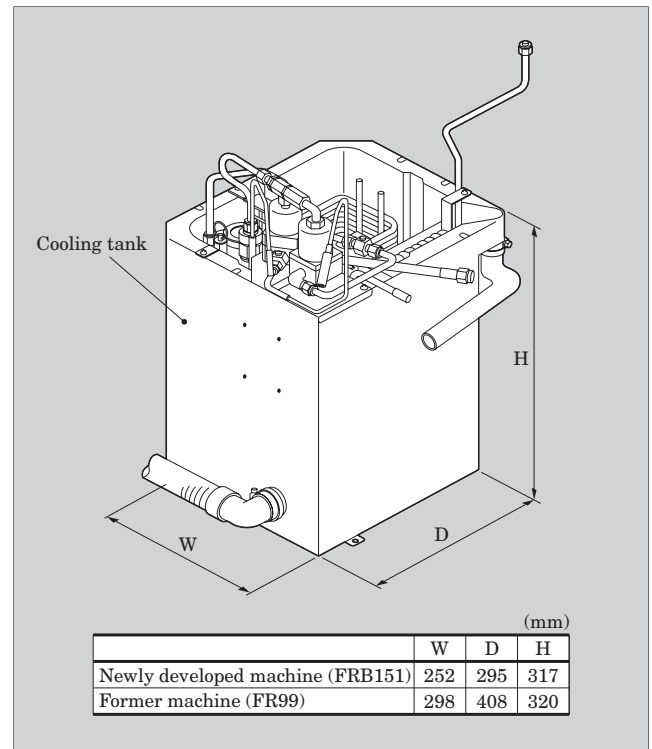
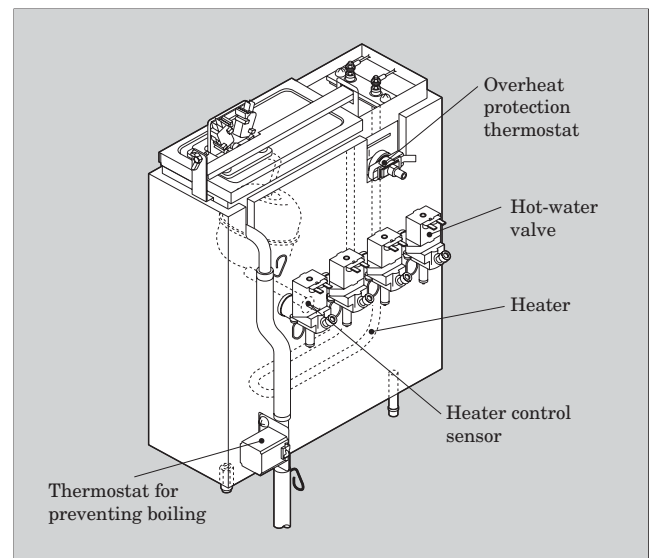


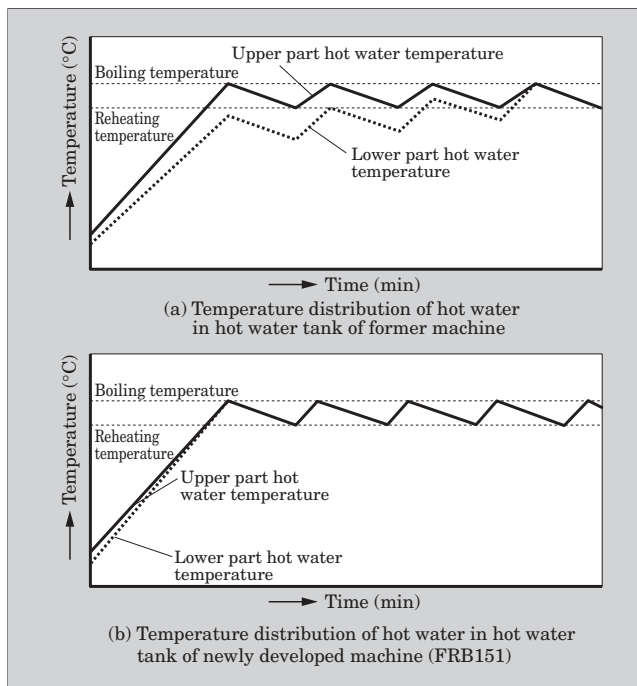
Fig.4 Hot water tank of the hot and cold cup vending machine



necessary effective space within the machine, and moreover, it has a single-heater heating and control system instead of the dual-heater heating and control system of the former machine in order to realize downsizing and cost reduction.

The challenge in complying with beverage regulations concerning beverage temperature, number of cups continuously vendible, etc., by means of a single-heater heating and control system was to achieve a uniform temperature distribution of the hot water in the hot water tank at the time of boiling. This

Fig.5 Temperature distribution in the hot water tank of hot and cold cup vending machine



challenge has been successfully overcome by selecting the heater configuration and position of the heater control sensor. Figure 5 shows the temperature distribution in the hot water tank together with that of the former machine.

Moreover, the on-time ratio has been reduced to 1/3 that of the former machine due to adoption of single-heater heating and control (at an ambient temperature of 10°C), and accordingly, energy saving has been accomplished.

Hot water discharge valves are arranged in a row in front of the machine instead of on the side as in the former machine. Accordingly, handling performance and exchangeability are improved.

5.2.3 Cup dispenser mechanism

A 500 single cup mechanism was developed utilizing the full effective volume within the machine to accommodate a quantity of cups suitable for a machine at a small-scale location. Thus, downsizing is achieved and the route service efficiency is improved.

Recently, the cups' paper quality has been changed to reduce cost, and as a result, cup strength is sometimes degraded. This leads to failure in cup delivery due to the cup being pinched by the conventional spring-driven cup mechanism. Sudden separation of the cups by spring force is the cause of this problem. Accordingly, a cam-driven cup mechanism has been developed to improve the reliability of cup separation. Figure 6 shows the principle of this mechanism. A driving cam attached to a cup motor turns the lever of a cup dropping mechanism to a predetermined position and at the same time, a spring is stretched and fixed to a position determined by the

Fig.6 Principle of motion for cup mechanism of the hot and cold cup vending machine

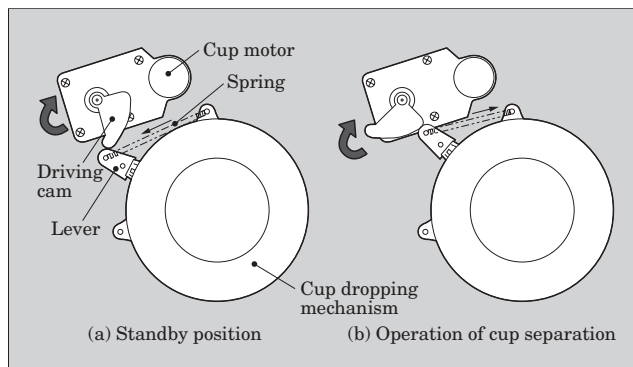
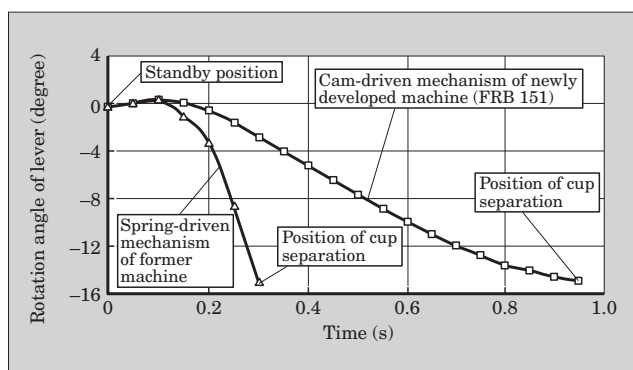


Fig.7 Relation between rotation angle of lever and cup separation time



lever. The spring is held in that position. When a cup vending request occurs, the driving cam turns and the lever is pulled back gradually along the outer contour of the driving cam by means of the spring force. Thus, the cup separating operation is performed and the cup is delivered successfully. In Fig. 7, the relation between rotation angle of the lever and cup separation time is shown in comparison with that of the former machine.

6. Conclusion

An overview of the hot and cold cup vending machine has been presented.

Requirements of cup vending machines from the consumers' standpoint are improvement of taste and diversification of beverage types, and operators' side requirements are the ability to attract customers, and sanitary and low-cost machines suited to highly efficient route service.

In order to keep up with market demand, Fuji Electric intends to continue making efforts to develop cup vending machines acceptable to all consumers and operators that are concerned with cup vending machines.

Lastly, we would like to thank all persons involved for their ongoing guidance and assistance in the development of these machines.



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