We have more than 5,000 ticket vending machines installed at present. Since the advent of the first ticket vending machine in about 1925, we have reached the current genre of ticket vending machine after a great deal of modifications and improvements. Looking back on the engineering history of the ticket machine, this paper introduces various changes from the viewpoint of passengers and discusses what ticket vending machines should be like in the future.

1 Introduction

Vending machines for cigarettes and beverages can be seen everywhere in Japan. The progress of technologies has made it possible to sell even flowers and books through vending machines. About 5.5 million vending machines are in use in Japan (as of December, 2002). In the railway industry, tickets are sold by ticket vending machines. In our company, almost 90 percent of all tickets are sold by ticket vending machines.

The following describes the transition of the ticket vending machine used by our company from the technological viewpoint and discusses what ticket vending machines should be like in future.

2 Advent of ticket vending machines (inchoate stage: 1925 through 1955)

The first ticket vending machine is said to have appeared in Japan in about 1925. It was designed according to a very simple structure and was operated by a manual lever and it sold hard (thick paper) platform tickets that had been printed in advance.

3 From manual to power driven system (1st generation: 1956 through 1963)

Research and development efforts started immediately after the war. The manual system in the aforementioned inchoate stage was improved into a power driven system. In early 1956, a simple machine for platform tickets was developed. This was followed by a machine that sold a certain type of ticket in response to the insertion of a certain type of coin (Fig. 1). This was developed into a machine that sold tickets in response to the insertion of two types of coins (10-yen and 50-yen coins), returning 10-yen change. This was further followed by the advent of a machine capable of returning 10-yen and 50-yen change in response to the insertion of 10, 50, and 100-yen coins (Fig. 2).

There was a limit to the number of hard tickets that could be loaded into the ticket vending machine. To solve this problem, a study was made to develop a system whereby soft tickets (thin paper) were printed when purchased. This was implemented in 1960. Soft tickets were printed with ink and a rubber printing die using power-driven operation.

4 Selling multiple kinds of tickets (second generation: 1964 through 1971)

The computer made its debut amid business prosperity resulting from the post-war high rate of economic growth due to development of electronic technologies. A reserved seat ticket booking system MARS was introduced in 1960. The introduction of MARS promoted a plan for developing a ticket vending machine capable of selling short distance tickets, and demand was created to develop and introduce a new model capable of printing a great variety of short distance tickets.

Multiple type ticket machines for hard tickets (Fig. 3) were introduced in 1964. To solve the problem of low-volume and limited-variety sales as the disadvantage of the hard ticket machine, a multiple type ticket machine for printing soft tickets was introduced in 1966. According to the method adopted by this machine, the original ticket was in the form of a paper roll and a section was cut off for the sale of each ticket, and each ticket was printed by a printing die. The disadvantages of this method were that passengers’ hands were
smeared with ink if there was too much ink on the ticket, and the
ticket was not readable if the amount of ink was insufficient. To
solve this problem, this method was replaced in 1969 by the method
of applying ultraviolet rays to ‘diazo sensitized paper’ to print the
image, and in 1972 by ‘the chelate method’, an improved version of
the diazo sensitized paper. In
‘the chelate method’, a special
colorless transparent water-based
ink that instantly turns black
when it comes into contact with
a certain special type of chemical
agent was adopted. This
chemical principle of color
development was called chelate
coloring.

From 1968 onward, the standing type machines installed on
concourses were replaced by ticket vending machines being placed in
demarcated “ticket corner” areas, and the built-in type machines
became mainstream. The current width of 500 mm is based on the
dimensions designed during this period. Ticket vending machines
designed to sell tickets for interconnection with suburban lines of
other railway companies were installed in 1972. This ticket vending
machine contains push buttons arranged along the lines of a map
(Fig. 4).

As replenishing coins for change had become the bulk of labor for
operators, in order to reduce this burden, a mechanism for automatic
control of the change replenishing work for more than ten ticket
vending machines was introduced.

In 1973, a machine was introduced that had selection buttons for 16
different fare amounts, thereby able to cover fares for distances of 50
to 100 kilometers. Its main features were the function to recheck
inserted coins, a cassette for replenishing large quantities of coins,
and the function of reusing coins that had been inserted into the
machine as change.

In 1976, railroad fares were raised in response to the rise in prices of
general commodities. To cope with the increased use of thousand
yen notes, a ticket vending machine capable of handling these notes
was introduced for Shinkansen (Fig. 5).

Japan National Railways expanded the area of short-distance ticket
sales, with the result that the range of fares was expanded and the
number of fare increments was increased. This required the
development of a machine for handling both coins and bank notes.
Further, when the machine was to be used to sell long distance
tickets, it would be required to handle 5,000-yen and 10,000-yen
notes in addition to 1,000-yen notes. Efforts for developing these
technologies discussed so far were stepped up, and an innovative
microcomputer-based ticket vending machine (Fig. 6), the basis for
the current-generation ticket vending machine, was developed based
on the technology for handling multiple tickets, a bank note sorter,
techniques for printing on the ticket face using a thermal dot-matrix
system (computer-aided printing technology using heat sensitive
paper), and mechatronics technology for handling high-value bank
notes. This ticket vending machine is called “Model 53V” (where “53”
is the Japanese equivalent of the calendar year 1978, and “V” stands
for Vending machine). A great number of these ticket vending
machines were introduced subsequent to the privatization of Japan
National Railways. Thus, this model became firmly established.

The major functions required of the 53V in the handling of bank
notes included accurate identification of high-value notes (1,000,
5,000, and 10,000-yen notes), transfer of these notes, and return of
change in response to a 1,000-yen note. In the field of printing, this
new model had a function for issuing two types of tickets
(Edmondson tickets for short distance travel and large-sized tickets for
reserved seats) using the thermal dot-matrix method capable of using
software for editing and printing an image on the face of a ticket, and
a function of printing of a wide variety of ticket faces (e.g. ticket with
a map). This model was further characterized as a space saving and
maintenance-free machine. Further, each function was configured in
a block (Fig. 7), allowing combinations to be formed in order to meet a particular application need. The buttons that passengers push were changed from the conventional illuminated push-buttons to a system where the numerical value of each push-button was represented by means of LED, thereby reducing the amount of maintenance work and the work involved in fare revision. As a result of the increased number of ticket vending machines in use, machines for monitoring and batch processing of sales data from each of the ticket vending machines have come into use, so that the work of station back-office staff has shifted from an individualized nature to that of systematization.

In 1985, the prepaid orange card was issued, and this opened up an age of card-oriented business in the railway industry. Efforts were made to develop a card-compatible ticket vending machine. Due to the limited space for mounting a card processor, however, the Model 53V had to be either a card type or banknote-type. In other words, one machine could not handle both cards and currency.

Followed by the improvement and development in ticket vending machines, automated fare adjustment machines, fare adjustment machines for manned windows, transfer-fare adjustment machines, etc., and automated exit wicket machines, all of which were improved. The magnetization of the back of the ticket in particular required a large-scale improvement in the ticket vending machine and MARS terminal. In 1991, a prepaid type stored-fare card system, “IO Card”, compatible with automatic ticket gates was introduced. Thus, it is necessary to create a totally integrated system, and not just an automated vending machine. The total system would include not only the vending machine, but also the entrance wicket and exit wicket. And so, we introduced the machine that is the basis for such a totally integrated fare collection system.

In the same year, we developed and introduced an automated commuter pass vending machine that sells new passes before the old ones expire (Fig. 10). Reserved-seat tickets had been sold by the station staff up until then, but in 1993 we developed and introduced a customer-operated ticket reservation terminal (Travel Edie) (Fig. 11). This machine is operated by touching the screen, and is a forerunner of the touch-type ticket vending machine.

Further, a vending machine installed on the station platform for home-liner tickets (Fig. 12) that had also previously been sold by the station staff was introduced making a significant contribution to the
limited express tickets for train transfers. Further, to take the place of the commuter pass vending machine that sold new passes before the old ones expired, we introduced a new commuter pass issuing machine capable of selling new commuter passes.

In 2001, we introduced an IC card system “Suica,” ushering in a new age of fare collection. There will be changes in the functions required of Suica and the ticket vending machine, including a recharging function.

With the advent of the information network age, an IT-based ticket vending mechanism was introduced, and ticket vending machines will be required to undergo further innovations. In 1998, we adopted the “Ekinet” system that allowed a ticket to be booked via the Internet and purchased at the station. In 2002, the Ekinet ticket vending machine (Fig. 15) for purchasing tickets booked via the Internet were installed at the major stations. A system, introduced in 2001, for purchasing center liner reserved tickets via cellular phone also came into being.

As described above, with the development of machines, electronics, and IT technologies, ticket vending machines have been developed in various forms mainly based on hardware technologies. What is required in the future, namely, our subsequent target is to develop a machine that can be easily used by passengers. We would like to proceed with our research and development project, based on the understanding that it is essential to make efforts to develop ticket vending machines based on the effective utilization of achievements so far in the field of research into the man-machine interface, voice recognition, and the science of human behavior.

References:
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