

Coin and Bank Note Change Machine CR-01

Minoru Kobayashi Toshinao Takahashi
Katsushi Tanaka

The need increases to reduce the burden on cash management (disbursing change, depositing payments and detailing audits) at cash registers in the retail industry.

This paper introduces the CR-01 unit, a coin and bank note change machine, which can process the disbursing of change in bank notes and coins as well as deposit funds in a short time as a subsystem to the cash register POS system, achieving a low cost cash management system.

Features of CR-01 Coin and Bank Note Change Machine

The CR-01 coin and bank note change machine is an automated cash drawer developed for the purpose of rationalizing cash management operations, which are performed as part of cash register operations at supermarkets, convenience stores and volume sales stores. Change is disbursed according to the disbursement order from the POS system of the cash register and the total amounts received from customers are automatically counted and stored, dramatically speeding up the cash fund counting and storing operations at cash registers.

The CR-01 unit features the fastest speed in the industry with regards to fund depositing and disbursing, it incorporates a large capacity recycling storage capability and realizes the first internal automatic processing function in the industry for rejected coins, all at a low cost. These functions are expected to dramatically reduce the intermittent collection of funds, as well as the closing operations carried out at cash registers.

The main features are described below:

- (1) Low cost
- (2) Compact but large capacity
- (3) Cash management function
- (4) High-speed processing

(1) Low cost

Cash processing machines are considered to be peripheral devices for the POS systems of cash registers in the retail industry and a critical factor of this equipment is its cost.

In the change machine market there is a transition from equipment dedicated to handling coins only to equipment handling coins and bank notes. Besides its low cost this machine offers aspects that differentiate it from the competing products of other manufacturers, including a sophisticated cash management function, simplified structure with consideration given to prevent interruptions and malfunctions, as well as the integration of coin and bank note handling.



Photo 1 External view of CR-01

(2) Compact but large capacity

The size of the equipment allows it to be installed on the same mount currently supported by most cash registers and the equipment is designed with consideration given to ensure that the operability for cash register operators will not deteriorate as a result of introducing this equipment.

With a height of 120mm the equipment stores 160 coins in each one, 10 and 100 yen coins, 120 coins in each five and 50 yen coins, 105 coins in 500 yen coins, 300 bank notes in 1,000 yen notes and 100 bank notes in 5,000 yen notes. The equipment features storage that is able to recycle the contents in a cassette, which can be used to collect 200 bank notes. The equipment realizes a compact but large volume (**Photo 1**).

(3) Cash management function

Both coins and bank notes are counted at the time a payment is made, to ensure that the equipment is able to support both the advanced operation, which gives out change based on the amount received from a customer entered in the cash register, as well as the deposited payment determination operation, a method for counting the deposited amount and then giving out the change.

Coins that could not be machine counted are not returned to the cash register operator but rather, machine processed, thereby reducing the burden on the operator.

(4) High-speed processing

The change disbursing speed for change is one second for 999 yen in coins and 2.7 seconds for 9,000 yen in bank notes. The payment speed deposits six coins in one second and four bank notes in one second, realizing the fastest processing speeds in the industry.

Configuration of Coin and Bank Note Change Machine CR-01

The hardware configuration is shown in **Fig. 1**, while a block diagram of the substrates is shown in **Fig. 2**. The unit is made with an integrated structure comprised of a control board that analyzes commands received from the POS system of the cash register before allocating commands to coin and bank note units, a common section made up of the power supply, a coin section, which handles the depositing and disbursing of coins, as well as a bank note section that handles the depositing and disbursing of bank notes.

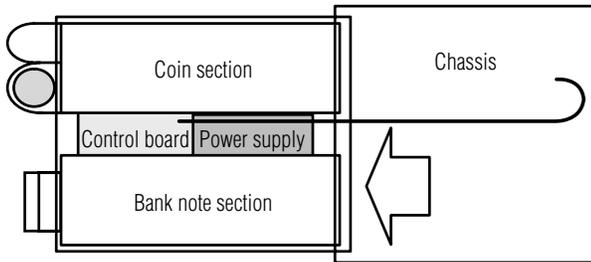


Fig. 1 Hardware configuration

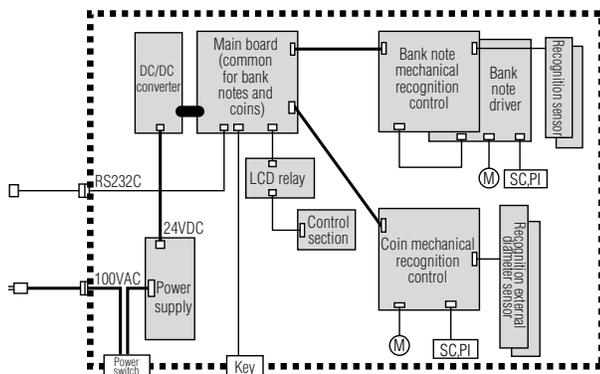


Fig. 2 Block diagram of substrates

Features of coin section

The structure of the coin section, shown in **Fig. 3**, incorporates a deposit slot with a disc and a gate that separates each individual coin. The rotation of the disc inserts multiple coins, which are separated as individual coins before being fed onto the deposited fund feed route.

The coins fed to the deposited fund feed route are transported to the recognition section in intervals exceeding a certain distance, which are created through the speed differences between the grip roller and belt. Six varieties of Japanese coins are identified, based on the coin material and the external diameter, etc.

Coins that could not be identified by the recognition section in an ordinary manner are fed to the reject storage section, whereas those coins that have been identified normally are fed to the sorting section.

The sorting section takes advantage of the difference in the external dimensions of coins by feeding them through sorting slots that drop them into coin storage sections (hoppers) for each individual denomination, according to their external diameter.

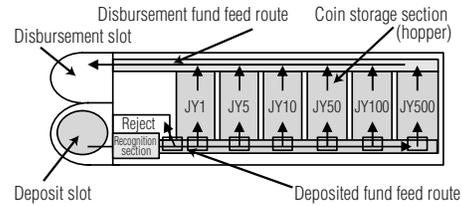


Fig. 3 Schematic diagram of coin section

Other than storing the deposited coins of individual denominations, the hopper is also equipped with a disc that has holes to separate and count individual coins. These coins are fed to the disbursement fund feed route by the rotation of this disc.

The disbursement fund feed route loads the fed coins onto a belt and feeds them to the disbursement slot, where they are discharged as change.

Features of the coin section are described next.

(1) Compact deposit feed

In general the feeding speed of the belt feeding section, located downstream from the grip roller and upstream of the fund feed route, is set faster so that at least a certain feeding gap distance can be secured in order to ensure stable feeding and recognition processing of coins.

This equipment secures a deposit feed speed (six pieces per second) with the fastest rate in the industry, while the speed difference has been minimized between the grip roller and belt in order to miniaturize the deposited fund route.

By minimizing the speed difference the distance is shortened in order to secure time for the actuator operation at the reject section, which starts after a coin is determined to be a reject at the recognition section, thereby making it possible to shorten the length of the feed route.

However, by minimizing the speed difference, on the other hand, the distance of the gaps between coins being fed becomes quite short. If a thinner coin is fed between thicker coins, it becomes more difficult for pressure from the belt to be applied on the thin coin in the middle, creating an unstable feeding problem.

For this reason, out of consideration for the fact that feeding intervals vary from one coin denomination to another, minimum coin feeding intervals are determined, based on the denominations fed through specific locations on the feed route. Rollers applying pressure on the belt are allocated based on this information (**Fig. 4**).

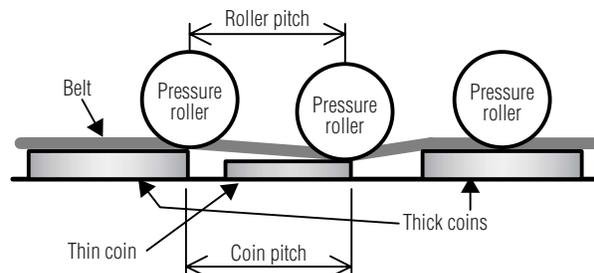


Fig. 4 Roller allocations

Furthermore, stable feeding is achieved by ensuring pressure is applied even to thin coins fed between thick coins and by optimizing the applied pressure to make sure that coins do not stick to the belt.

(2) Compact, large capacity and high-speed hopper

The disbursing hopper of the equipment utilizes a disc system shown in Fig. 5, as described previously.

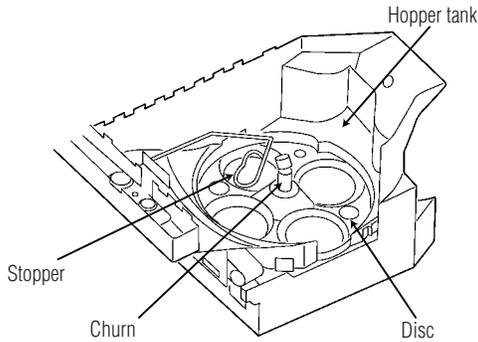


Fig. 5 Disbursing hopper

This system with superior durability offers higher speeds in comparison to feeding systems using belts. The occurrence of jamming at the feeding section is less likely, whereas maintenance, including such tasks as the removal of a jammed item, is also easy. Therefore, with such advantages it is possible to secure reliability with this system.

However, since the accumulation of coins is conducted randomly, coins that fall through sorting slots tend to be concentrated at and accumulate under one slot more than any other, which makes it difficult to secure a storage capacity when the equipment is miniaturized.

Through the use of a three-dimensional CAD a large capacity was secured in a limited available space within this equipment, with consideration given to the design of the hopper tank to ensure that the flow of coins being accumulated will be smooth.

Furthermore, other than the churn, installed to accumulate coins in an evenly leveled manner, a stopper has also been installed to secure an accumulating space directly below the sorting slots.

Also, in terms of control the hopper disc is rotated while funds are being deposited to increase the churning effects, thereby improving accumulation.

The large capacity, which is top ranking in the industry, has been realized through the strategies described above.

Features of bank note section

Shown in Fig. 6 is the structure of the bank note section, where depositing, disbursing and the collection of bank notes are performed as basic operations.

Only bank notes loaded into the fund depositing and disbursing section have their denominations identified at the recognition section for the depositing operation. Depending on the respective denominations, the funds are fed to and stored in the 1,000 yen or 5,000 yen storage sections to be used for change in subsequent transactions. When deposits of 2,000 yen or 10,000 yen bank notes are

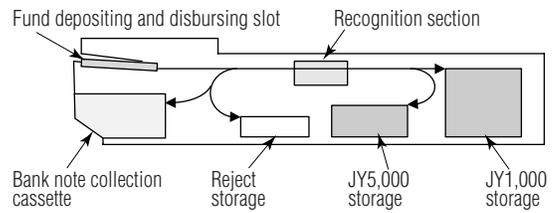


Fig. 6 Schematic diagram of bank note section

made, however, they are temporarily stored in the 5,000 yen storage section since they are not subject to recycling for disbursement and are subsequently fed to and stored in the collection cassette before the next transaction.

Funds for fund disbursing operations are fed in the opposite direction to that of fund deposit operations. Bank notes fed out of the respective storage sections are identified for their denomination at the recognition section and fed to the fund depositing and disbursing section before being discharged as change.

The collection operation is disbursement with the collection storage section used as the destination for bank notes. The fund feeding route is switched over just in front of the fund depositing and disbursing section and funds are fed and stored in the collection cassette.

Other than the above described basic operations this equipment features a function that handles notes considered to be unsuitable for storing in a safe or discharging to the fund depositing and disbursing section, based on feeding conditions and determinations made at the recognition section as rejected bank notes, sends and stores such bank notes in the reject storage section to manage them internally in the machine.

Features of the bank note section are described next.

(1) Compact low cost separating and accumulating mechanism

A schematic diagram of the separating and accumulating mechanism adopted for this equipment is shown in Fig. 7.

The gate roller system, comprised of a pair of rollers, has been adopted for the bank note separator mechanism of ATMs.

Since the gate roller system processes bank notes at a high speed, a high degree of precision is mandatory for the roller dimensions as well as the gate adjustment mechanism, resulting in large size and higher cost issues.

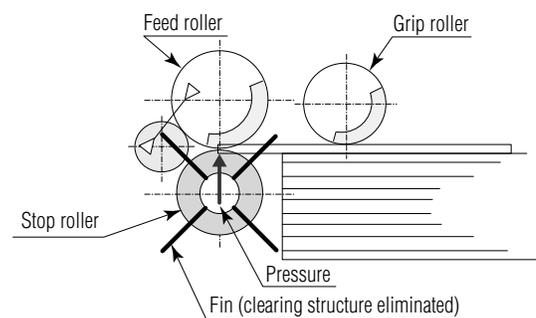


Fig. 7 Pressure contact separating and accumulating mechanism

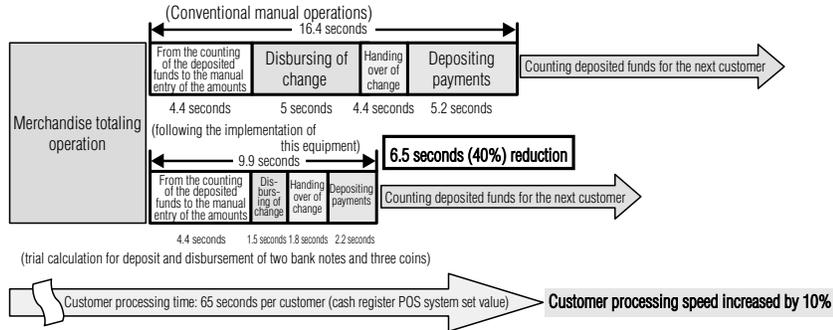


Fig. 8 Comparison of customer servicing time

A pressure contact roller system that can be created for a low cost as well as miniaturized, was adopted for the change machine, which does not require an ATM level of high-speed processing.

Issues relating to the adoption of a pressure contact system, such as an increased rate of multiple feeding and deterioration of the separating capability due to roller wear, were counteracted by implementing strategies, including optimizing the insertion angle of bank notes on a separation roller and by adopting roller materials with a superior wear resistance.

A fin mechanism that presses on the ends of accumulated individual bank notes, has been adopted for storing bank notes. The conventional fin mechanisms have a clearing structure to ensure that the fins do not apply any pressure to the bank notes at the time they separate from the bank notes.

For the change machine, however, this clearing structure was eliminated through the changing of the fin material and their individual alignment.

Through the adoption of the pressure contact separating system and by eliminating the fin clearing structure a reduction in the cost by approximately 50% as well as miniaturization were realized in comparison with gate systems.

(2) Bank note collection cassette incorporating reject storage

The accumulating space inside the bank note collection cassette, which is within the equipment, is sectioned into collection storage and rejection storage space by the storage plates. The feeding destination of bank notes can be switched at will at any time. The collection storage is used to collect the cash funds stored inside the equipment and the reject storage is used to hold the bank notes for which an ordinary determination of denominations is not possible. For this reason a single unit can manage all deposited funds, regardless of the condition of the bank notes, to achieve a dramatic improvement in the cash management operations of our users.

Expected effects following implementation of coin and bank note change machine CR-01

Due to its high-speed processing and cash management function the following effects can be

expected following the implementation of the coin and bank note change machine CR-01.

(1) Shortened customer servicing time

In comparison with conventional manual operations the implementation of a change machine can reduce settlement times by 40%, thereby reducing the burden on operators processing with cash registers and improve customer satisfaction, as shown in **Fig. 8**.

Furthermore, shortening the customer processing time by 10% makes it possible to also reduce the operating costs for cash registers by 10%.

(2) Improved cash management function

Since fund depositing and disbursing management is performed based on the counting of funds by machine, complete eradication of erroneous calculations and inhibiting effects of unauthorized operations can be expected.

Furthermore, since the machine is an integrated coin and bank note change machine, it becomes possible to keep track of the overall balance of funds for each cash register, realizing an automatic management that does not rely on the operator, while shortening the time required for cash register closing procedures.

Evolution of coin and bank note change machine CR-01

The coin and bank note change machine CR-01, was introduced to the retail market in April 2005 through an alliance established with a major POS manufacturer.

We intend to expand our market implementation by developing OPOS^{*1}) standard drivers and compatibility interfaces for the systems of other manufacturers in the future.

Authors

- Minoru Kobayashi: System Hardware Company, System Hardware Div., System Design Dept.-3, Design Team-1
- Toshinao Takahashi: System Hardware Company, System Hardware Div., System Design Dept.-3, Design Team-1
- Katsushi Tanaka: System Hardware Company, System Hardware Div., System Design Dept.-3, Design Team-1

*1) OPOS is an open driver architecture for easily integrating peripheral devices for POS systems in a Windows environment.