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Mechanization of Train Seat Reservation System (Report 2)

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1. Introduction

In Report 1, a number of problems to be considered in mechanization of train seat reservation system were discussed; particularly much space was devoted to the problem of real-time processing system. The present Report deals with MARS-1, a super-express train seat reservation system, which has been designed on the basis of these discussions, with special emphasis on its practical aspects, perticularly on its reliability.

2. Outline of MARS-1

2. 1 Development

We embarked on a research for mechanization of train seat reservation system early in 1955, but our research did not lead to any concrete designing on account of the low level of electronic computer technique in Japan in those days. Nonetheless, as stated in Report 1, discussions, investigations and tests were vigorously pushed and with valuable advices from experts outside the railway in the beginning of 1958 the blueprint of a small-scale real-time processing seat reservation system was nearly worked out. Later in that year, based on this blueprint the Hitachi Works completed MARS-1, which was a tentative system capable of handling the seats of 4 super-expresses and others, totaling 10 trains. This machine was regarded as an experimental step toward realization of a nationwide mechanized system on the JNR in future. It went into operation at the end of January 1960 and has since been in continuous service for more than two years. The results of operation prove that the machine is generally satisfactory in performance with good stability and high reliability and hardly any trouble has been reported that impeded business. MARS stands for Magneto-electronic Automatic Reservation System.

2. 2 Composition and performance of MARS-1

The machine is composed of the Center Processer (Fig. 1) installed adjoining the Ticket Center

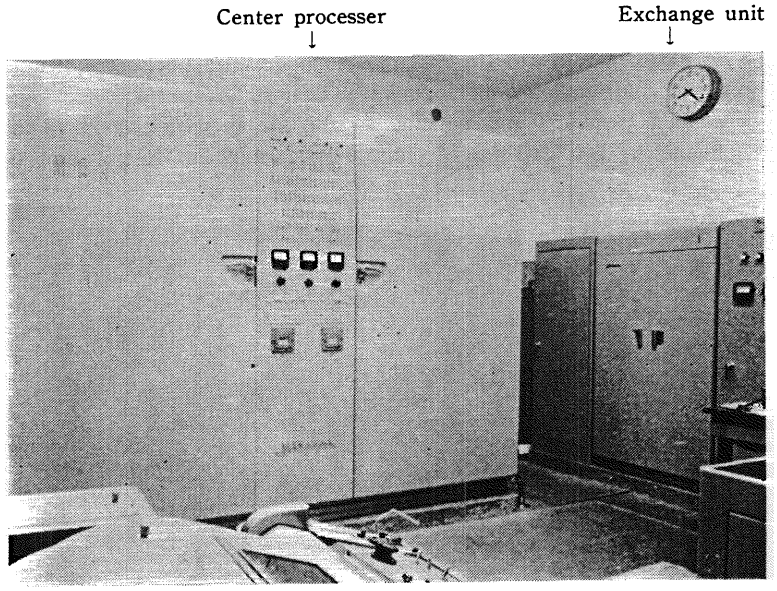


Fig. 1 Center processer of MARS—1

† Automation Lab.

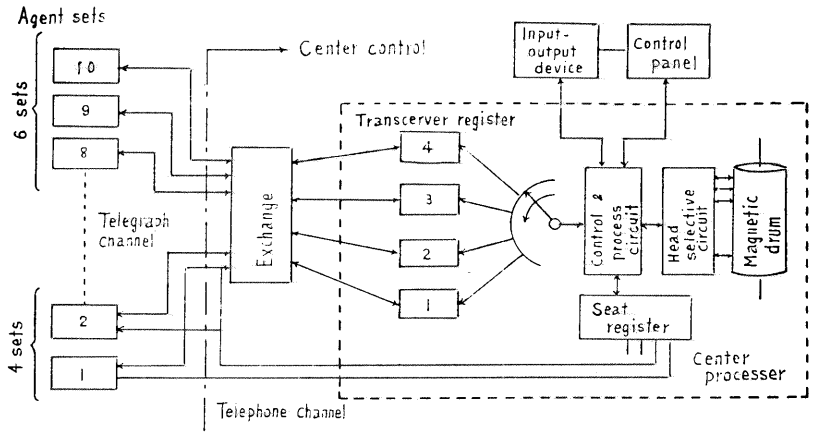


Fig. 2 MARS—1 System

of Tokyo Station, the agent sets provided at respective stations, and the communication channels linking these two.

The system is represented in Fig. 2.

Control center : Center Processor, control panel, input-output unit, exchange unit

Agent sets : Type A for special windows, Type B for common windows, key set, transceiver control, printer, seat vision (exclusively for Type A)

Communication channels : 50 baud d. c. telegraph channels;
Agent sets for Type A are located at comparatively short distance from the Center Processer and the latter is connected by telephone wire with the seat display, with the transmission speed being 1, 000 baud.

In Fig. 2, a customer request is set by the push-button of the key-set attached to the agent set of each station and the machine is started. Then the corresponding telegraph channel is connected by the exchange unit with a transceiver register of the control center, that is, one of the primary registers (when all the primary registers are occupied, it must wait for connection) and the request information thus set by the push-button will be automatically transmitted to be stored in the primary register. The control and process circuit makes a specified processing of the informations introduced in the primary register as they come successively and sets the output of the processing in the same prime register. The answer information is sent back over the telegraph channel to the original agent set. The seat display information in the case of Type A agent set is returned over a separate telephone wire. The reservation system is designed in Type A and Type B. There are a few of Type A; intended for installation at major windows, they can perform all the necessary functions, while Type B, being provided at common windows, can perform only limited functions.

The magnetic drum is a memory unit serving as the file in which the seat informations are stored or canceled; the contents of this drum will change from moment to moment depending on the re-

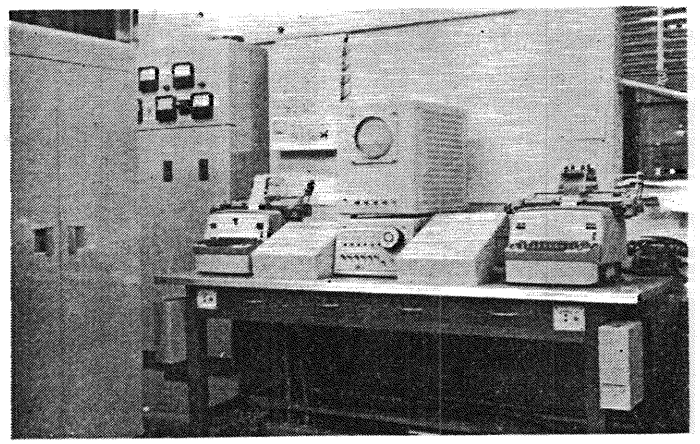


Fig. 3 Agent sets (Types A & B)

quest information from the agent set. Just before the departure of a train, the status of seat reservation in the train is read from the drum; the reading will go through the input-output device, from which a printed chart comes out for delivery to the train guard, while the informations on the seats of the trains in the following reservation period which are punched in advance, will be introduced through the input-out-put device into the magnetic drum. In addition to the control of all these functions, the control panel serves to perform all the necessary works for operation and maintenance of the system.

Performance details of MARS-1 are as follows:

(1) Object of reservation: 10 trains totaling 3,600 seats (maximum number of seats in a train being 900)

(2) Reservation period: 15 days

(3) Reserved section: 3 sections

(4) File processing system: Seat-designation, real time processing system. Good seats are issued on first come, first-served basis and in such manner that they may be evenly distributed in each car: up to four seats can be handled simultaneously by one processing.

(5) Seat information on the file: Informations on each seat designated in a train of certain number, departing on a certain date; its class, berth or not, coach number; reserved or not yet reserved for each travel section, or whether one passenger has it to himself for the entire travel section.

(6) Window transaction: Inquiry, about availability of seats, reservation, designation, cancellation, seat display, performance checking.

(7) Checking: Information is transmitted at a speed of 50 baud, with a parity checking of each item in the information. The information from the Agent Set in which error being detected is manually re-transmitted. The Center Processor is in duplicate operation in parallel and the results of operation are mutually compared in the performance checking. As to the memory unit, the sum of pulses for each track is checked.

(8) Connection between Agent Sets and Center Processer: Waiting exchange connection system is adopted.

Performance time: Processing time per one information in the Center Processer is about 0.1 sec and that in Agent Sets (excluding the time for manual processing) is about 3 sec.

3. Agent Set

3.1 Key set

In consideration of the practical effect of use, the production technique, cost and other matters, the push-button system is adopted for a setting of request information in MARS-1. MARS-1 being a prototype and, as stated in Report 1, the technical problem of printing out an answer in the form of

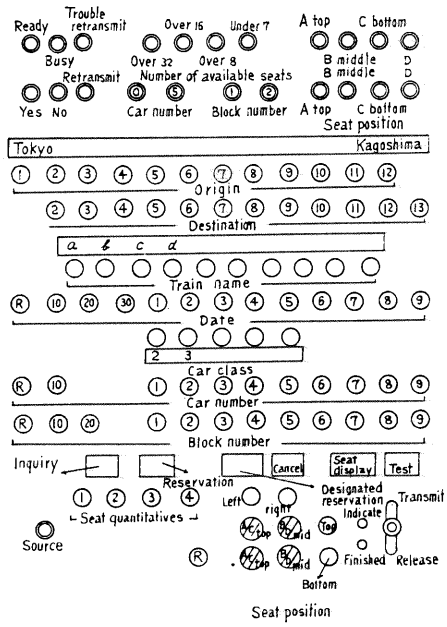


Fig. 4 Push-button arrangement of Type A agent set in Type B, the push-buttons for car number, block number, seat position, designated reservation, cancellation and seat display are missing
a: Tsubame b: Hato c: Kodama 1 d: Kodama 2

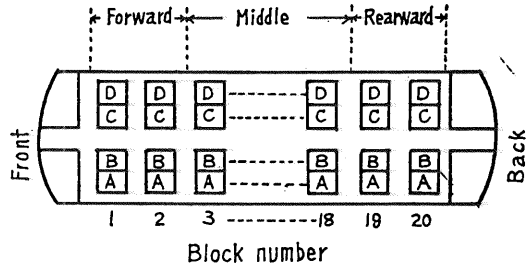


Fig. 5 Designation of seat position

a ticket being not yet solved, it has been decided to utilize the push-button of Key set for designation of trains and stations instead of their stamps, for their numbers are few. The button arrangement is as shown in Fig. 4; in the upper part there are answer-indicating lamps and numerals-indicating lamps.

The names of a station and a train, the date, the class of car, and in the case of designating a seat, the car number, block number and seat position, that is, A, B, C or D (Fig. 5) can be simultaneously specified for up to four seats. Then instead of reserving a particular seat, one fitting the best conditions is to be picked out (inquired or reserved) from among the available seats remaining non-reserved, only the number (up to four) of seats is specified. After these conditions are specified, one of the square buttons indicating the types of operation is pressed and the transmitting key at the lower right is thrown. Then transmission and reception take place automatically and an answer appears at the top.

Among the six lamps at the top left, the "ready" lamp goes on at a pressing of the button; and when an answer filling the requirement comes, the "YES" lamp lights up and when an unsatisfactory one comes, the "NO" lamp does. In the case of the codes, transmitted or received, being caught in the parity check, if the false action originates from the Center Processor, the "re-transmission" lamp will go on; if there is any fault in the circuit stopping the transmission or reception half-way, the "fault-re-transmit" lamp will go on. When all the primary registers are occupied, the "busy" lamp will do. Against an inquiring operation, the rough number of remaining seats in addition to an information on the seat location is displayed, four lamps being assigned for the purpose, indicating the number of seats in four steps: less than 7, 8 to 15, 16 to 31, and more than 31.

In a test operation a pseudo-information is sent and received to test the normal working of each part in the transmission and reception system.

3. 2. Printer

The printer at the window represents a modification of an electrical typewriter. Every answer, when accepted, automatically actuates the printer to print it out. Printing is confined to reservation, designated reservation, cancellation and performance test. The use of printing is not as a ticket but as a monitor of performance. The printing form is illustrated in Fig. 6. This type of a general-purpose electrical typewriter is structurally and functionally not always found adequate for the special purpose of window duty and moreover it is expensive. However, in those days nothing more suitable and cheaper was available and it was inevitably employed.

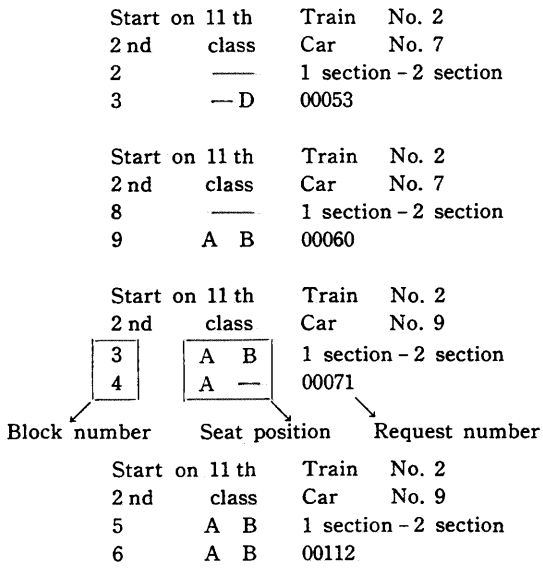


Fig. 6 Print form of agent set

(Actual printing is in Japanese characters; examples shown above are translated for convenience of understanding by foreigners)

3. 3. Transceiver control

The button-set request information is codified by the relay contact and the diode matrix and successively transmitted as a 6-unit start-stop signal. Also the answer information is received as a similar signal and set in the relay. Instead of a mechanical means, a transistorized circuit is adopted as start-stop device. Besides the controlling and parity checking of transmissions and receptions, the control serves to drive the printer and regulate the answer display. Figure 7 is a block diagram of this control.

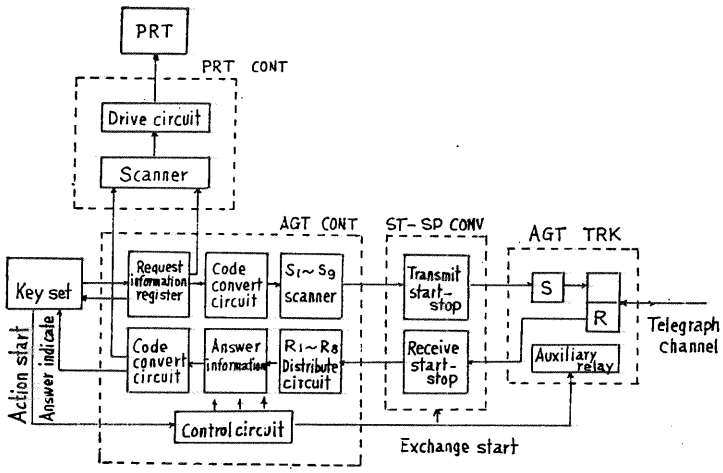
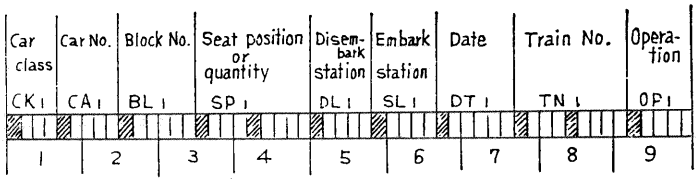
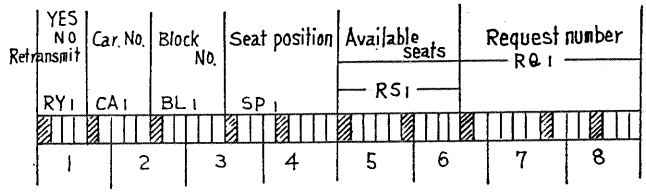


Fig. 7 Block diagram of agent set transceiver control



6-unit start-stop transmission sequence
Mark ■ is odd parity bit, Request information



6-unit start-stop transmission sequence
Mark ■ is even parity bit, Answer information

Fig. 8 Composition of transmitted and received information

The information, transmitted and received, is composed as shown in Fig. 8. The coding is on a binary basis and a parity bit is added to each item. The information, as it passes from the window to the control center, is checked by the Center Processer of the Control Center. If an error is detected, a "re-transmit" demand is issued to the concerned Agent Set, and in accordance thereto, the operator of that Agent Set again sends out the same information. The answer information from the Center is checked at the control of the Agent Set and if an error is detected, it is discarded then and there. Thereby the probability of an error in a set of transmission and reception passing the parity check undetected is equal to 10^{-6} to 10^{-8}. Meanwhile, that of a given operation being discarded on account of a mistake detected in the answer by parity checking is on the order of 10^{-4}. Besides these checkings, a monitoring of the performance time is executed by another facility, which issues an alarm by a red lamp against an excess of time over the specified limit

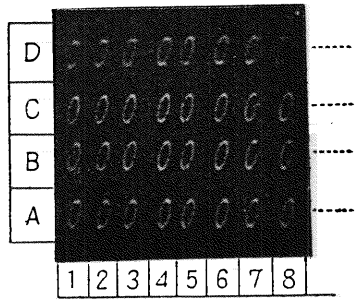


Fig. 9 A part of indication on seat vision

3.4. Seat display

This unit has the function to visualize at a glance the situation of reservations in a given car of a given train on Type A Reservation System. The informations on the seats to be displayed are stored in the register of the Center Processer and therefrom a repeated pulse information on the seats is transmitted. To this end, a telephone wire links directly the register of the Center Processor with this Seat Vision and the speed of pulse transmission is about 1000 baud. The frequency of repetition is about 10 per sec. and a mistake, if committed, will at once be corrected. Display is made as illustrated in Fig. 9 on a static type cathode ray tube with the seat arrangement reproduced as in an actual car; the seats are represented with circles, the reserved ones shining less bright and the non-reserved brighter. Because of its simple system of transmission, the Seat Vision is not effective over so long a distance, but in principle it ought to be fit for transmission to any Agent Set.

4. Center Processer

4.1. Exchange Unit

The Exchange Unit serves to make a necessary connection of channel to a free transceiver register (primary register) in the Center Processer upon a connection request signal from an Agent Set; when there is no free register, it must wait until one becomes free. MARS-1 is provided with 4 sets of primary registers, each one of which is preferentially connected with a particular Agent Set.

Generally speaking, connections of waiting calls are not made in the order of their sequence but at random. When an answer is returned from a primary register to an Agent Set, these two are automatically cut off from each other by a signal from the former.

4.2. Center Processer

As described earlier, a request information from each station enters a primary register of the Center Processer and later goes through a processing in the control and the processing circuits in succession to produce an answer. The Center Processer responsible for this processing is a kind of specialized electronic computer on fixed programming system equipped with a large number of input-output registers; transistors and germanium diodes are employed as elements of a logical circuit. It is a clock 100 kC serial type synchronous computer.

4.2.1. Features of Center Processer

Special attention has been paid to designing of this Processer, which is intended to function as the nerve center of a large-scale system transmitting to and receiving from numerous points many informations under the limitations that, unlike a common general-purpose electronic computer, it must work on a real-time basis and for 24 hours a day without interruption. Thus it processes the following features:

(1) By means of a static flip-flop and a diode gate circuit logical actions are definitely expressed by logical algebraic equations.

(2) In anticipation of the necessity for great quantities of transceiver registers with over 50-bit capacity for connection with Agent Sets, a recirculation register using a magnetic drum is adopted.

(3) For the logical system of processing the seat file, a thoroughgoing time-sharing control system utilizing quick-access recirculation registers with magnetic drums is employed, permitting a high-speed search or updating of the file by means of a small number of parts.

(4) As the unit of memory in the seat file, not a word but 900 bits (maximum number of seats in a train) are taken as base for the saving of the memory capacity, with the length less than 900 bits being variable.

(5) All the main circuits including the magnetic drum are duplicated, each circuit acting in parallel and independently; and through parallel operation the outputs of two circuits are checked.

(6) The sum of pulses for each track is checked for the shifting of seat file information to guarantee the memory.

(7) For the facility of trouble-shooting, various indications and alarms are issued and it is so arranged that the main control pulses may be suppressed to be manually transmitted one by one and the performance step may be tracked (this is very useful because of the few number of processing steps).

Electronic circuit components used for the Center Processer include 2,500 transistors, 10,000 diodes and 80 vacuum tubes. Additionally there are a number of resistances and condensers corresponding to the diodes and some relays and push-buttons.

Adoption of fixed programming in MARS-1 is based on the reason that this Processor was required to perform a very limited function of searching a seat file; the existing stored program general-purpose computers in those days were found very inefficient for such processing; and the machine was no more

than an experimental one, for which no consideration of flexibility to meet future changes was necessary. But subsequent developments in computer technique indicated that even a stored program machine might be adapted for this kind of processing work with considerably good efficiency through addition of a special functional attachment. On this ground in the organization of a future nationwide system emphasis will be placed on flexibility.

4. 2. 2. Memory unit

For the seat file, a less than 250, 000-bit capacity will suffice, but in view of the use of the machine as registers for different purposes, a 400, 000-bit magnetic drum is provided. The details of the drum are as follows: 30 cm $\phi \times 30$ cm; 2, 850 rpm; tracks totaling 200 (of which 12 are assigned to registers); 1, 944 bits for one track; 145 heads for seat filing; memory system as shown in Fig. 11.

The cars comprised in a train are memorized in entirely different order from the one in which they constitute an actual train. It means that the cars are memorized in the order of better condition in order to realize the "first-come, better-served" terms. For this purpose, the serial number of each car in a train precedes the pulse of seat in that car.

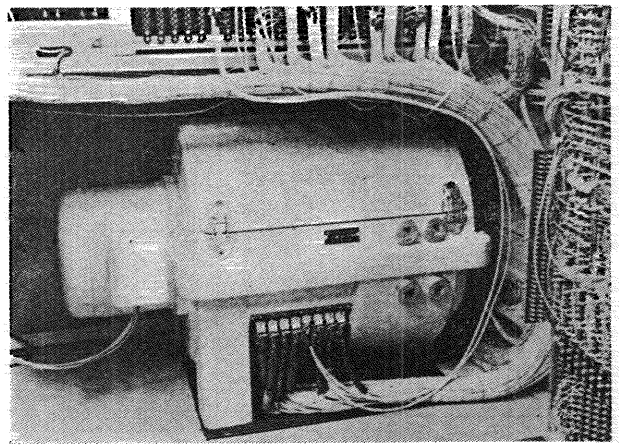


Fig. 10 Magnetic drum (HMD—2) for MARS—1

4. 2. 3. Logical circuit composition

Figure 12 is a block diagram of logical circuit, in which four sets of primary registers and A, B registers, four sets of seat registers, a typeout-tape-read registers, a handling No. register, etc., are the above-mentioned recirculation registers. Other circuits, excepting the magnetic drum write circuit, are all composed of transistors and diodes. The computer cycle and the search mode control circuit include 5 sets of static flip-flops, the secondary register includes 43 sets of them and the α register includes 6 sets.

In the scanning circuit, two sets of flip-flops constitute a counter which issues a selective signal for four primary registers. Sequence of computer performance is controlled by the computer cycle and the search mode control circuit. In a primary register to which a certain Agent Set is connected a request information is stored bit by bit and for this purpose this register is 1-bit precession type. When a reception is concluded, the "ready" signal is sent to the scanning circuit. From among the serially stored 54-bit request informations in the primary registers, the scanning circuit selects one, which then is serially introduced into the secondary register; thereby 11 parity bits being eliminated through parity checking, 43 bits only remain to be introduced into the secondary register. Immediately afterward, the secondary register is converted to a processing circuit, each part serving as counter, shift-register or comparison circuit. According to the specified conditions, a seat pulse is read off the magnetic drum and introduced into the register A and the read information, while circulating through the register A (972 bits for one train), is shifted into the register α, where it is compared with the information from the secondary register and the pulse pattern is examined; where a necessary pulse is found, only that pulse is picked up to be circulated through the register B (the register α is joined to form 972 bits), at the same time the sought answer is set in the secondary register.

As stated above, MARS-1 is on duplicate, parallel operation, in which the performance check of the double equipment is made when answers are set in both. Thereby, if the answers really compared agree with each other when the secondary registers in both are shifted, the memory of the magnetic

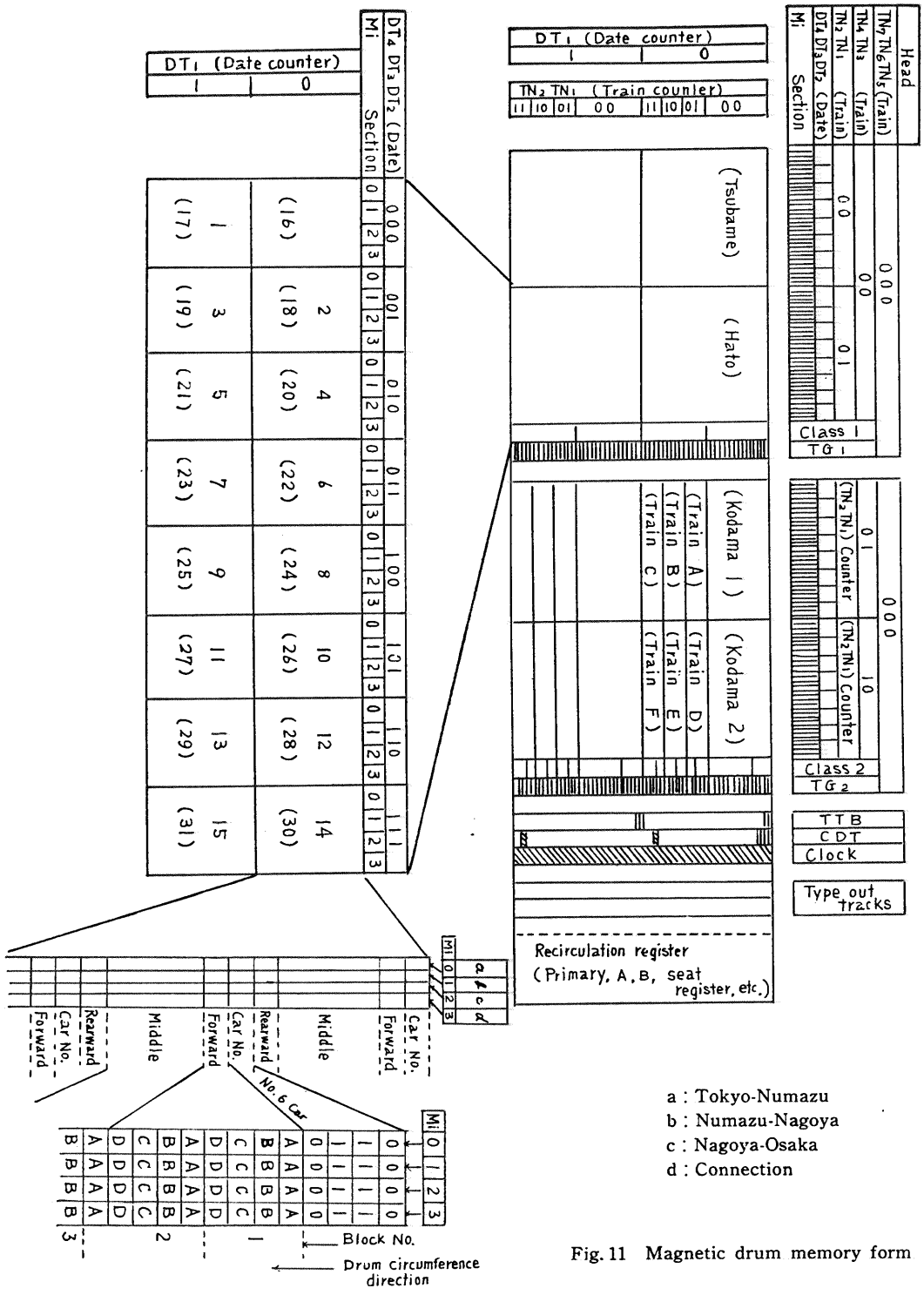


Fig. 11 Magnetic drum memory form

drum is corrected by the pulse circulating in the register B, and simultaneously the answer from the secondary register is sent to the primary register, thereby parity bits being added. Then the primary register immediately starts transmission. This transmission is also performed by 1 bit precession operation.

When a request information entering the secondary register fails to pass a parity check, the answer "re-transmit" is at once issued. Same thing occurs when agreement is not obtained between answers; in that case, however, the buzzer issues an alarm.

To read off an information from the magnetic drum, sum checking is invariably enforced; when

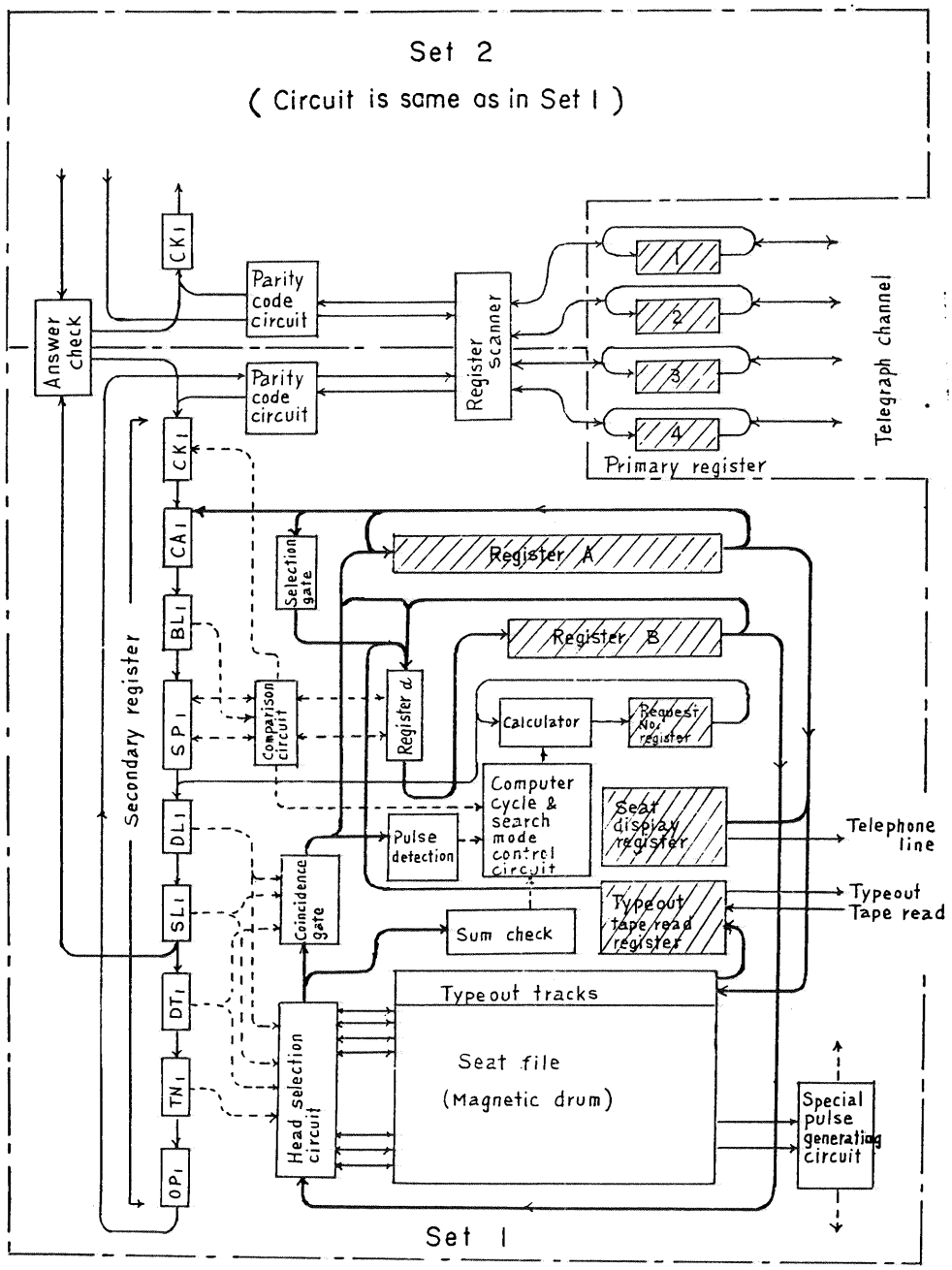


Fig. 12 Block diagram of file processer composition
(Hatched area is recirculation register)

the information fails to pass this checking, the circuit concerned is cut off to go on a single operation.

Seat display register, typeout-tape-read register and their control circuits can be operated in parallel separately from the above-mentioned reservation operation.

4. 2. 4. Various processing actions

(1) Inquiry or reservation: In this case, instead of designating a particular seat, the best seat from among the available ones is sought. Thus, the service to the clients is improved, while passengers can be evenly distributed in the cars.

Figure 5 shows the procedure of searching a seat : a given car is split into middle, forward and rearward and a search is made according to the sequence as listed in Table 1. For instance, when the request is for a single seat, the whole car fitting the requirements is scanned first on the window side of middle ; when there is no vacancy, the search proceeds to the window sides of forward and rearward and so it goes on. When the client calls for more than two seats, the search follows the

sequence shown in the Table and seats are picked up from among the four in any of the boxes. When two seats are desired, they are invariably chosen side by side.

When the seats are picked out, the contents of the magnetic drum remain unchanged in the case of an inquiry, but they will be corrected at once in the case of a reservation. In the case of an inquiry, the balance of available seats will be roughly estimated as an answer.

(2) Designated reservation or cancellation:

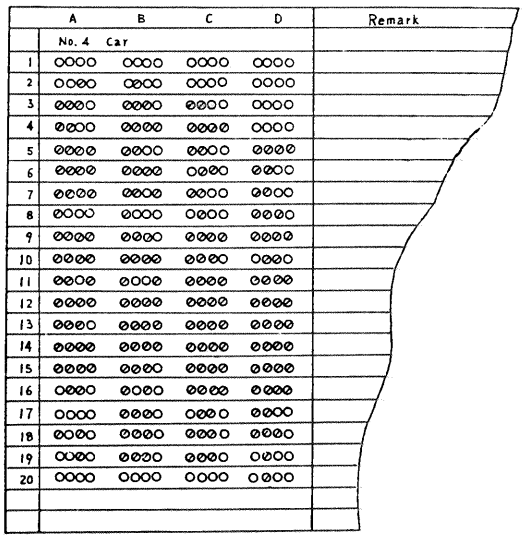
Designated reservation implies reservation of up to four designated seats (within a box), a search being made to see if there is any seat or seats remaining available or any already reserved. If a vacancy or vacancies are available, the contents of the magnetic drum are revised; revisions for reservation and cancellation are just reverse to each other. This operation is confined to Type A Reservation System.

Table 1 Procedure of seat search

Sequence	One seat requested	More than two seats requested
1	Middle, right-left window side	Middle, left side
2	Forward and rearward, right-left window side	Middle, right side
3	Middle, right-left	Forward and rearward left side
4	Forward and rearward, right-left passage side	Forward and rearward right side

(3) Seat display: For this purpose, the information pulse of a designated seat in a designated car of a designated train is shifted into the seat register, which is provided exclusively corresponding to the Type A reservation system; there are four sets of them in MARS-1 (another set is provided in the Center Processer control panel). The seat register transmits pulses over the telephone line at a speed of 1,000 baud. Meanwhile, as the answer information, simply a "YES" code is sent back to the Agent Set.

(4) Others: It goes without saying that provisions are made for such functions as eliminating a certain information from an arbitrary position in the seat file or entering a new information to replace the eliminated one or mutual copying of informations between duplicate files. Meanwhile the reservation status table (Fig. 13) giving information on the state of seats in a train to the train guard can be printed out using the input-output device.



Notes:

Section 1
" 2
" 3

1. ○ ⊘ ○ ○ → Information about whether the seat is occupied for all the sections by a single person
2. ○ ····· Vacant
3. ⊘ ····· Reserved

⊘ ⊘ ⊘ ⊘ ··· Pattern when all the sections are occupied by a single person

□ □ □ ○ ··· Pattern when not all the sections are occupied by a single person

Fig. 13 Reservation chart

4.3. Input-output device (Fig. 14)

The input-output devices to enter a new information in the file or print out an information from the file. The control circuit to drive this device constitutes a separate unit from the one to control

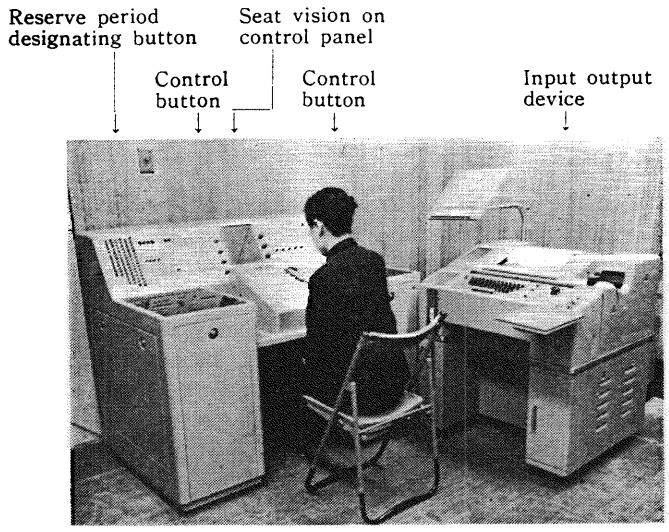


Fig. 14 Front view of control panel and input-output device

reservation operations. Transmission and reception of information are carried out via the typeout-tape-read register. FORMAT control for train identification in printing is executed automatically.

4. 4. Control panel

The panel can control the starting, stopping and testing of the Center Processer. The attached operating board has the same function as the Agent Set and in addition it can perform in conjunction with the control panel all the operations for writing in, writing off, printing and copying of file entries. Also it is capable of suppressing the control pulses and issuing them one by one manually or doing a marginal checking (Fig. 14).

5. Operational Results of MARS-1 and Controversial Points

Over two years have passed since MARS-1 actually was put into operation. In the meantime, business problems and others involving the reliability and maintenance of it as a real-time system have been thrashed out to give general conclusions. Particularly in regard to the problem of its reliability with which we are most concerned, better than expected results have been achieved.

5. 1. Business effect

The most notable from the standpoint of business is a change in the customer service. MARS-1 handling a limited number of trains, however, the effect was not so far-reaching as to liquidate a window queue. Nonetheless, in terms of necessary time for dealing with one request from a customer a great improvement is admittedly accomplished. In the case of non-mechanized processing of business, a customer request is accepted at the window, the ticket center is phoned for inquiry, the answer comes in, and finally a seat designation card is issued. Hampered by waiting for telephone call or processing of file, all these operations run up to 5 to 30 minutes. By contrast, MARS-1 can dispose of all the business in one minute or so. Therefore it is predictable that upon realization of total mechanization of this business in future, the window queue will surely be shortened or even entirely disappear.

Besides the manpower required for window business, that of the ticket center will be substantially cut down. The center business includes not only reservation processing but also a concentrated handling of cancellations. Moreover, the seat file for the succeeding train and a seat reservation chart to be handed down to the train guard should be formulated. The amount of work to be done for the trains handled by MARS-1 in this connection has been reduced from 20 to 4 man hours.

The change in the manual operation attendant on mechanization will affect the rates of processing errors and various accidents. Particularly in initial exploitation of MARS-1, various handling or operating errors were committed on account of the personnel being unaccustomed, though only a small number of seats were handled: for a daily reservation of 320 seats, the error averaged 0. 47 seat (0. 15 %), which was a somewhat unfavourable figure against 0. 17 seat in the case of manual processing. Later, the figure improved to 0. 01 %.

Seeing that hardly any mistake of processing in the circuit occurred owing to parallel checking of duplicate system, it is obvious that cases of customer inconvenience through mistaken reservation are on the decrease.

5. 2. Functional questions

At the planning stage, the functions of MARS-1 were exhaustively discussed on all the available data to satisfy the operational requirements. Technical restrictions and economic considerations compelled, however, omission of some functions and as a result some imperfections were left, major items of which are as follows:

(1) Ticket printing

If the answer indicated on the Key Set is to be manually entered on the ticket, there will be no need for ticket printer; but in that case misentries may occur or time will be lost for entries. For these reasons, it would be desirable not only to indicate an answer but also to print it out automatically.

(2) Operation monitoring

Some device to locate the trouble in case a mistaken reservation or any other error is committed is a "must" for such real-time processing system as MARS-1, because a lapse of time will make it impossible to undo the mistaken processing. In MARS-1, Agent Sets are responsible for printing to this end, but in them nothing but a man can locate a trouble, if any happens and this will be a considerable bother. Nearly perfect monitoring will be possible, if at the Center Processer the informations transmitted to or received from Agent Sets are registered on the magnetic tape recorder. At the time of MARS-1 designing, use of domestic magnetic tape recorders then available was avoided, because none of them was found fit for practical use.

(3) Tariff calculation and statistical works

When a ticket is printed, the tariff should also be entered on the ticket. This will require a calculating mechanism and it will become desirable to review the calculated tariff. On the other hand, various statistical works are in demand. Mechanisms to execute all these functions are missing from MARS-1.

(4) Flexibility

In the course of long usage of the machine, it would be inevitable that the scale and system of seat reservation undergo some changes. To cope with such possibility, it would be advisable, unlike in MARS-1, to adopt a stored program system resembling G. P. C. As already stated in Report 1, in that case the input-output unit to be coupled with Agent Sets or the filing unit by which to search a seat or revise the contents should assume a specialized mode.

5. 3. Reliability

As mentioned previously, great efforts were made to improve the reliability of MARS-1. The effect of these efforts became evident in actual operation of the machine. The results shown here cover a half-year period from February, 1960.

5. 3. 1. Operational results of MARS-1

According to the plan at the design stage, one to two hours of maintenance time were to be set aside every day, but in actuality on account of the personnel not being well accustomed and for business reasons, 24 hours a day, 7 days a week basis of operation was decided upon. Thus, a trouble, if any happens, was to be attended to promptly, and preventive maintenance was confined to a package test, which was to take place several times a year. As for the marginal checking, it was also to be limited to several times a year.

5. 3. 2. Performance results of Center Processer

Figures 15 and 16 respectively show the incidence of troubles and the performance results. Immediately after the machine was officially placed in operation, troubles were liable to happen, thereafter the incidence rate steadily declined and now the operational efficiency (ratio of business execution time to total operation time) has settled down to an average of 99. 93 %; and the ratio of single operation to total operation time is equal to under 1 % average.

The proportions of the troubles in electronic parts such as transistors, diodes, etc. and those in mechanical parts such as relays, push-buttons, printer, etc. were 2 : 3; the fault rate of transistors per 1, 000 hours was 0. 008 %, that of diodes being 0. 003 % and that of resistances being nearly zero, while the trouble incidence in mechanical parts was unsatisfactory.

The average life of the file processer at the control center, $1/\lambda$, is equal to 6. 6 days as converted in terms of a single equipment, that is, $1/\lambda=158$ hours, and the average maintenance time for it is 40 minutes or $1/\mu=0.67$ hour. The distribution of maintenance time may be considered to be exponential as assumed in Report 1. These results are on a higher level than could be expected from the conventional domestic electronic computer.

5. 3. 3. Performance results of Agent Sets

For the initial stage there were only 10 sets of Agent Sets. Their performance was not fully satisfactory, yet they were found serviceable enough. But the adopted printers were not always appro-

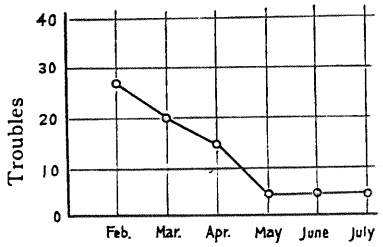


Fig. 15 Trouble incidence of center processer of MARS—1 (including input-output device and control panel)

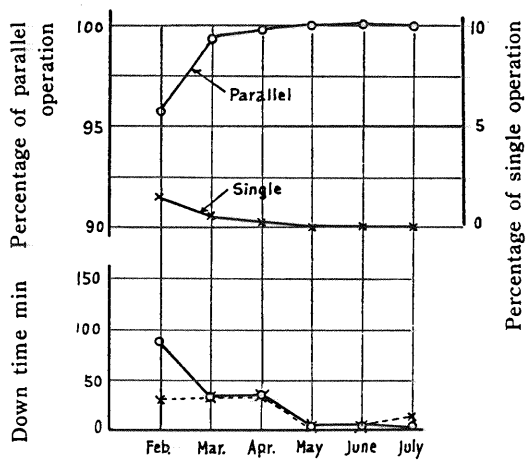


Fig. 16 Performance results of MARS—1
○ : Total
× : Accident

priate, causing many troubles.

Proportions of Agent Set troubles between electronic and mechanical parts were about 1 : 12 and farther improvement of Agent Set in which mechanical parts predominate was deemed desirable.

Figure 17 shows the monthly trouble incidences of the 10 Agent Sets. The average life and maintenance time of Agent Sets are respectively

$1/\lambda \fallingdotseq 10$ days,

$1/\mu \fallingdotseq 60$ minutes.

For an equipment having such a few parts, this value of $1/\mu$ is deemed rather great. This is presumably the result of the bad conditions of maintenance under which the Agent Set finds itself at a station window.

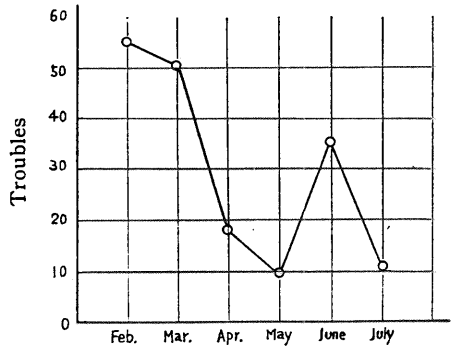


Fig. 17 Trouble incidence of Agent Set (10 sets)

6. Conclusions

In the present report, the composition and performance of MARS-1, the tentative seat reservation system of JNR, are outlined with reference to the results of its actual exploitation and controversial points therein. This represents the first attempt in Japan to apply an electronic computer to a real-time information processing system. Its remarkable success has proved a valuable contribution to the promotion of a mechanized real-time system not only in JNR but also in many different quarters. Encouraged by this experience, JNR is now planning MARS-101, that is, an improved version of MARS-1, enlarged several tens of times in scale with higher flexibility and wider functions; it will materialize in about a year. (Pre. Report No. 69, 1961)