

COMPUTER CONTROL SYSTEM FOR OIL DEPOTS

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I. INTRODUCTION

Oil depots are relay points for supplying large scale customers such as gasoline stations with products from the oil refineries. The automation of oil depots is being closely investigated by many companies in order to cope with the ever increasing demands for petroleum products, gradually deteriorating conditions on city streets and shortages of manpower. Fuji Electric has considerable experience in everything from automation of delivery equipment and computer control to both large scale and small scale systems. This article will introduce the computer control system delivered to the Tagonoura and Matsumoto Oil Depots of Shell Sekiyu K. K. The Tagonoura system went on line in July, 1970 and the Matsumoto system in August, 1970. Both are now operating satisfactorily.

II. OUTLINE OF DELIVERY SYSTEM

As was described above, an oil depot is a place where various petroleum products from the refinery such as gasoline, kerosene, light oil, heavy oil, LPG, asphalt and lubricating oil are stored temporarily before delivery to retail customers such as gasoline stations. These various products are generally brought to the oil depot by ships or tank cars and are delivered by trucks or in drums. Fig. 2 shows layout of the delivery system (Matsumoto oil depot). This delivery system handles three types of petroleum products: main oil products, LPG and asphalt. There are actually a total of 15 products. These products are delivered by the equipment shown in Fig. 1.

There are two delivery methods: by lorry and by drum. There are also two delivery systems: delivery by measuring volume and delivery by measuring weight. Gasoline, kerosene, light oil and heavy oil are delivered by measuring the volume, while LPG and asphalt are delivered by measuring the weight.

This system is planned so that no personnel are required, office work is rationalized and delivery is fast by employing a card system and an order system.

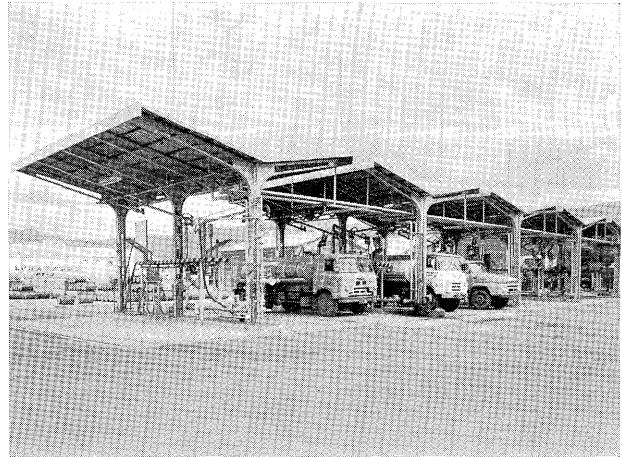


Fig. 1 Outline of the delivery system

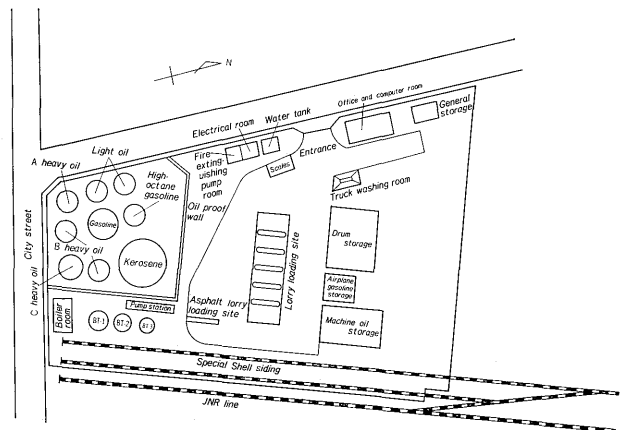


Fig. 2 Layout of the delivery system

The number of deliveries change somewhat depending on the time but the system has been arranged to handle peak periods early in the morning and after the lunch hour. A total of 256 orders can be handled in one day.

III. CONSTRUCTION OF THE COMPUTER CONTROL SYSTEM

A schematic diagram of the equipment is shown in Fig. 3. The functions and specifications of the main components are as follows.

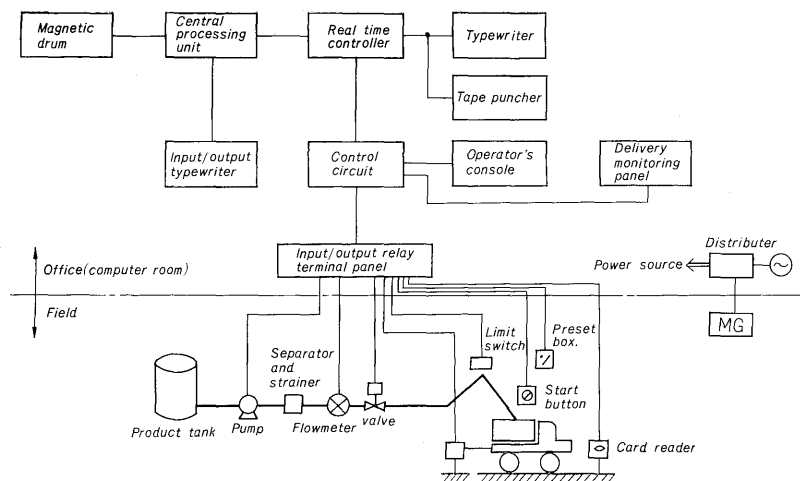


Fig. 3 Schematic diagram of the equipment

1) Central processing unit and auxiliary storage (magnetic drum)

This equipment is the heart of the system and it performs storage of order information, set amount loading control and arrangement of delivery data. A small FACOM 270-10 computer is used in this system.

The specifications are as follows:

Memory capacity-core: 4,048 words
-magnetic drum: 32,384 words

System: stored program

Instructions: 1 1/2 addresses, 14 types

Drum speed: 1,200 rpm

Tape reader included (reading speed: 200 CH/sec)

2) Input/output typewriter (Datawriter)

This is connected to the central processing unit and is used for paper tape reading, punching and printing as input/output equipment for the computer. In this system, it is also used for compiling delivery order forms and daily reports.

Tape reading speed: 500 Ch/min

Tape punching speed: 800 Ch/min

Typewriter printing speed: 8 Ch/sec

3) Real time controller (RTC)

This equipment is the interface between the process input/output terminals from the process and the computer and is constructed of silicon semiconductors, with various units for different applications. Since all the units are of the building block type, units can easily be added or rearranged and maintenance is facilitated. In this system a channel unit, interrupt units, code output units, code input units, typewriter and tape puncher controlling units, and a power supply and terminal unit are used. All the units are accommodated in a locker.

4) Control circuit

This circuit consists of relays, diodes, etc. and has the following functions:

- Relaying RTC input/output
- Relaying the operator's console input/output
- Set amount shut down control, pump starting and stopping

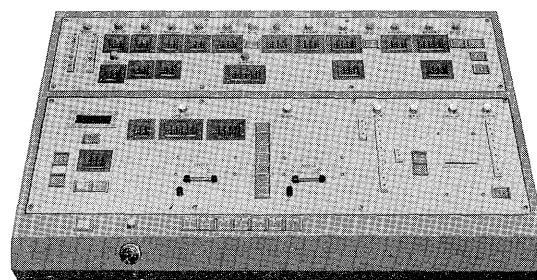


Fig. 4 Operator's console

- Indicator signal code conversion
- Various interlocks to prevent loading errors
- Various interlocks for loading safety
- Micro-voltage input amplifying and processing (card reader, grounding check, etc.)
- Others

5) Operator's console

An outer view of the console is shown in Fig. 4. It has the following functions:

- Setting order amounts (type and amount of oil to be loaded, name of receiver, lorry no. etc. are set by push buttons, cards etc.)
- Non-real time compilation of delivery notes
- Instructions for compilation of daily reports, printing of list of orders not delivered, etc.
- Indication of order sequence number
- Instructions for order changes and cancellation
- Others

Ordering the type of oil to be loaded, the name of receiver and the lorry no. in the computer is performed automatically by using cards or setting buttons and then pushing the "order storage" button on the operator's console. The cards are stored in the processing shelf near the operator's console.

6) Local equipment

The following equipment is located at the loading site.

- Flowmeter (with pulse signal generators for 1 k/ or 200 l)
- Set amount stop valve

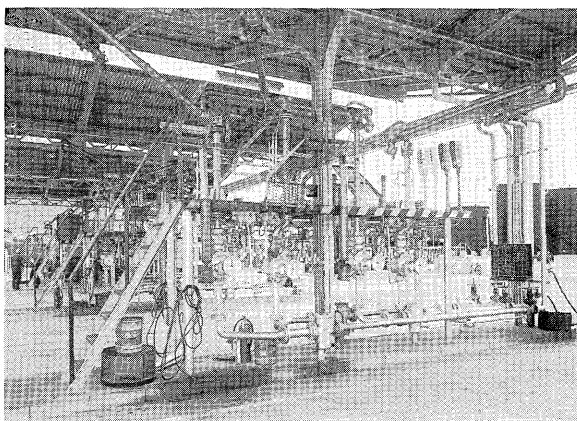


Fig. 5 Equipment at the field

- Card reader
- Grounding check
- Pre-set box (switching of 1, 2 and 4 k l)
- Start instruction button, emergency stop button
- Limit switch to detect loading arm position
- Scales and weight signal generator
- Alarm indicator lamps and buzzer

All of this equipment is of explosion proof construction. The card reader reads the card number of the lorry. The reading principle is the proximity relay. Fig. 5 shows the equipment at the site.

IV. COMPUTER CONTROL SYSTEM FUNCTIONS

This system is a perfect order system based on the lorry number card. The operations are as follows.

1) Ordering

The order which is requested by telephone etc. up to one day previous is set in the operator's console. The items in the order are :

- Order sequence number (3 figures)
- Name of receiver (9 figure code and 15 character "katakana" name)
- Type of oil (6 figure code and 15 character "katakana" name)
- Truck number (2 figures)
- Trip number (1 figure)
- Type of delivery note

Of these, the name of the receiver, type of oil and lorry number are read in by the card reader in the operator's console. The sequence number is automatically renewed. The order is typed out as a delivery order form by the input/output typewriter.

2) Delivery

The lorry driver has a card for his lorry. On the day of the delivery, this card is inserted in the card reader at the loading point and the earth equipment is connected. The loading amount for each hatch is set at either 1 k l or 2 k l and the start button is pushed. The computer then reads the contents of the card, and checks the contents of the order and the type and amount of oil. If these are as in the order, the control valve is opened. When the lorry

has no ground or when the attempted delivery differs from the order, starting is not possible.

3) Shut down

The flowmeter gives out a slow down signal and a shut down signal for every 1 k l (or 200 l). When the set amount is 1 k l , a slow down signal from the control circuit is given at about 50 l before shut down, and the control valve is only half open. Just after this, when exactly 1 k l has been loaded, a shut down signal is given and the equipment is stopped at the set amount. When the set amount is 2 k l , the signal when 1 k l is reached is by-passed and there is no shut down signal. The pulse signals for each 1 k l are added in the counter located in the delivery monitoring panel. The shut down signal is sent to the central processing unit and loading is terminated.

4) Delivery of LPG and asphalt

LPG and asphalt are handled by weight. When the lorry enters the depot, the tare, i.e. the empty truck, is weighed. Once the lorry is on the scales, this empty weight is set on the lorry card in the card reader. After the "power supply" button is pressed, the "oil type" button and "empty weight" button are pushed. The lorry number and empty weight value are stored in the computer. The lorry is then loaded with the fixed amount at the appropriate loading point and again driven onto the scales. After the power supply button is pushed, the oil type button and the full load button located in the operating box are pushed. The computer then reads in the contents of the card and the scale weight value. The lorry number is matched and the empty weight value is subtracted in order to calculate the weight of the load.

5) Printing delivery notes

When the type of oil and the fixed amount have been loaded in the case of volume delivery or when the full load button has been pushed in the case of volume delivery, the delivery notes are made out by the typewriter located in the office. Fig. 6 shows an example of the delivery note, with the daily report in the background. Since the lorry card can

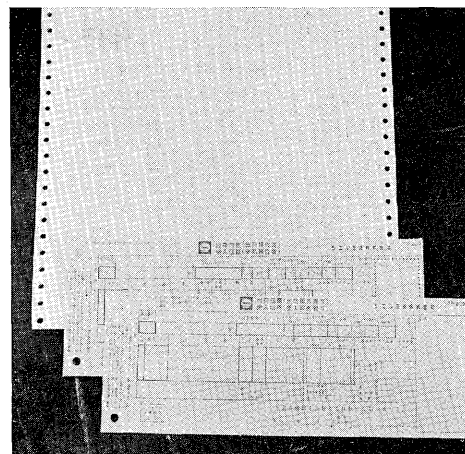


Fig. 6 Delivery note and daily report

not be removed until the delivery note is typed out, this lorry card serves as an exit pass. The same information as typed out on the note is also punched on paper tape to be stored in the other computer located in the head office.

6) Daily report and list of orders not delivered

When one day's deliveries are completed, the delivery data for the day are added according to product and typed out. If orders still remain, the contents of orders not delivered that day are typed out on a list of amounts not delivered.

The functions of this system for general deliveries are as given above. In addition, there are delivery monitoring panels which show delivery conditions, emergency stop buttons and alarm indicator lamps and buzzers at each delivery point. Careful consideration has been given to both safe and accurate loading.

V. SOFTWARE

1) Features

The following points were considered when planning the application software of this system.

- (1) The level of each program was fixed so that the waiting time for the operators in the office and at the local station (lorry station, weighing operation box, etc.) is as short as possible.
- (2) Since there are almost no differences between the systems used at the Tagonoura and Matsumoto depots, the programs are both the same. The only point of difference between the two systems is the arrangement of the table.
- (3) Even when the number of loading points and number of islands are changed somewhat, there is absolutely no change in the programs and only the tables need be altered.
- (4) The software is fool-proof and incorrect data due to a mistake on the part of the operator can not be included. The cause of the mistake is printed as an error message by the typewriter.

2) Outline of the software

There are three main operations in this system. These are as follows from the viewpoint of the software.

- (1) Order→loading to fixed amount→delivery note typing

All of the data required from delivery to preparation of the delivery notes which were inserted from the operator's console are arranged on the computer drum. The data include the order number, lorry number, trip number, type and amount of oil, receiver's name and receiver's code. These are arranged in the table so that there will be smooth processing with a minimum of steps from a start in interrupt.

When a start signal is received from the lorry delivery point at the local station, the lorry card is read and all of the orders to be loaded at that

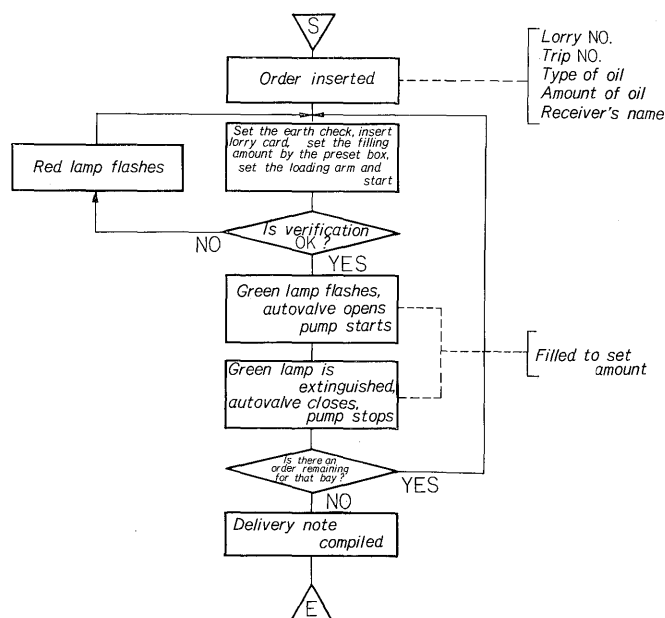


Fig. 7 Flow chart of quantitative delivery

island are placed in the core table. However, identification numbers are added only to the type of oil and receiver's name ("katakana" names) required for printing the delivery note and only these numbers are placed on the core. When the next loading starts, the order lists on the drum need not be consulted and verification is only by the data on the core. In this way, the processing required at the next start interrupt is kept to a minimum. When the loadings are completed, the lorry cards are unlocked automatically and the delivery notes for the loads are automatically printed.

The number of the corresponding tank are accumulated according to these note data and these are used in calculating the daily total. These data are punched on tape in a set form for each note. The timing is related to the operation of the tape puncher and the relation with the data buffer; data corresponding to 36 notes are collected and then punched on the tape.

All types of operator mistakes and equipment failures have been considered at each of these steps. All such conditions which can be considered from software are printed by the typewriter as error messages. Such messages include LIMIT SW, ERROR (device which indicates loading arm direction), TW and TP ERROR.

- (2) Order→Weighing→Preparation of delivery note

LPG and asphalt are delivered by weight. The computer makes up a table containing data for each LPG or asphalt lorry (a maximum of data of 24 in this system). First, when there is an interrupt caused by the "empty weight" push button, the lorry number and weight value are read in and the weight of the empty truck is stored in the memory. Next, the lorry is loaded and driven on

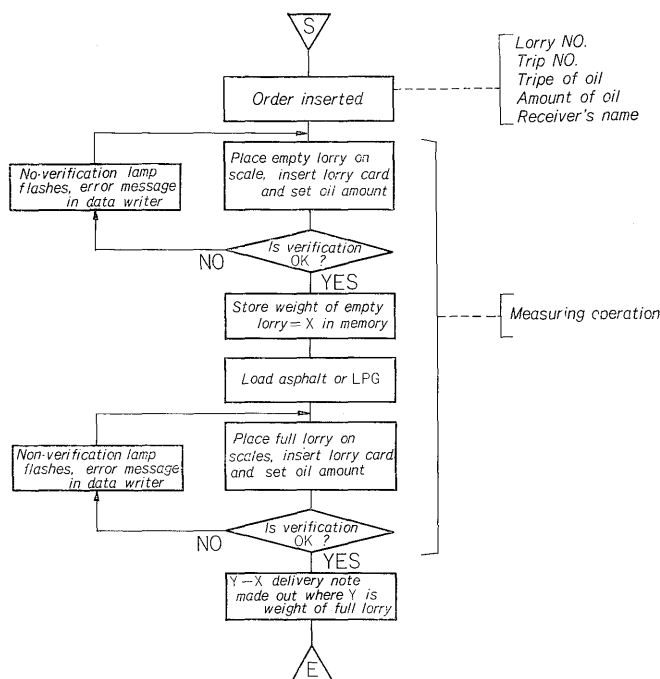


Fig. 8 Flow chart of measuring delivery

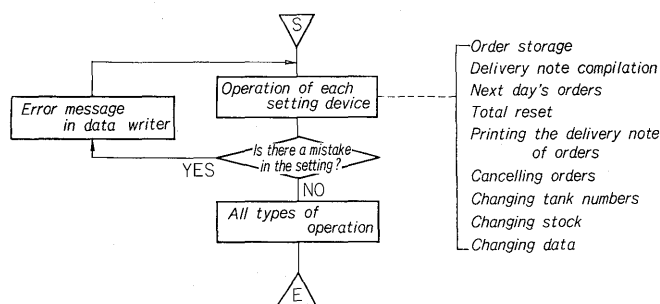


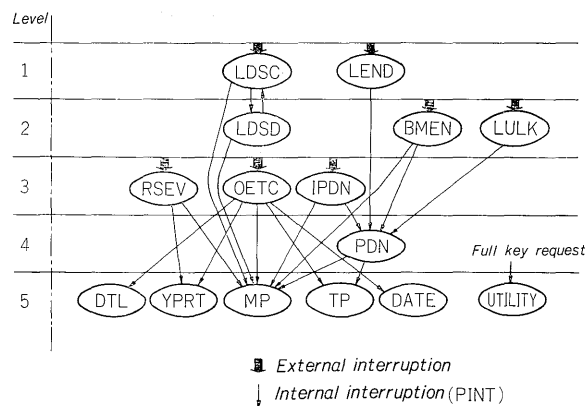
Fig. 9 Flow chart of operation

the scales for the full weight. At this interrupt, the full weight value is read in. The empty weight value read in previously, is subtracted from the full weight value and the net delivery note is automatically prepared. In addition, there are also return, addition and cancellation operations; but in all cases, the desired delivery note is compiled.

(3) Various operations by operator's console

The exchange of data between the operator and the computer is accomplished by means of a operator's console, a Datawriter and a typewriter. These can perform various operation; for example, order storage, manual note compilation, next day's orders, printing daily total, total reset, printing the delivery notes of orders, order cancelation, changing tank number, changing date, etc. Operations using the operator's console can also be performed prior to output of the data for these operations. In other words, the operator can make settings one after the other without waiting for the delays of the I/O devices.

3) System utility



LDSC: Loading start program (core)	delivery notes of orders, etc.
LDSD: Loading start program (drum)	IPDN: Manual note compiling program
LEND: Loading end program	PDN: Note printing program
BMEN: Measurnig operation program	DTL: Daily total printing program
LULK: Lorry card unlock program	YPRT: Order printing program
RSEV: Order program	MP: Message printing program
OETC: Program for cancelling order, next day's orders, printing amount of order not delivered, printing day's total, total reset, tank no change, printing the	TP: Tape punching program
	DATE: Date changing program
	UTILITY: HDL, HDD, COMP, OWST, etc.

Fig. 10 Program tree

Following 4 programs are adopted as utilities considered ideal for this system.

(1) HDL (Hexadecimal Loader)

This program loads the dumped system tape in hexadecimal form from the reader included in CPU on the drum. Only when the code conversion table is altered, either Facom writer code tape or Datawriter code tape can be used.

(2) HDD (Hexadecimal Dump)

This program gives out the drum contents in the Datawriter. This output tape can be loaded directly by the HDL program.

(3) COMP (Compare)

This program compares the drum contents and the system tape contents and when there are differences, the two contents are printed by the Datawriter.

(4) OWST (One Word Store)

This program can change drum words by means of full key operation. The relations between the programs and their levels are shown in Fig. 10.

VI. CONCLUSION

This article has described computer control of delivery equipment for oil depots. Oil depots are being examined carefully by various companies with a view to automation of delivery equipment and savings in manpower. It is hoped that this article will be of some help in this respect. The authors would like to sincerely thank all those who helped in the completion of this system.