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TELEPERM COMPACT CONTROLLER

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I. FOREWARD

Industry is pouring all its power into resources saving, energy saving, environment, safety, etc., in addition to making existing plants larger and more efficient, and the demand for higher performance, higher precision, and higher reliability in measurement and control systems is steadily increasing with process diversification.

We have been supplying the Teleperm electronic instrumentation system and, since 1975, the FUJI MICREX microprocessor based digital process control system to meet these demands and have an enviable record of achievements in all industrial fields. On the other hand, in 1978 we placed the PRM unique digital calculator to perform complex, sophisticated operations for an analog instrumentation system on the market and adopted to various fields.

The newly developed Fuji Teleperm Compact Controller is a single loop digital controller that can be handled the same as an analog controller and simplifies the adoption of digital instrumentation from small scale single loop instrumentation and is flexibile enough to meet the expectations of various users for measurement and control systems.

II. DEVELOPMENT OBJECTIVES

The Fuji Teleperm Compact Controller is a revolutionary microprocessor-based single loop controller that incorporates a solid-state indicator and other new technologies. The case dimensions meet international standards.

The following describes the development objective of the Teleperm Compact Controller.

1. Handling identical to that of analog controllers

Independent monitoring and operating device for each loop, elimination of the need to know software for instrumentation design, manufacture, testing, and maintenance, same easy handling as that of an analog controller, and the advantages of digital instrumentation from a single can be adopted.

Consideration has also been given to expansion in loop increments, simple modification of internal control and computation functions, etc.

2. Abundant control and computation functions

In addition to PID control functions, abundant control and computation functions can be flexibly combined. Transmission to a higher level system, and other control characteristics are improved and ample cost-performance is displayed.

3. All-electronic indicator

The adoption of a plasma display and light emitting diodes at the indicator eliminates mechanical moving pointers, servosystem moving drum, and other mechanical moving parts and assures high precision indication and reliability.

III. SPECIFICATIONS

1. Features

1) Loop reliability

(1) The Teleperm Compact Controller is basically a single loop controller and has the most risk-dispersed configuration.

(2) Manual functions are provided. To be precise, since soft manual and hard manual are both provided as hardware at continuous output type, loop down probability is extremely small.

(3) Since a self-check function displays the trouble contents, recovery time is short. Test program unit allows, detailed checks and simplifies inspection and calibration.

2) Improved cost-performance

(1) Internal processing of computation functions around the controller and simple sequence processing functions simplifies wiring and reduces instrument panel space.

(2) Digital processing of all the computation functions improves, computation precision and permits more complex computations.

(3) Various control function demands can be flexibly met by combining various control and computation functions.

3) Improved operability, servicability, and expandibility

(1) Supervision is easy by the simplified mechanism and

Table 1 Specifications of Teleperm Compact Controller

Item		Specifications
Type		Continuous output controller (Type PMK) Step output controller (Type PML)
Input signals	Measured value	DC 1 ~ 5 V
	External set point value	DC 1 ~ 5 V or pulse width input
	Auxiliary analog input	DC 1 ~ 5 V, 5 channels
	Auxiliary digital input	4 channels
	Opening meter signal	10 - 100 - 10 Ω 3-wire potentiometer or DC 1 ~ 5 V
Output signals	Manipulation output	DC 4 ~ 20 mA or pulse width output
	Auxiliary analog output	DC 1 ~ 5 V, 2 channels
	Auxiliary digital output	8 channels
Indication	Measured value, set point value	Plasma display, resolution 0.5%, scale length 100 mm
	Manipulated variable	LED display, resolution 2.5%, scale length 60 mm
Data Entry Unit		Constant, parameters setting and display function Control and computation element connection
Transmission function		Transmission to higher level system
Installation	Environment	0 ~ 45 °C, 20 ~ 90%RH
	Power requirement	DC 24 V
	Power consumption	Approx. 20 W
	Dimensions (W x H x D)	72 x 144 x 400 (mm), IEC (DIN) Standards

the flat-faced front that matches panel. Moreover, solid-state indicator is accurate and easy to read. SV and MV pushbuttons make it easy to handle. Simple lock lever mode switch pervents erroneous operation.

(2) Because the controller internal wiring and constants setting are performed by Data Entry Unit, on-site adjustment and alteration are extremely simple. Moreover, digital display of constants and parameters in industrial value eliminates individual error and erroneous readings.

(3) The controller has a unit construction, and since the units are the same without regard to the control and computation functions, the number of spare parts can be reduced.

(4) Since the case is International Standard size and is independent for each loop, it is an international produce expandable as a system.

4) Centralized supervision and operation

Serial transmission function enables, centralized supervision and operation from a higher level system.

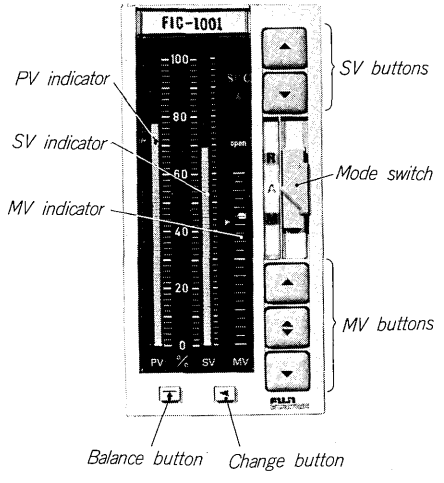
2. Specifications

Table 1 lists the specifications of the Fuji Teleperm Compact Controller.

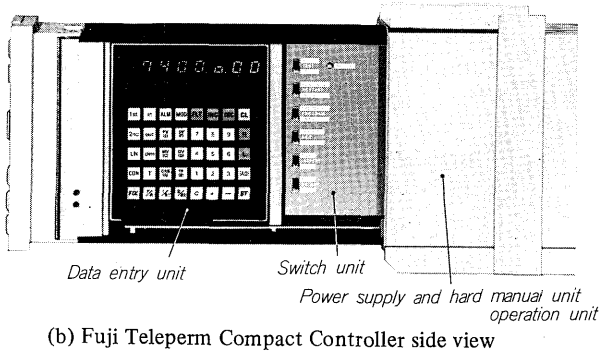
3. Construction and functions

Fig. 1 shows the construction of the Teleperm Compact Controller.

The front face operated from the front of the panel is equipped with pushbuttons that change the set point value (SV), pushbuttons that manually operate the manipulating variable (MV), opening meter that indicates the opening of the valve, indicator that indicates the measured value (PV) and set point value, upper and lower alarm displays (△▽lamps), hard manual variable (HMV) and computer setting mode display and R-A-M mode selector switch, and its confirmation lamps.



(a) Fuji Teleperm Compact Controller front view



(b) Fuji Teleperm Compact Controller side view

Fig. 1 Structure of Teleperm Compact Controller

The upper and lower limit lamps also serve as fault lamps and light when fault occurs.

Momentary pushbuttons (balance button, change button) permit cascade signal balance confirmation and manipulated variable display.

The Data Entry Unit is used to set and display constants and to connect control and computation elements, data, parameters, and connection of elements can be read and written from the keyboard.

The Switch Unit has selecting switches of the controller's operating mode and stores the kinds of computation contents, wiring contents, and set constants. Various control and computation functions can be executed according to the contents of this unit.

The transmission unit inside the controller exchanges data with the higher level system and connects the controller to the higher level system by serial transmission. Maximum transmission speed is 19.2 kB/s and maximum cable length is 500 m.

The body has a draw-out construction, and can be pulled out to the hard manual manipulated variable unit (HMV). The body and frame can be separated by pushing up the lock button at the bottom of the body and pulling out the body. Since the HMV remains at the case, even if trouble occurs, its affect on the plant is minimal.

The HMV is equipped with HMV switch, control knobs, and deviation indicators that indicate the difference between the HMV and body outputs that allow switching without causing a shock to the plant. *Fig. 2* is a block diagram of the operation output part.

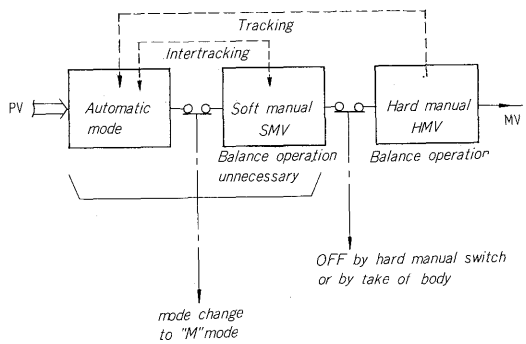


Fig. 2 Block diagram of operation output part

The power unit is a harmonic switching type DC/DC converter that supplies the power needs by each unit from DC 24 V supplied from a common power supply.

IV. CONTROL AND COMPUTATION FUNCTIONS

From investigation of the analog controller, analog calculator, and relay sequence functions in conventional measuring control loop, and the functions of the DDC microcontroller of the FUJI-MICREX digital control system, the functions of the control loop are divided into control blocks and computation wafers. A functional, flexible controller can be built and the best controller for the application can be realized by combining these blocks and functions.

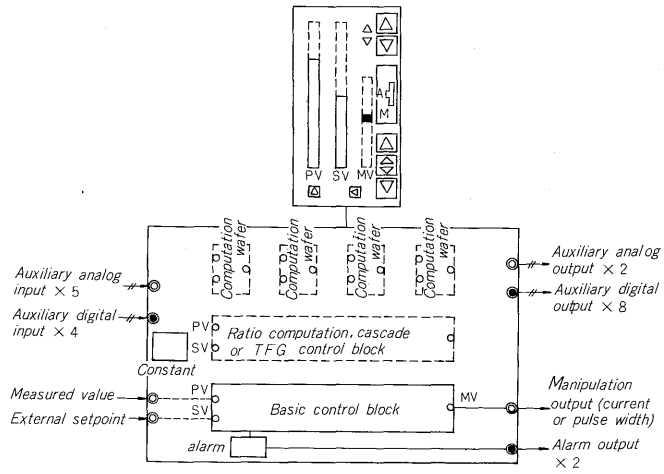


Fig. 3 Block diagram of control and computation function

Fig. 3 is the block diagram of the control and computation function.

The control blocks are a position type PID control block, velocity type PID block, ratio computation block and Time Function Generator Block. Basically, the Compact Controller employs one of the following control systems:

(1) Basic control (consisting of one PID control block).
(2) Ratio control (consisting of a ratio computation block and a PID control block).
(3) Cascade control (consisting of two PID control blocks).
(4) Program control (consisting of a TFG block and a PID control block).

The following control systems utilizing the features of digital instrumentation can also be realized:

(1) PID control with dead band
(2) Deviation square type PID control
(3) Adaptive gain PID control
(4) Feed-forward control
(5) Dead time control
(6) Selective control

The various computations accompanying the control functions are performed inside the controller by combining the computation wafers. The computation wafers consist of basic computation wafers, resembling analog calculators, and extended computation wafers having functions difficult to achieve with conventional analog computation. Examples are shown in *Table 2*. Up to seven of these computation wafers can be freely combined in Basic control, up to five can be combined in Ratio control, and up to four can be combined in Cascade control, up to six can be combined in Program Control.

The following is an example of the Compact Controller control and computation function used in boiler feed water flow rate control (3-point water level control). This control

Table 2. Examples of computation wafers

(a) Basic computation wafers

No.	Name	Computation contents	Remarks
1	Linearize wafer 1	$V \rightarrow f(V)$	7 polyganal lines
2	Linearize wafer 2	$V \rightarrow f(V)$	7 polyganal lines
3	Square root wafer	$V \rightarrow \sqrt{V}$	With cut below a certain value.
4	Addition wafer	$V_1, V_2, V_3 \rightarrow +$ → V_1+V_2, $V_1+V_2+V_3$	
5	Multiplication and addition wafer	$V_1, V_2, V_3 \rightarrow \times, +$ → $V_1 \times V_2$, $V_1 \times V_2 + V_3$	
6	Addition and division wafer	$V_1, V_2, V_3 \rightarrow +, \div$ → V_1+V_2, $(V_1+V_2) \div V_3$	
7	Subtraction and multiplication wafer	$V_1, V_2, V_3 \rightarrow -, \times$ → V_1-V_2, $(V_1-V_2) \times V_3$	
8	Temperature and pressure compensation wafer	ΔP, K_P^2, $1/K_T^2$ → TP$\sqrt{\ }$ → Q_N	
9	Switching wafer	V_1, V_2, ON OFF signal → V_2 or V_1, V_1 or V_2	
10	Selector wafer	V_1, V_2 → HI/LO → HI output, LO output	

(b) Extension computation wafers

1. Timer wafer
2. Lead element wafer
3. First order lag element wafer
4. Dead time element wafer
5. Lamp output wafer
6. Analog addition wafer
7. Pulse generation wafer
8. Average wafer
9. Integrate wafer
10. Gap wafer
11. On-Off wafer
12. Limiter wafer

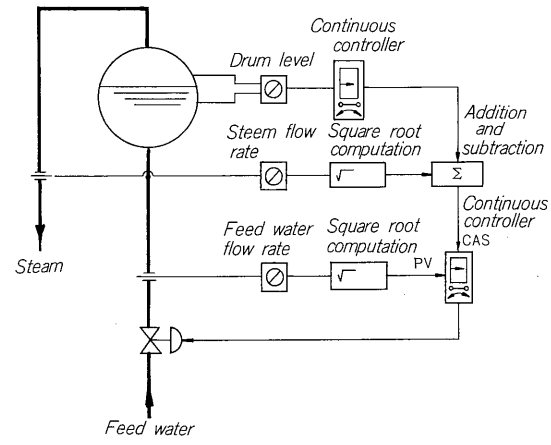
system measures the drum level, feed water flow rate, and steam flow rate and maintains the boiler drum level constant by combining cascade control and feed-forward control.

Fig. 4 (a) shows the analog instrumentation system and *Fig. 4* (b) shows the Compact Controller instrumentation system. *Fig. 5* shows the hardware and software wiring inside the Compact Controller. Cascade control system uses four basic computation wafers, such as a square root wafer.

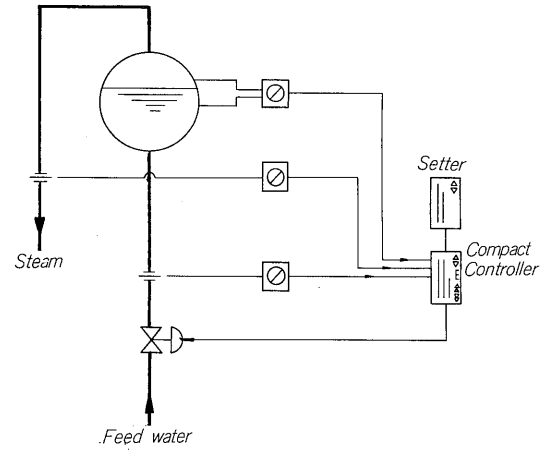
The most functional controller for the process can be built by combining the control blocks and computation wafers in this way.

V. APPLICATIONS

The Fuji Teleperm Compact Controller has a wide range of applications and can be used to partially digitalize

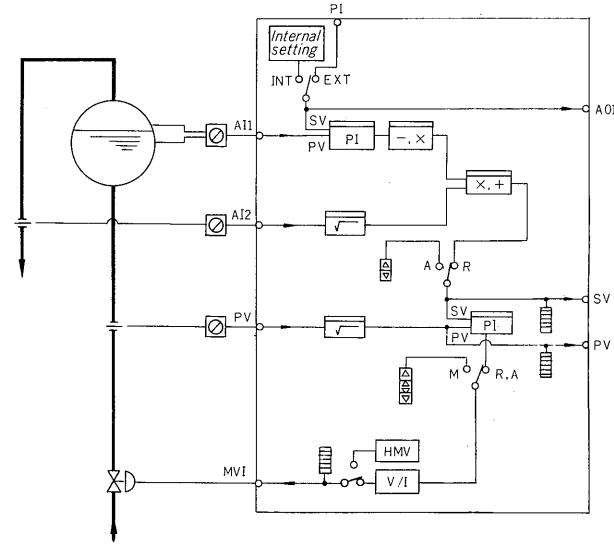


(a) Analog system



(b) Compact Controller system

Fig. 4 Application to boiler feed water flow rate control

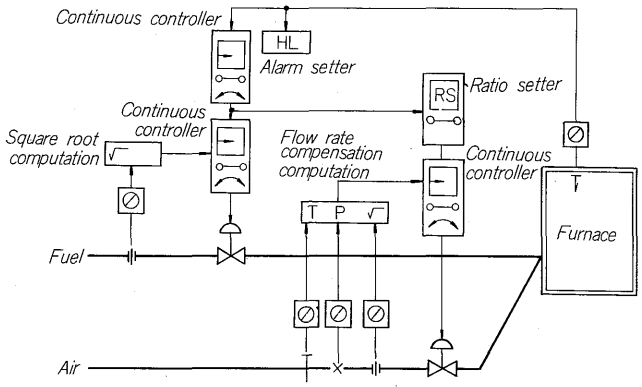


Notes) (1) ▭ indicates computation wafer, control block.

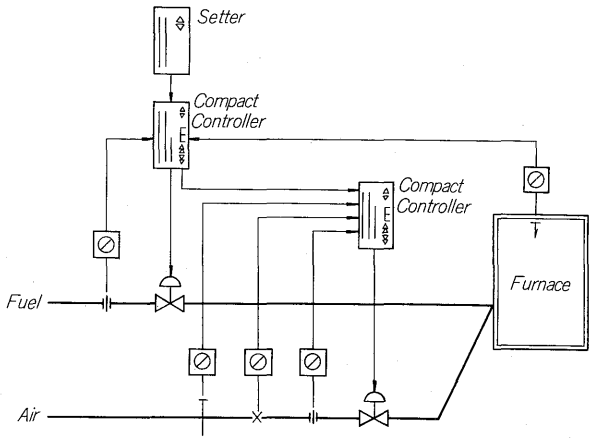
(2) ▯ indicates an indicator.

(3) ▣ indicates setting and manual operation pushbuttons.

Fig. 5 Example of internal connection of Teleperm Compact Controller

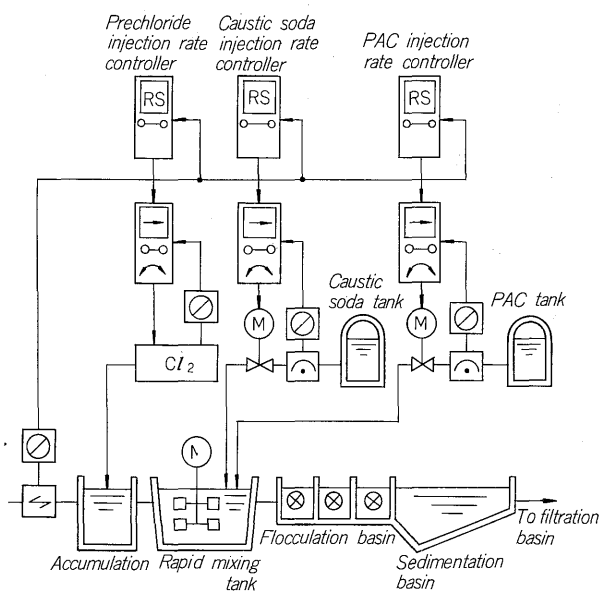


(a) Analog instrumentation system

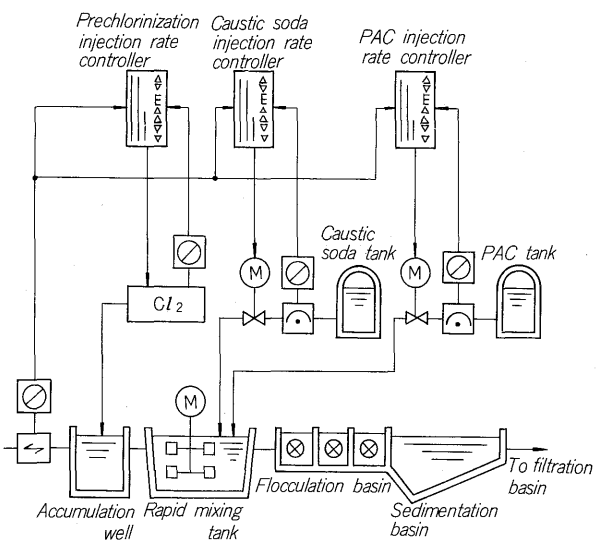


(b) Compact Control instrumentation system

Fig. 6 Application to furnace combustion control

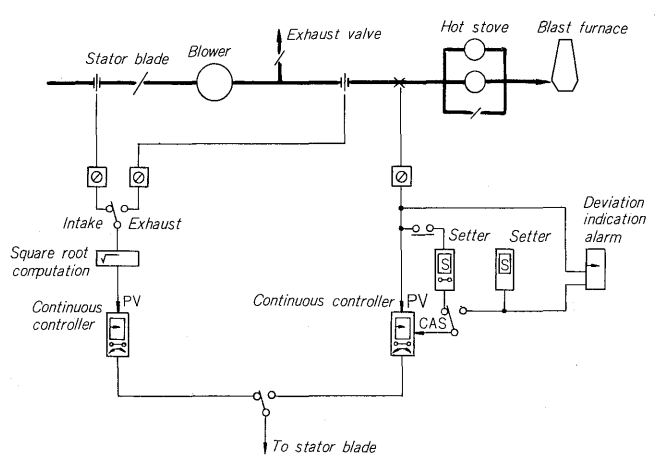


(a) Analog instrumentation system

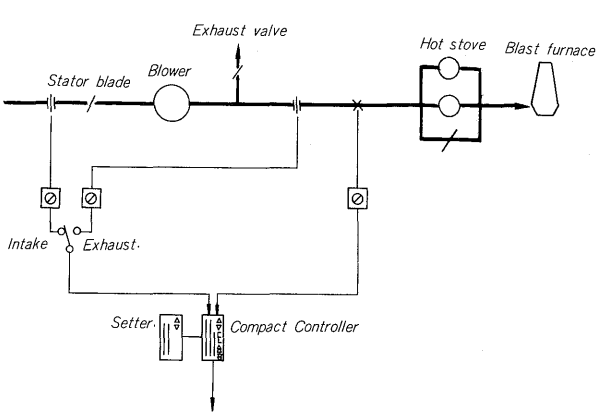


(b) Compact Controller instrumentation system

Fig. 7 Application to control of chemical injection at water processing plant



(a) Analog instrumentation system



(b) Compact Controller instrumentation system

Fig. 8 Application to blower constant flow rate-constant pressure control

or completely replace analog instrumentation systems, or to apply the advantages of digital instrumentation from one loop to systems to improve process control by combining it with existing or new plants.

The previous section described an example of boiler feed water flow rate control. The following describes several applications by comparing them with conventional analog instrumentation.

(1) Furnace combustion control (*Fig. 6*)
(2) Chemical injection control (*Fig. 7*)
(3) Blower constant flow rate-constant pressure control (*Fig. 8*)

The number of instruments used can be reduced substantially from that of the analog system by using the Fuji Teleperm Compact Controller. Moreover, the control functions can be improved and a cost-performance greater than that of analog instrumentation can be realized with digital instrumentation.

VI. CONCLUSION

The new Fuji Teleperm Compact Controller was introduced above. The Fuji Teleperm Compact Controller incorporating solid-state display and other technological advancements and system technological advancements and based on our abundant experience in measurement and control techniques is expected to be applied to a wide range of fields by users.