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INSTRUMENTATION FOR WATER PLANT

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I. PREFACE

Water is indispensable in everyday life for both domestic purposes and industrial purposes. Water works and the problem of sewage disposal become very important in city-planning. This is particularly evident in the rapidly developing towns of Asia.

Our company has provided instrumentation for the large water works in Tokyo, Sendai, Kawasaki, Yokohama etc.,

In scale and character, the instrumentation for Higashi Murayama water plant in Tokyo is a prime example of control by TELEPERM-TELEPNEU system.

This report outlines Fuji's general instrumentation for water works.

II. GENERAL CONSIDERATIONS

In ordinary water works, the objects of the instrumentation may be stated as follows:

(1) Intake (tower)......level, turbidity, opening of gate, temperature.
(2) Raw water channel......level, rate of flow.
(3) Sand basin......level, turbidity, pH, alkalinity, acidity, temperature.
(4) Mixing chamber (and chemical feeders)......level, rate of flow, specific gravity, pH, alkalinity, acidity.
(5) Chemical sediment basin......turbidity, R.P.M., level.
(6) Filter basin (and washing devices) ......level, rate of flow, loss of head.
(7) Wash water pool......level.
(8) Distribution basin......level.
(9) Conduit pipe line......rate of flow, pressure.

By means of physical, chemical and biological treatment, water plants make clean drinking water from under-ground water or surface water (river, lake and dam water). Water works employ various processes and instrumentation conforms with the source of raw water and distribution conditions.

An example of this instrumentation is the device that controls the pressure of the conduit pipe in the simple plant that pumps ground water to the town. Another is the instrumentation for water works that can distribute on a large scale clean water to a big city when the source of raw water is far removed from the pumping station itself.

The latter ordinarily has most of the instrumentation described above; the telemetering device (by which the condition of the intake is observed) and the washing device for rapid filter basin is tele-controlled automatically or manually in central control room.

Fig. 1 or *Fig. 2* shows an example of these. Using mainly graphicmeter, the panel board is comparatively small enough to be watched easily.

Instrumentation for water works characteristically have many gauges for observation.

Control system is specified as controls of wash water device, chemical feeders and filter basin.

The following paragraphs introduce the TELEPERM-TELEPNEU system which may be adapted to these controls.

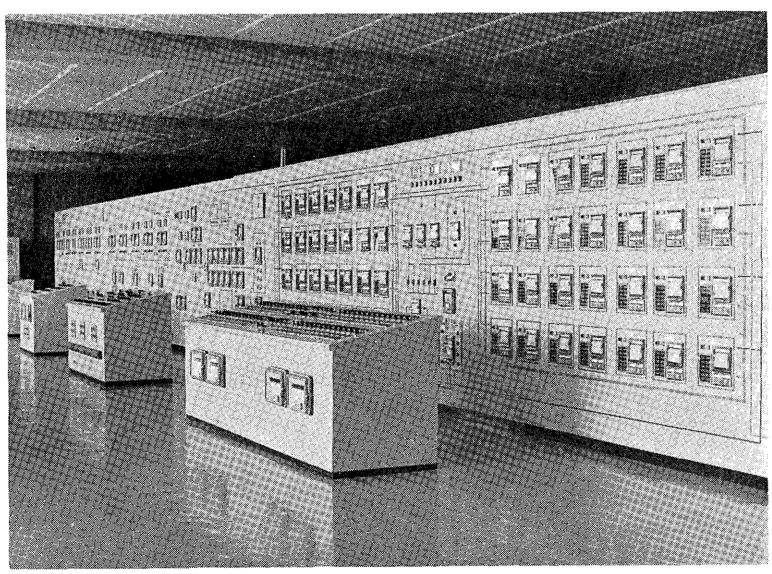


Fig. 1 Control desk board and main graphic panel board in central control room

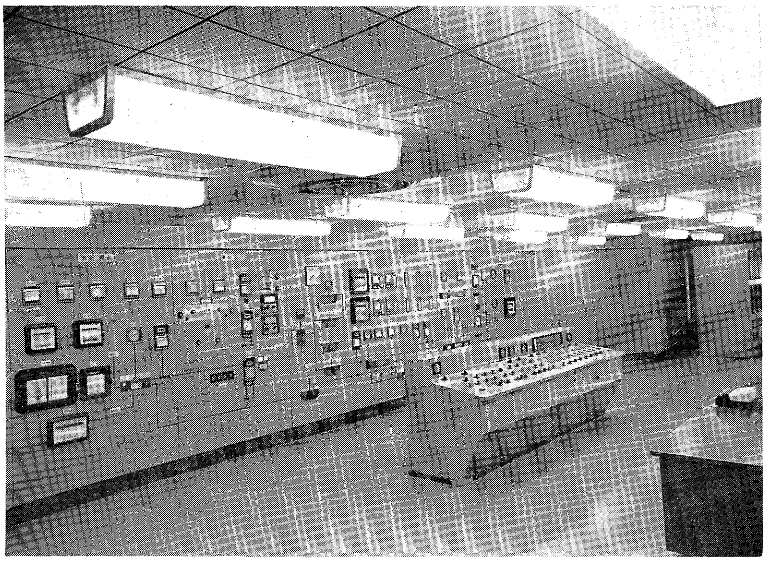


Fig. 2 Control desk board and main graphic panel board in central control room

III. TELEPERM-TELEPNEU SYSTEM FOR WATER PLANT

Feeding alum is efficient for accellerating sedimentation by flocculation ; chlorination is for sterilization.

Feeding quantity is controlled to be directly proportional to the rate of water flow by the TELEPERM controller. TELEPERM or TELEPERM-TELEPNEU controller regulates the rate of flow from filter basin on the setting point determined by the plan of distribution, demand quantity and the quality of the raw water.

1. Control of Chemical Feedings for Sedimentation

Factors in coagulation are turbidity, temperature and pH of raw water, and so on : thus the feeding of chemicals for sedimentation must be determined by the condition of raw water.

The addition of chemicals is sometimes controlled by experiment, using a jar-tester and evaluating its data, but this cascade-control for determining the effect of turbidity temperature and pH of raw water is not adopted for deciding the feeding quantity.

A set of flow meters and gauges for feeding control and measurement of raw water intake consists of venturi tube, differential transmitter (model: MMF), recorder, totalizer, setter, operating device, driver, etc.

The transmitters are a non-mercury type designed to produce 0~50 ma, d-c signal proportional to the flow of raw water or to the flow of chemical.

The controller sends the pulse signal (ON or OFF position of relay) to the motor-valve which regulates the flow of chemical in proportion to the flow of raw water.

2. Control of Chlorine

Chlorine gas is ordinarily used as a sterilizing agent. However, its rate of flow is so small that measuring of it is fairly difficult.

A colorimetric analysis of dissolved chlorine is necessary for maintaining an accurate ratio.

1) Primary addition of chlorine

Chlorine ratio is controlled by the transmitter of the raw water flow.

The resistance proportional to the opening rate of control valve is used as a substitute for the signal of chlorine flow. TELEPERM transmitter (model : MEU-BW) converts the value of resistance to 0~50ma d-c signal.

Controller regulates the chlorine with pre-set ratio on the setter (model : QGW) by driving the motor valve.

2) Secondary addition of chlorine

Primary addition of chlorine is controlled proportional to the flow of the raw water ; secondary addition is controlled proportional to the flow of total filter effluent. Generally there are many filter basins in one water purification system.

The signal from the transmitters measuring the flow from each filter basin are totalized by the TELEPERM transmitter (model ; MEU-10) and become the input of the totalizing recorder and ratio controller.

Except for this, they resemble the primary chlorine control.

3. Controlling The Rate of Flow of Filter Effluent

1) Master control and totalizer

In each filter basin the rate of flow of effluent is individually controlled by pre-set values.

The number of active filter basins changes at times. Demand quantity is variable and has no connection with the number of active filter basins.

Master control-setter (model: QGW) and transmitter (model : MEU-BW) gives the flow control of each filter basin the setting value in consideration of the number of active basins and the setting value of demand quantity on the master controller. This signal is 0~50 ma dc, too. As is stated above, the signal from the transmitter (model MMF) measuring the flow from each filter basin is totalized with the TELEPERM transmitter (model : MEU-10), becoming the input of the totalizing recorder. The output dc of TELEPERM transmitter is useful for delivering and accounting (summing, dividing, and so on).

TELEPERM-TELEPNEU controller (model: QEPR) is useful if the drive is pneumatically operated.

Imputs from the transmitter are d-c 0~50 ma. *Fig. 3* shows the instrumentation diagram picking up only the feeding and filtering control by TELEPERM system.

2) Slow starting

Slow starting is done at the time when basin ter-

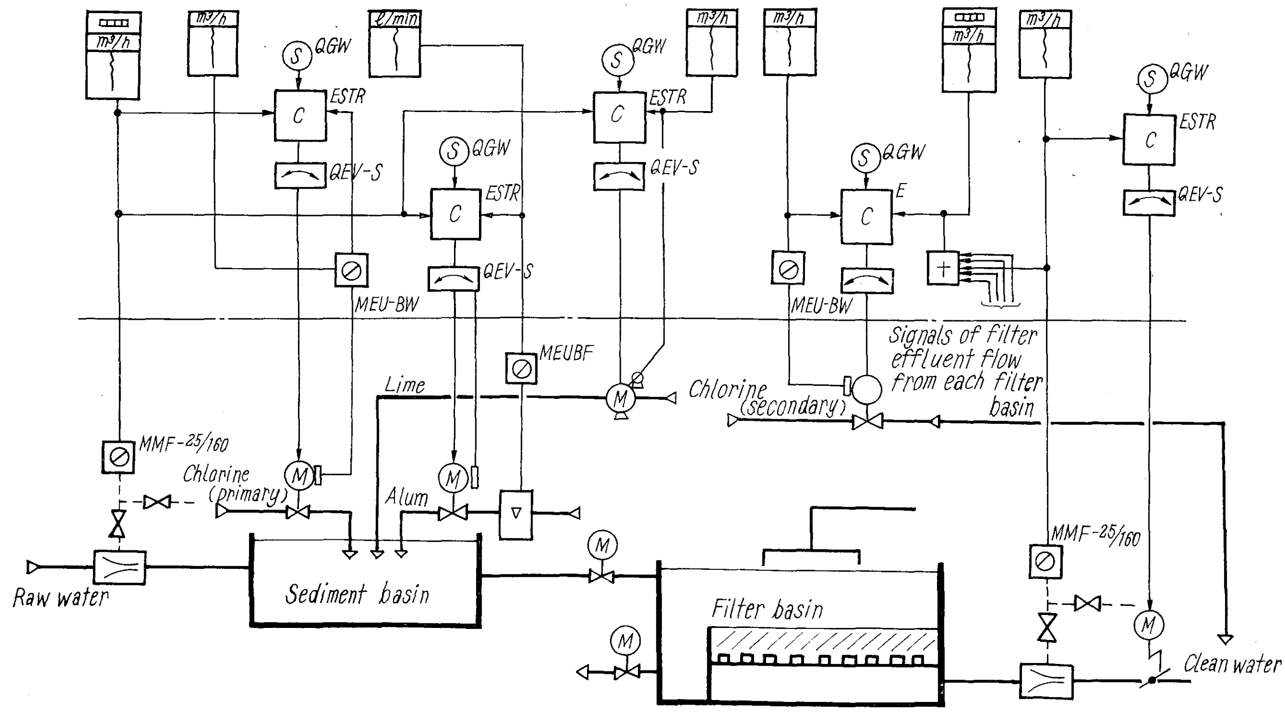


Fig. 3 Instrumentation diagram of chemical feeding and filtering control by TELEPERM system

minates filtering after washing and is important to perform the film of filter.

Timer, pulse-generator and relay is used for electric driver. Timer and time delay device is used for pneumatic driver.

IV. WASHING EQUIPMENT

Washing equipment is a characteristic device in water works with a rapid filter basin.

1. Principal Operating Methods

There are many methods of washing, the principal ones being as follows:

1) Automatic operation

In this method, washing may start when the alarm contactor for high limit of the loss of head is excited, or when the duration of filtering arrives at the limit setting time.

2) Semi-automatic operation

Washing may start when any one filter basin for washing is selected manually. Washing is then carried out automatically.

3) Remote operation from the desk in the central control room

Selection of washing filter basin and operation of the washing equipment may be carried out artificially on the desk in the control room.

4) Remote operation from the desk in the gallery

On the desk in the gallery the operation of washing may be done artificially as above 3).

5) Operation on the spot

Washing may be carried out manually to handle the operating device of valves on the spot.

In many cases automatic operation takes not only one of methods (above 1) or 2)), but a combination of manual methods (above 3), 4), 5)).

2. Washing Process

Fig. 4 shows the stages of washing.

Washing is carried out in the following stages:

1) Providing for wash

The condition on which the filter basin stops to filter will be considered under three headings:

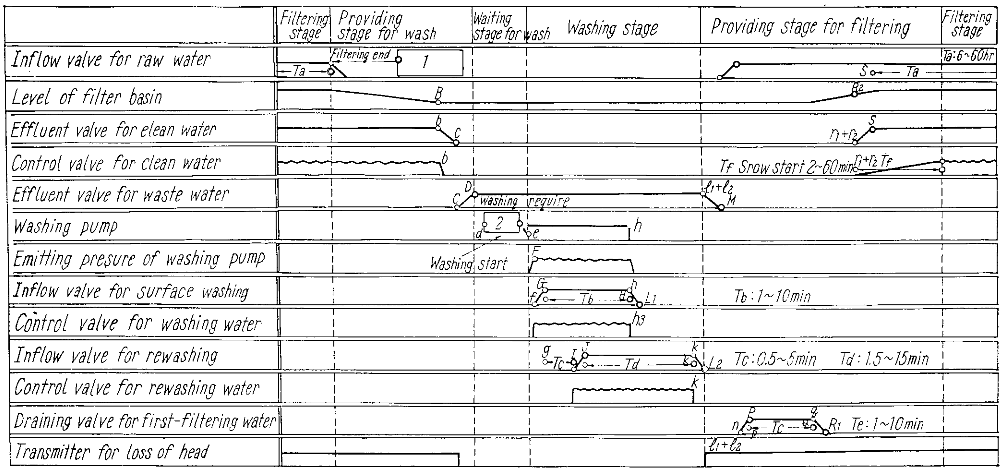
(1) Loss of head for filtering arrives at the upper limit.
(2) The setting time for filtering goes by.
(3) In spite of above conditions any filter basin is selected to be washed.

If any one of above conditions be occupied, the progress, in starting order, are:

(1) The inflow valve of raw water closes and water level drops.
(2) When the setting time goes by or water level arrives at the same time the control of effluent flow is stopped.
(3) By the signal that closes the filter effluent valve the lamp of " filtering " goes out, the effluent valve of waste water starts to open and the devices measuring the loss of head for filtering and water level of filter basin are stopped.
(4) After the effluent valve for waste opens fully, the signal of " washing require " is emitted.

2) Waiting for wash

The filter basin that emitted the signal of " washing require ", in requiring order, is memorized with



1: Time for loss of head (Ta) manual selection circuit 2: Memory circuit

Fig. 4 Washing process of filter-basin

the memory circuit of washing equipment and in the state of " waiting for wash ". That state of one basin stays till the condition of starting to wash is occupied.

The conditions of starting to wash are as follows:

(1) The water level of wash water tank comes above the setting limit.

(2) The water level of waste basin comes below the setting limit.

(3) Other filters remain not to be washed

(4) The basin takes the priority position of waiting to be washed in memory circuit.

3) Washing

When all condition of above (1)~(4) are occupied in one filter basin, that basin is selected for washing and is given the signal of starting to wash the basin by the memory circuit. The progressive action:

(1) The pump for surface-washing starts

(2) When the emitting pressure of the pump arrives at the setting value, the inflow valve of surface-wash water opens and at the same time the control of water flow is started.

(3) When the setting time for back-washing start goes by the inflow valve of back-wash opens and at the same time the control of its flow is started.

(4) When the setting time for surface-wash passes by, the pump for washing is stopped and at the same time the inflow valve of surface- washing closes and the control of water flow is stopped.

(5) When the setting time for back-wash passes by, the inflow valve of back-washing closes and at the same time the control of its flow is stopped and measuring the loss of head starts.

4) Providing for starting to filter

On the condition that both inflow valves of surface wash and back-wash closes at full limit, the signal of washing end is emitted to the selection and memory circuit.

The progressive actions.

(1) At the same time the effluent valve of waste water closes.

(2) When it closes at the full limit the inflow valve of raw water starts to open.

(3) When the inflow valve of raw water opens at the full limit the effluent valve for draining starts to open.

(4) When the setting time for discharge goes by the effluent valve for draining closes.

(5) When the effluent valve for draining closes at full limit and the water level of the filter basin arrives at the higher setting limit, the effluent valve of clean water starts to open. At the same time slow starting of control valve on the filter effluent carries on.

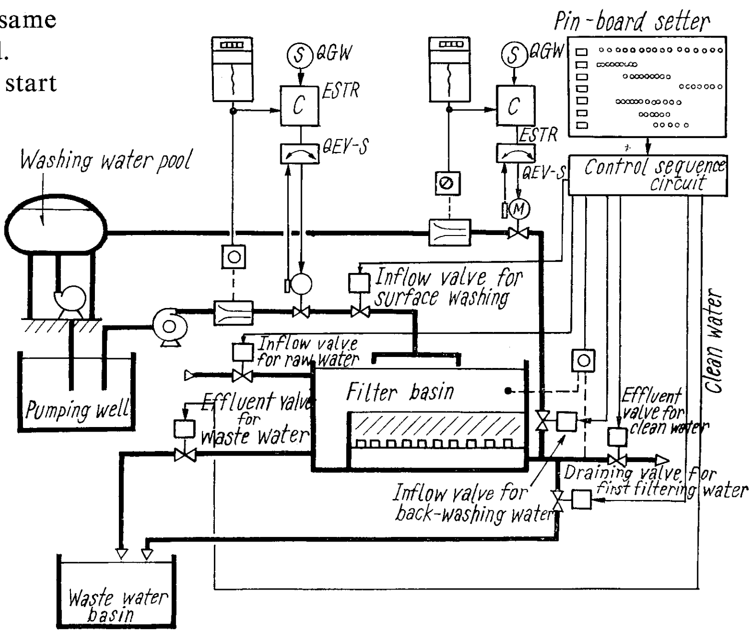


Fig. 5 Instrumentation diagram of washing control at filter-basin

(6) When the setting time for slow starting goes by the filter basin returns completely to the state of filtering.

Fig. 5 shows the instrumentation diagram of washing control at filter basin.

3. Indication of Sequences and Pin-board Setter for Automatic Washing.

In the water work which has many filter basins it is important to know not only " which basin comes at which state " but " which stage does washing arrive at. "

Fuji's original pin-board setter for automatic washing sets up the acting time of valves and pump and indicates intuitively their time and order, expressing plainly the transition of washing stages with lamps.

In manual operation, too, the pin board setter is used to shift on the same process with voluntary speed by push button operating.

Fig. 6 shows the pin-board setter

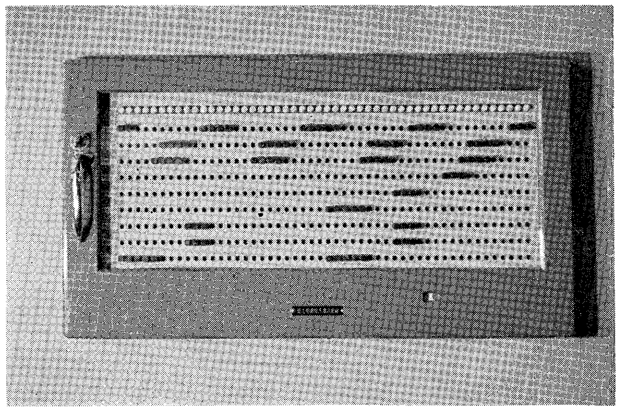
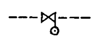
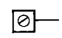
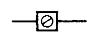


Fig. 6 Pin-board setter

Table 1 **Assortment of symbols**

Division	Name	Model	Symbol
Transmitting and Transducing Unit	Venturi		
	Stop-valve	SV–40	
	Drain vessels	VDV–40	
	TELEPERM flow transmitter	MMF	
	TELEPERM transducer	MEU	
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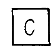
Receiving Unit	Q Series moving coil type recorder	QDS	
	Q Series flow integrator	QDZ	
Controlling and Positioning Unit	Q Series TELEPERM setter	QGW	
	TELEPERM controller	ESTR	
	Q Series TELEPERM manual selector	QEV–S	
Actuating Unit	Damper driver	EKA	
	Motor valve		

V. CONCLUSION

As described above, the instrumentation for water works is used mainly today for observation and partially for ratio and quantitative control.

We shall be able to use Data-logger for on-line control of water works if the industrial analyzer meters and flow gauges measure with higher fidelity.

In the not-too-distant future TELEPELM-TELEPNEU systems will become particulary useful in applications of data-logger and digital control requiring easy methods for delivery of signal.