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TELEPERM SYSTEM S-SERIES INSTRUMENTS

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I. INTRODUCTION

Remarkable technical progress has been noted in the process instrumentation field. Various systems and principles are being applied, improvements in performance are constantly being made, and newer and more convenient instruments are making their appearance daily. As evidence of their excellence and high performance standards, the use of FUJI ELECTRIC's instrumentation appliances is becoming wide-spread. Combining long experience and technical innovations in the study of the existing instrumentation system, FUJI ELECTRIC has produced an entirely new and unique system and series of instrumentation equipment. It is anticipated that this will result in materially broadening the present scope of instrumentation application. The following is a general outline of the New TELEPERM System S-Series.

II. PURPOSE

SIEMENS & HALSKE CO., with which FUJI ELECTRIC engages in technical research, announced the completion of the TELEPERM- TELEPNEU System in 1957. This made possible both a fully electric and a pneumatic system, as well as combinations of the two. This was an extremely feasible instrumentation system, particularly when installed with unified equipment. At that time, the TELEPERM System of this type of instrumentation used electronic appliances. As the first in its field, this was considered the most advanced. FUJI ELECTRIC completed the production of the entire system in 1959, and in the same year it was exhibited at the Measuring Instrument Show. Since that time, as one of the major products of FUJI ELECTRIC, the system has been used extensively in many fields and excellent results obtained.

The system was originally developed with the theory that the best kind of instrumentation is one which is technically and economically superior, and which permits the selection of numerous combinations, varying in complexity, of electrical and pneumatic instruments. The advantage of the system is its versatility and adaptability, whether used in large, medium, or small industry.

The 1962 publication "Instrumentation by the TELEPERM - TELEPNEU System—Special Issue" mentioned the highly satisfactory results in the process instrumentation field. During the following two years, the system showed further commendable results. During the five years since its inauguration, many modifications and improvements have been made. The completion of the New TELEPERM · S-SERIES has been the result of study and research relative to the following factors:

(1) Improvements and developments as a natural consequence of long usage experience.
(2) Customer suggestions and new requirements.
(3) Utilization of new materials and parts as developed and made available.
(4) Introduction of design and manufacturing techniques, along with other methods.

The features of the present TELEPERM - TELEPNEU System may be summarized in four general categories:

1) Unified signal system

Common usage of controller and other various receiving instruments can be made with a unified transmitting signal (including dc, pneumatic pressure). This is advantageous, not only from the standpoint of manufacture, but also from that of operational maintenance and handling. A minimum of spare parts is required, and the unified signal facilitates the processing of a complicated control circuit.

2) Compensating system

A compensating system is always used in the transmitter of either force, motion balance, or electronic amplifier system. This is to protect the instruments from power, air pressure, temperature, line resistance, and other external variations.

3) Unit system

Component parts are unified for building block structures, and the units can be placed one atop the other to constitute instruments with different functions. Equipment components are also unified, and they are arranged relative to independent functions of indicating, recording, controlling, setting, and manual operating respective-

ly. These may also be assembled one atop the other for complete instrumentation.

4) Combination system

For ease in combining systems, and with regard for the external appearance of the arrangement, all panel mounted instruments and manual control equipment are of standard size, and electro-pneumatic combination may be made.

The above fundamental features of the TELEPERM-TELEPNEU System, incorporated at the time of its initial development, are still important factors and as such influenced the development of the New TELEPERM · S-SERIES. Reliability, accuracy, easy handling, and economy were all considered, relative to the four fundamentals discussed in the foregoing ; all studies and research were predicated upon these factors, and an industrial instrument has been produced which most fully meets those requirements to date.

III. FEATURES OF NEW TELEPERM SYSTEM S-SERIES INSTRUMENTS

TELEPERM is defined as the dc current transmission of the TELEPERM-TELEPNEU system. In addition to adopting an entirely new system, the New TELEPERM System incorporates numerous improvements besides the former system. The former Q-SERIES of panel mounted instruments, of standardized external dimensions, has been replaced by the new S-SERIES of new standardized dimensions.

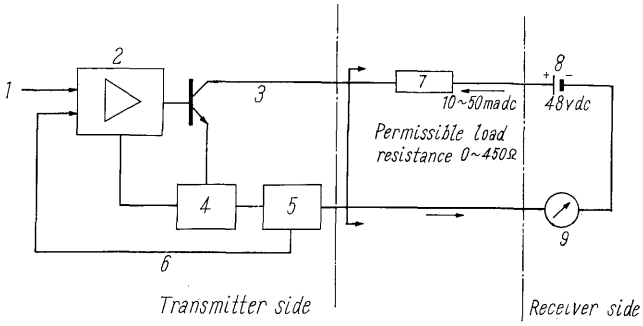
1. Features of New TELEPERM System

Although the New TELEPERM System uses the same high-level dc current transmission system as that of the present TELEPERM, there are large changes as shown in the following features :

1) Use of a full dc two-wire system include EMF transmitter (for temperature)

Formerly, the transmitter required four wires ; two ac for power supply, and two dc for signal output. The dc two-wire system uses the two dc wires for both power and signal, and is used to great advantage. This system has been found to be most practical for industrial instrument signal transmission. The dc two-wire system has been adopted for use as the transmitter for temperature, pressure, flow, and level measurements.

Fig. 1. illustrates the principle of the dc two-wire system. Current is supplied from a common dc supply in the receiving side, passes through a regulated voltage supply built in the transmitter and is used for amplifier power. The amplifier allows the output (signal current) to pass to the receiving instrument, depending on the detected input. The amplifier output is fed back to the amplifier input side by the feedback circuit, and is unaffected by line resistance variation. Amplifier voltage is kept constant by the voltage regulator. Only



① Input
② Amplifier
③ Power transistor
④ Voltage stabilizer
⑤ Feedback element
⑥ Feedback
⑦ Line resistance
⑧ Common power supply
⑨ Receiving instrument

Fig. 1 Principle of " dc two-wire system "

two wires connect the transmitter and the receiver sides. The advantages are as follows :

(1) Construction simplicity and economy

Two wires are adequate for each combination of transmitter and receiver connection, and if the transmitters of more than one unit are tied together, one of the two wires may be used in common for one side.

(2) 100 v ac power is not necessary at site. This permits easy handling, and is more advantageous in explosion-proof construction.

(3) Common use of dc power supply improves the reliability and facilitates suppression of power supply variation, keeping it to a minimum.

(4) Independent standby power, for instrument use, is easily connected

Instruments often must be connected to a separate power supply. When a 48 v dc battery is used, the power supply is easily obtained, especially during power failure.

(5) Handling ease

Handling is easier because ac power is unnecessary. The wiring is simplified and maintenance is no problem.

(6) Less power consumption and lower transmitter temperature rise

The amplifier consumes less power and it requires no built-in power supply ; this results in minimum temperature rise.

2) Use of 10～50 ma dc as unified signal current

When selecting the signal current, various checks must be made. These checks include the type and value of the signal, and the existence of a base. However, the advantages of dc are well known. : it is easily handled and the affect of induction interference is almost negligible.

The larger the current, the more advantages accrue :

(1) Resistance to induction interference.

(2) Rigid and accurate force balance mechanism can be obtained.

(3) Use of moving coil type recorder is possible.

For the above reasons, the TELEPERM System has long used 50 ma and the New TELEPERM also uses 50 ma dc. The only exception is that the former signal system, without base when the signal current is 0 ma at 0 input, has been replaced by a signal system with base current of 10 ma under the same conditions.

The most important factor of the electrical system is its computability. Realizing that a signal system without base, with 0 start point, is advantageous in making use of that factor, the former TELEPERM System has used unified 0～50 ma signal current. The New TELEPERM System uses 10 ma base current for the following reasons:

(1) Base is necessary with a dc two-wire system. A constant power value must be supplied to the transmitter when its input is zero.

(2) Computability, which is thought to be of advantage when without base, is sacrificed. However, this handicap is negligible due to the technical and economical advances which have been made in the progress of the base processing circuit.

(3) In view of the fact that it is preferable to set the base current to $\frac{1}{5}$ of the maximum usually taken for electrical and pneumatic signals, 10 ma has been chosen.

The system with base also reveals further advantages:

(1) Easy discrimination can be made between measured value 0 and current 0, i.e., transmission line and power supply failure.

(2) Complete and accurate closing of the control valve is possible.

2. Features of S-SERIES

The front external dimension of the former Q-series was 144 mm. The new S-SERIES is 160 mm, slightly larger. Controller, recorder, indicators, setter, and manual selector are all mounted on the panel and control desk. Their standard size is 160 mm in width. There are three standard heights of 160 mm, 120 mm, and 80 mm. All units are removable from the front for ease in handling maintenance. There are two standard depths, for convenience in wiring.

3. Features Common to All Instruments

As mentioned previously, these products are the result of long experience and advanced techniques. It is intended that their performance be high, and that operation and handling will be more convenient than heretofore. Some of their more outstanding features are as follows:

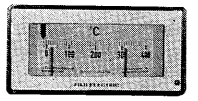
1) Improved performance

(1) More accurate

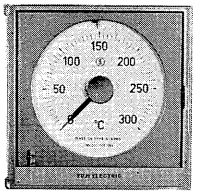
(2) Expanded measuring range

(3) Entire electrical circuit is solid state, increasing the operational life and reliability.

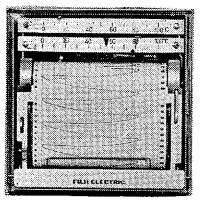
2) Functional improvements



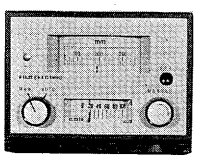
(a) Moving coil type indicator with alarm contact, Model S-EIM 2/HL (160×80mm)



(b) Self-balancing type indicator, Model S-EIWS (160×160 mm)



(c) Self-balancing type recorder, Model S-ERS (160×160 mm)



(d) TELEPERM controller, Model S-ECC (160×120 mm)

Fig. 2 Dimensions of S-SERIES instruments

(1) Various types of indicating controllers, divided type controller, setter (manual or motor drive), and manual selector, designed in sufficient number to match panel and desk control systems.

(2) Various types of integrators for current input, resistance input, and pulse input usage.

(3) In addition to the connection with the unified signal current, the thermocouple, resistance bulb, and ring-tube transmitter connections be can made directly to the controller, without using an EMF transmitter.

(4) The process measurement value can be read directly by the self-contained deviation indicator of the controller.

(5) For both the EMF transmitter and the computing elements, a sufficient number of input units are available.

(6) An adequate number of recorder range units are available.

(7) An adequate number of computing elements for the various types of computations.

(8) There are also alarm contacts, setting and transmitting resistance as accessories for the receiving instruments.

3) Easier handling, inspection, and maintenance.

(1) All transmitters are small and light for easy handling.

(2) Pipe and wall mounting for simple installation.

(3) Additional check terminals for easy inspection. 0 point and span check can be easily made.

(4) Adjustment of circuit resistance unnecessary because of 0 to 450 ohm transmitter

permissible load resistance.

(5) Common usage and uniformity of parts given primary consideration; plug-in or screw mounting used whenever possible to facilitate installation or removal.

(6) Receiving instruments may be pulled out to permit easy handling of various parts.

IV. COMPONENT UNITS OF NEW TELEPERM SYSTEM S-SERIES INSTRUMENT

1. General Outline

There are three different types of transmitters, each of which differs in principle. The first type is for electrically detectable values such as temperature and pH, etc., and is a transmitter based on electronic amplifier conversion system. The second is the force balance conversion system and is used for low pressure, differential pressure, flow, and level. The third is based on the ABGRIFF (angular deflection transmitter) conversion system, the transmitter being constructed with angular deflection-to-current converter element for pressure, differential pressure, flow, and level. These transmitters and the receiving instrument group, including the controller, are connected by only two wires. Transmitter power for amplification is supplied from the common power supply, and the signal current proportional to the detected value passes through the receiving instrument simultaneously. A number of instruments of standard dimensions, and with independent functions, are used in the instrument group, taking full advantage of the combination system.

The feedback compensated on-off controller and the continous system controller are available and are the same as those formerly in use, except that they are now panel mounted for convenience in drawing out from the front.

The S controller (intermittent), drives the electric motor drive actuator, and the C controller (continuous) drives either the pneumatic or hydraulic system element by means of the electro-pneumatic or electro-hydraulic converter.

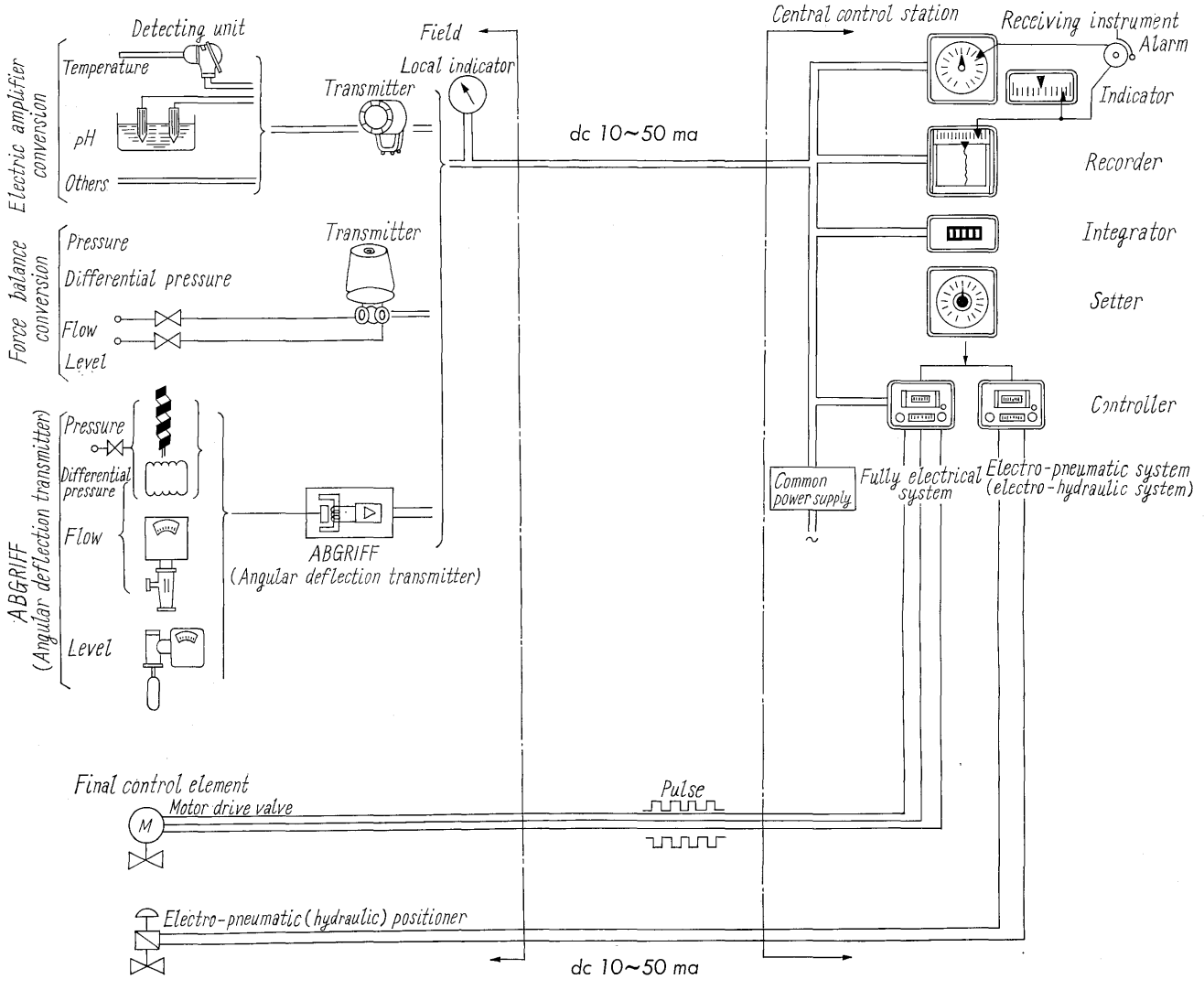


Fig. 3 New TELEPERM System S-SERIES instruments

2. Transmitters

All three types of transmitters are of the conpensating type to enhance their accuracy and stabilize the converter output. Various improvements have been made for ease in installation, adjustment, and maintenance. The following standardized specifications apply to all three :

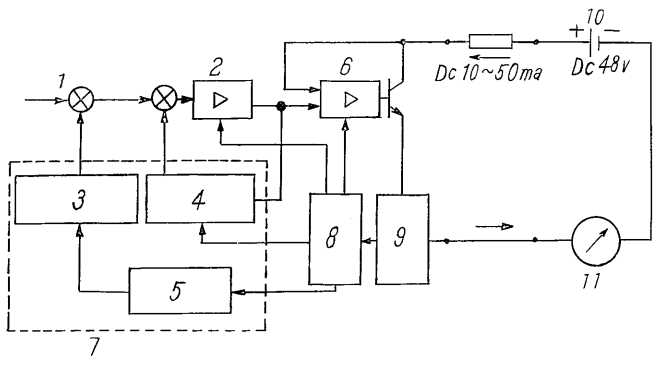
Accuracy : ±0.5%
Permissible load resistance :
0 to 450 ohms
Protection : All-weather type
Ambient temperature : −10 to 60°C
Ambient humidity : 0 to 90% RH

Explanation of each type follows :

1) Electronic amplifier transmitter

Transmission is made for temperature (thermocouple and resistance bulb), gas analysis (heat conductivity type and infra-red type), and pH.

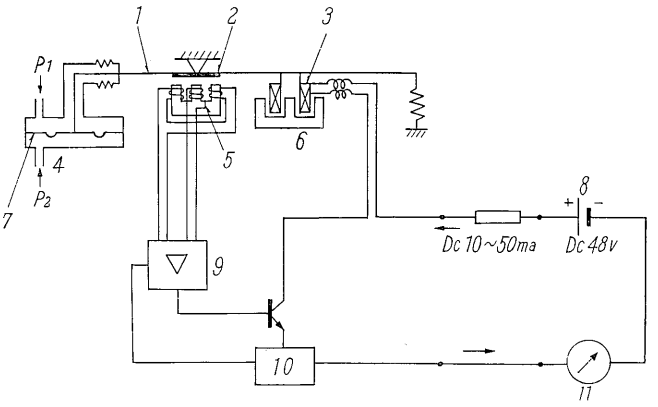
The input stage of the electronic amplifier type transmitter uses a magnetic amplifier, and the subsequent stage uses the transistor amplifier. Neither use mechanical chopper nor vaccum tubes. Solid state construction provides long operational life. (Refer to *Fig. 4.*) Deviation between the feedback and input voltage, caused by the output current, enters the magnetic amplifier coil and is amplified. The magnetic amplified output is amplified by the transistor amplifier and drives the final stage output transistor. The output current generates the feedback voltage through the resistance of the feedback unit, and becomes balanced with the input voltage. When non-linearity is applied to the feedback unit, the non-linearity of the thermocouple and resistance bulb is compensated so that a linear relationship may be established between the measuring temperature and the output current.



① Input
② Pre-amplifier
③ Reference junction compensation, fails-safe and suppression
④ Feedback unit equipped with linearizer
⑤ Reference voltage power supply
⑥ Isolation amplifier
⑦ Input unit
⑧ High frequency oscillator
⑨ Regulated voltage supply
⑩ Common power supply
⑪ Receiving instrument

Fig. 4 Principle of electronic amplifier system

Fig. 5 TELEPERM EMF transmitter (electronic amplifier)



① Balance beam
② Moving iron
③ Plunger coil
④ Pressure chamber
⑤ Pick-up coil
⑥ Permanent magnet
⑦ Diaphram
⑧ Common power supply
⑨ Transistor amplifier
⑩ Voltage regulator
⑪ Receiving instrument

Fig. 6 Principle of force balance system

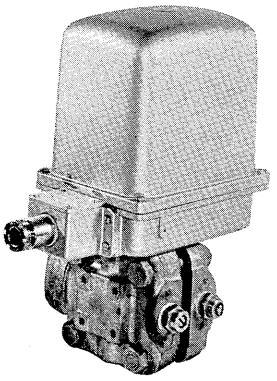
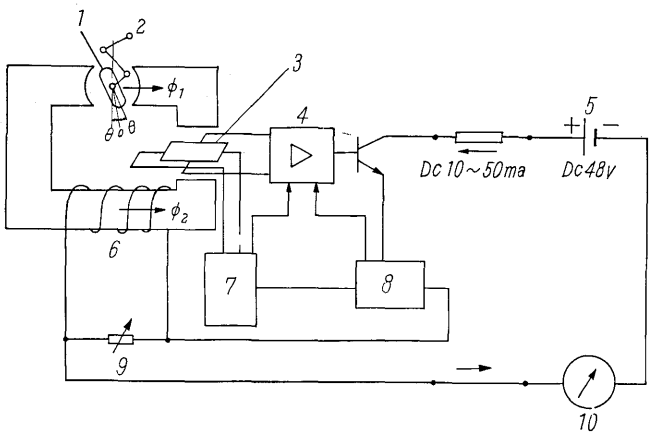


Fig. 7 TELEPERM differential pressure transmitter

2) Force balance transmitter

The low pressure transmitter, differential pressure, flow, and level transmitter (flange type) are among those belonging to this type of transmitter. All of these use a diaphragm to balance the applied force and the transmitting current force, in order to obtain a signal current proportional to the detecting value. *Fig. 6.* illustrates an example of a differential pressure transmitter.

When the measuring differential pressure (P_1–P_2) actuates the diaphragm of the pressure chamber, the motion is conveyed to the balance beam, deviating the movable iron piece. This movement becomes the input of the transistor amplifier as output variation of the differential winding pick-up coil, and the output current is changed. Feedback force, propor-



① Permanent magnet
② Input rotating shaft
③ Hall generator
④ Transistor amplifier
⑤ Common power supply
⑥ Feedback winding
⑦ High-frequency oscillator
⑧ Voltage regulator
⑨ Range adjuster
⑩ Receiving instrument

Fig. 8 Principle of ABGRIFF system

tionate to the output current, is generated between the plunger coil and the permanent magnet.

When this force, and the force to the diaphragm by the measuring differential pressure are balanced,

Table 1 **TELEPERM Transmitters**

System	Article	Model	Application
Electronic Amplifier System	TELEPERM EMF transmitter	E-ETI	Temperature, gas analysis, pH, resistance
	TELEPERM Electro-magnetic flow transmitter	E-FTEM	Flow
Force Balance System	TELEPERM low pressure transmitter	E-PTD	Low pressure
	TELEPERM differential pressure transmitter	E-DTD	Differential pressure
	TELEPERM flow transmitter	MMF II	Flow
	TELEPERM level trantmitter (flange type)	E-LTD	Level
ABGRIFF System	TELEPERM pressure transmitter	E-PTH (B,V)	High, middle, and absolute pressures
	TELEPERM differential pressure transmitter (twin bellows type)	E-DTB	Differential pressure
	TELEPERM area flow meter	E-FTT	Flow
	TELEPERM flow transmitter (weir type)	E-FTW	Flow
	TELEPERM level transmitter (displacement type)	F-LTF	Level
	TELEPERM level transmitter (float type)	E-LTR	Level
	TELEPERM tank level transmitter	E-HTR	Level

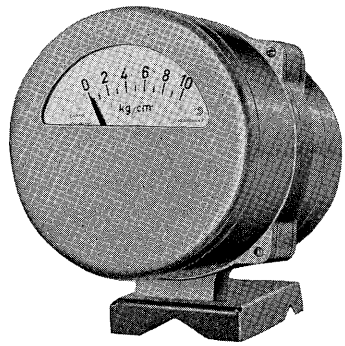


Fig. 9 TELEPERM pressure transmitter (ABGRIFF system)

the current running through the plunger coil (transmitter output current), becomes proportional in value to the measuring differential pressure.

3) ABGRIFF (angular deflection transmitter)

This is an element which converts an angular deflection into current. Referring to *Fig. 8.*, the angular deflection of 0 to 22.5°(θ), of the permanent magnet, is converted into 10 to 50 ma dc. A quantity to be extracted angular deflection can always be measured when this combination is made with the rotating permanent magnet. For example, if a pressure is detected by the Bourdon tube, the movement of the tube is conveyed as angular deflection.

The angular deflection of the permanent magnet causes magnetic flux ϕ_1 which is proportional to this angle. The Hall generator picks up the flux in the magnetic circuit, amplifying and rectifying the output current to pass through the feedback winding and produce compensating flux. The amplified output current continues to vary until magnetic flux ϕ_1 and ϕ_2 are balanced, so that the output current is always proportional in value to the angular deflection or process value. The TELEPERM ABGRIFF is self-contained in bellows-type or Bourdon tube pressure gauge, twin bellows-type differential pressure transmitter, area flow meter transmitter, weir-type flow transmitter, displacement type level transmitter, float type level transmittter, and tank level transmitter, and is usually provided with pointer for local indication.

3. Receiving Instrument and Controller

1) Receiving instrument

All receiving instruments are panel mounted. Their dimensions are based on that of 160 mm, and they are square or rectangular.

Various types of instruments are available, similar to those used in the former system. The indicators are of two different tyeps, that of electronic self-balancing and of moving coil. There are also two types of recorders, also electronic self-balancing and moving coil types. All are of the square 160 mm size, except that of the moving coil type indicator which is 80 × 160 mm rectangular. There are two types of integrators, continuous which uses either unified current or resistance variation as input, and pulse integrator which uses pulses as input. Both

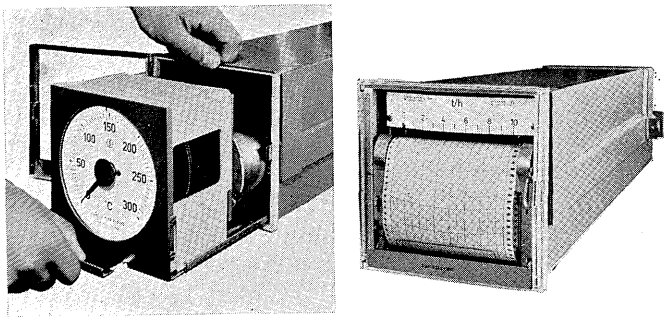


Fig. 10 S-SERIES self-balancing indicator and recorder

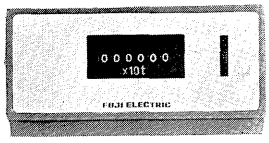


Fig. 11 S-SERIES pulse integrator

are 80 × 160 mm rectangular. If required, the receiving instruments may be drawn-out from the front for maintenance. There are also additional devices available, such as alarms, etc.

***Table 2* S-SERIES Instruments**

System	Article	Model	Dimensions (cm) (width × height)
Indicator	S-SERIES moving coil type indicator	S-EIM	16×8
	S-SERIES cross coil type indicator	S-EIXM	16×8
	S-SERIES self-balancing indicator	S-EIWS	16×16
Recorder	S-SERIES moving coil type recorder	S-ERM	16×16
	S-SERIES self-balancing recorder	S-ERS	16×16
Integrator	S-SERIES continuous integrator	S-ESM	16×8
	S-SERIES pulse integrator	S-ESP	16×8
Controller	S-SERIES TELEPERM S-controller	S-ECS	16×12
	S-SERIES TELEPERM C-controller	S-ECC	16×12
	S-SERIES TELEPERM setter (manual)	S-ESTH	16×16
	S-SERIES TELEPERM setter (motor drive)	S-ESTM	16×16
	S-SERIES TELEPERM manual selector (for S controller)	S-EHS	16×5
	S-SERIES TELEPERM manual selector (for C controller)	S-EHC	16×5
	S-SERIES TELEPERM sub-panel (for S controller)	S-EHSTS	16×12
	S-SERIES TELEPERM sub-panel (for C controller)	S-EHSTC	16×12

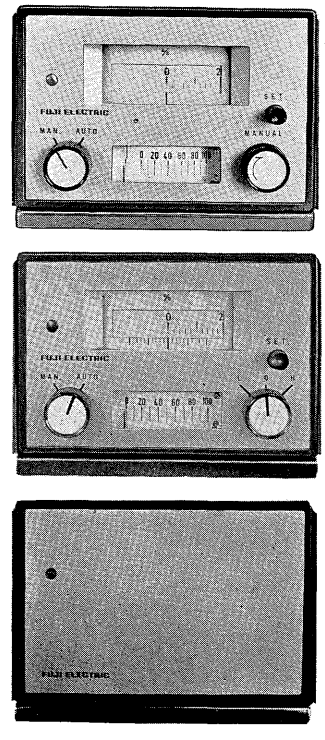
2) Controller

Model S-ECS, with pulse output as mentioned and similar to that of the former system, and model S-ECC with a continuous output of 10 to 50 ma, are available for the main unit of the process control of the new system. The former ESTR and EKR type controllers have been panel or rack mounted, and new types use drawable front panel mounting. The dimensions of both types are 120 × 160 mm, of the same external appearance. The pulse output of the model S-ECS controller acts upon the motor drive final control element, has unique control characteristics, and has been used extensively in various fields. It is anticipated that future use will become more widespread, as a fully electrical instrumentation system, in view of the advantages engendered by electrical motor operation, motor drive desired value setting, and pulse control.

Model S-ECC controller with a 10 to 50 ma continuous output, is connected to either final pneumatic or hydraulic control element after conversion from electro-to-pneumatic or electro-to-hydraulic, and is adaptable to either general or particularly quick respone process.

Fig. 12. shows the standard type controller with set point indicator, deviation indicator, auto-manual selector switch. manual regulator, and output indicator (the valve position indicator for model S-ECS). The deviation indicator, as is, indicates measurement values. This is sufficient to function as an indicating controller.

In addition to the standard type controllers described above, a divided type is manufactured. This



(a) C-controller (standard type)

(b) S-controller (standard type)

(c) S-controller (divided type)

Fig. 12 TELEPERM C- and S-controller

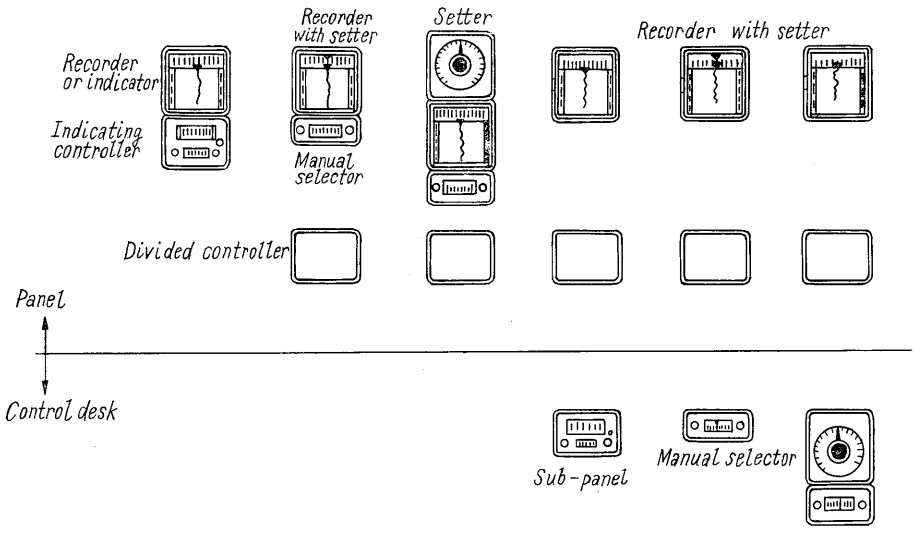


Fig. 13 Examples of S-SERIES instrument combinations

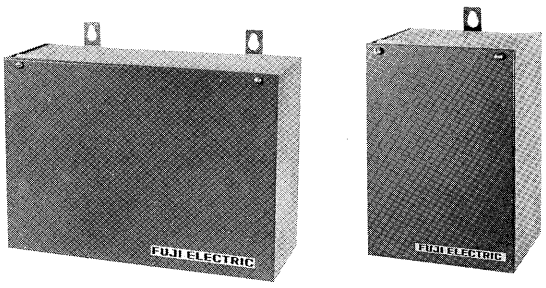


Fig. 14 TELEPERM computing elements

type is a controller without setter and manual selector, and is strictly a controlling unit. Independent manual selector and sub-panel (with setter) are available, for types S-ECS and S-ECC. This permits flexible combination and arrangement of receiving instruments, controllers, and manual selectors on the instrument panel and control desk, and full advantage is taken of the existing combination system features. Some standard combinations and arrangements are shown in *Fig. 13.*

3) Computing elements and others

An adequate number of various type operational amplifiers are available for different amplification and other types of operation, solving many complicated, process instrumentation problems. There are also electro-to-pneumatic positioners, pneumatic type final operation elements, and electric motor drive actuators available.

V. CONCLUSION

The above new products may be used as the nucleus and central equipment around which future instrumentation projects are designed. This paper has covered only the general highlights of the entire New TELEPERM System S-SERIES. There are many other important features which should be mentioned relative to the individual units. Those features as well as other highly relevant points, will be discussed in future editions of the FUJI ELECTRIC REVIEW.

Table 3 **TEREPERM Computing Elements**

Article	Model	Application
TELEPERM EMF converter	E-ETI-P	Temperature, gas analysis, and pH
TELEPERM operational amplifier	E-EOA-( )	Voltage, current, resistance, and input
TELEPERM limiter	E-EOA-KL (AL)	Upper or lower limit of output
TELEPERM square root extraction	E-IOR	Mainly for flow
TELEPERM adding amplifier	E-IOA-( )	Addition and substruction of up to 4 inputs
TELEPERM selective operational amplifier	E-IOA-( )	Selecting the maximum or minimum of 2 inputs
TELEPERM function generator	E-IOA-( )	Preparation of operational characteristics
TELEPERM multiplying amplifier	E-IOM-( )	Multiplication, division, and square root extraction of up to 3 inputs
TELEPERM flow compensator	E-IOM-( )	Flow pressure and temperature compensation
TELEPERM NOT operational amplifier	E-IOI-N	10~50 ma→50~10 ma
TELEPERM repeater	E-IOI-R	For load increase