

NEW **TELEPNEU** SYSTEM **S-SERIES** INSTRUMENTS

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I. INTRODUCTION

New TELEPERM System S-SERIES Instruments were introduced in the Fuji Electric Review (Vol. 11, No. 3, 1965). In this article, new TELEPNEU System S-SERIES Instruments are outlined. These instruments have been developed from the earlier TELEPNEU system.

II. PURPOSE

The TELEPNEU system is closely related to the TELEPERM system developed as a TELEPERM-TELEPNEU system by Siemens & Halske A.G. in 1957. This company engages in technical research with Fuji Electric. In 1959, Fuji Electric started to produce these instruments in Japan. As seen from practical results, this has been a successful venture over a wide range of fields.

Generally, electric and pneumatic systems have been developed as separate systems. However, this system includes both electric and pneumatic systems or electropneumatic systems, and combination of the two exhibits numerous, superb features. For this reason, the system is called TELEPERM-TELEPNEU. This is a highly logical system and has proven features.

The electric system has improved features from the viewpoint of remote transmission capability, calculating feasibility, and possibility of combination with electronic computers. The TELEPERM system has these application advantages in all processes. The pneumatic system is explosion-proof and resistant to corrosion. Construction assures ease of handling and understanding of the system. Thus, the system is playing a large role in processes, especially those of the chemical industry.

The Fuji TELEPNEU System is well known for its exclusive and superb features. The objective in developing new TELEPERM System S-SERIES Instruments was described in the Fuji Electric Review (Vol. 11, No. 3). For the new TELEPNEU System S-SERIES Instruments being introduced in this article, the purpose is the same as before. Completion has been the result of study and research relative to the

following items:

- (1) Improvements and developments as a natural consequence of long 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.

Fundamental features of the TELEPERM-TELEPNEU system are the same as those applied since the present system was developed. These features are listed and are applicable to the new TELEPNEU System S-SERIES.

- (1) Unified signal system
- (2) Compensating system
- (3) Unit system
- (4) Combination system

With these items as a basis, the system was designed to increase accuracy, reliability, and ease of handling, and to reduce costs.

III. OUTSTANDING FEATURES

The TELEPNEU System is defined as a pneumatic signal transmission system in the Fuji TELEPERM-TELEPNEU System. With entirely new ideas adopted, the new TELEPNEU System incorporates numerous improvements. The existing panel mounted instruments have been replaced with a new line of S-series instruments primarily designed with standardized external dimensions of 160 mm, as with the new TELEPERM System.

1. Features of New TELEPNEU System

The transmitter consists of two systems, force balance and TELEPNEU ABGRIFF. These are standardized as the new TELEPERM System. Units and components are also standardized. The new controller has numerous improvements and an entirely new system as compared with the earlier 4-bellows balance system. This results in higher performance and greater ease of handling. A new controller for the electropneumatic system has been introduced, and this is suitable for temperature control, making the TELEPNEU System complete. This line is known as

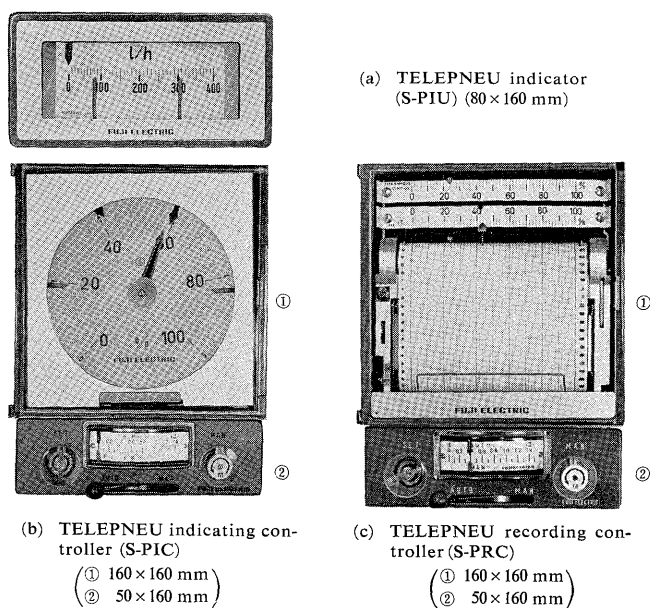


Fig. 1 Dimensions of S-SERIES instruments

IPSOPNEU controllers. Various computers such as those for square root extracting, adding and subtracting, and ratio are included in TELEPNEU System.

1) TELEPNEU Transmitter

Various transmitters for pressure, differential pressure, flow, level, and other objectives are equipped under two conversion systems, force balance and ABGRIFF. Components are interchangeable with those in the TELEPERM System, and have the following features:

- (1) Small and light. Simple mounting and handling.
- (2) Easy span and zero adjustments.
- (3) Wall-mounting or pipe-mounting.
- "Air set" and pressure gauge included.
- (4) TELEPNEU ABGRIFF system transmitter provided with pointer for local indication.
- (5) Both TELEPNEU ABGRIFF and detectors have unit construction and are interchangeable.
- (6) Identical pilot valves are used. Replacement is easy due to use of plug-in system.
- (7) Standardized components and units are used in the TELEPERM transmitters, resulting in fewer maintenance parts and greater handling ease.

2) TELEPNEU controller

The TELEPNEU controller has a mechanical balancing system with four bellows arranged in a row, usually mounted at the rear side of an indicator or recorder. Thus they are assembled in a unit as an indicating or recording controller. Although this basic construction is the same as that of the earlier TELEPNEU System, component devices incorporate entirely new ideas. Outstanding features of the TELEPNEU controller are listed below:

For the controller:

- (1) Small and rigid construction. Highly sensitive and stable operation.
- (2) Setting of proportional band is made by a pressure dividing system having no moving parts.

Integral time and proportional band can be set without affecting the control output.

- (3) Ball shaped restrictor is used for PID setting. This assures high stability and no hysteresis.
 - (4) Reverse operation of control is possible by means of a screw.
 - (5) "Rate before reset" differential calculation system provides excellent performance.
- For indicating (or recording) controller:
- (6) Both indicating (or recording) and controlling units can be pulled out. Even when units are in the "pulled-out" positions, operation continues.
 - (7) PID setting can be made from the front panel while observing controlling operation.
 - (8) The indicating (or recording) unit can be removed. In this case, the connecting portion is automatically sealed, and the controlling unit continues to operate.
 - (9) The controlling unit can be removed from the front panel. When removed, indicating (or recording) operation continues.
 - (10) Even if both indicating (recording) and controlling units are removed, manual operation is still possible.
 - (11) Indicating and recording units can be interchanged. The indicating controller becomes the recording controller, or vice versa.
 - (12) Automatic-manual or manual-automatic transfer is easily made under bumpless operation. In the case of manual operation, the integrating circuit is short-circuited by interconnection of the selecting lever. This assures smooth and fast transfer.
 - (13) Set point indication of the indicating (or recording) controller is securely and safely obtained as a direct indicating system of set pressure is employed.

3) IPSOPNEU controller

The IPSOPNEU controller is an electropneumatic indicating type designed primarily for use in temperature control, and is used individually as an indicating controller or recording controller in combination with a recording device. The controller has numerous features, as does the TELEPNEU controller.

- (1) Setting is electrical (dc potentiometer or dc bridge), resulting in high accuracy.
- (2) Deviation indicator is included, providing for use as an independent indicating controller.
- (3) With PI selecting relay provided, integral control action is cut-off when the operating output pressure exceeds a given set point. Thus, use as a P or PD controller is possible.

As this is an electropneumatic system, features of the TELEPNEU controllers described above in (2), (5), and (13), as in the pneumatic system, do not correspond to those of the IPSOPNEU controller.

However, the same function and performance exist concerning these points as electrical setting and PI selecting relay are provided.

2. Features of S-SERIES Instruments

Panel mounted instruments such as indicator, recorder, manual selector, and other items are designed with standard dimensions of 160 mm as based on a modification of the earlier Q-SERIES (144 mm). The new TELEPERM System also has 160 mm dimensions, and the S-SERIES is based on this dimension. This results in logical panel mounting. Identical dimensions as compared with the new TELEPERM System make possible mounting of standardized instruments, electric or pneumatic, resulting in the following features:

- (1) Ease of span and zero adjustments.
- (2) Instruments can be removed and operated from the front panels. Easy replacement of recording paper and supply of ink.
- (3) As with transmitters, components and units in TELEPNEU receiving instruments are interchangeable, and also with TELEPERM instruments. The interchangeability serves to facilitate handling and maintenance of the instruments.
- (4) The indicator unit (wide-angle type) and recording unit are interchangeable. As desired, either

the indicator or the recorder may be used.

IV. NEW TELEPNEU SYSTEM S-SERIES COMPONENTS

1. Layout of Components

Fig. 2 shows a general layout of components. Process variables such as pressure, differential pressure, flow rate, and level are converted into a pneumatic pressure of 0.2 to 1.0 kg/sq cm through a force balance or ABGRIFF system transmitter, and transmitted to the panel room. For temperature and various concentrations, electrical outputs of the thermocouple, resistance thermometer, and various concentration analyzers (voltage, current, resistance, etc.) are extended directly to the instrument room. Reasons for use of an electrical signal in this part are as follows:

- (1) As a detector for temperature, a thermocouple or resistance thermometer is most suitable due to wide range, accuracy, and precision, and these items are widely used in such processes.
- (2) Since the sensor and transmission line in a temperature measuring system are operated at ex-

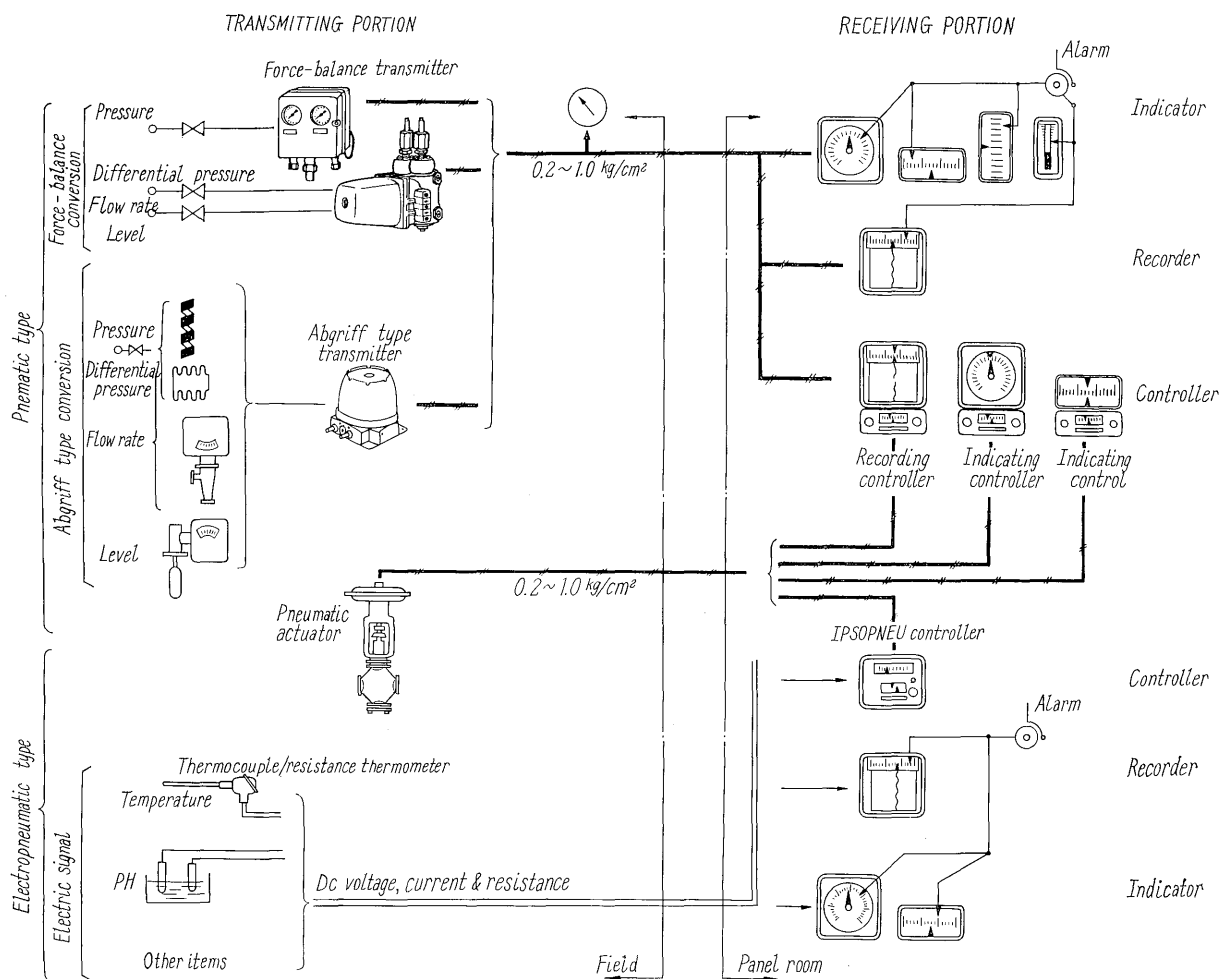


Fig. 2 TELEPNEU System S-SERIES instrument

tremely low power, arc energy is very small in case of an open or shorted circuit. This increases safety in relation to explosion. (Explosion-proof characteristics in this sense concerning circuits and equipment which handle small amounts of power refer to intrinsic safety. Such measures have already been adopted in Great Britain, the Soviet Union, Germany, and other countries. There is an international tendency to adopt the specifications, and Japan is included.)

- (3) Electrical signals from pH meters and various gas analyzers are now employed. Thus it is desirable to use electrical signals directly for transmission and reception, as the accuracy is high.

S-series receiving instruments are designed for use in combination systems, and are based on standardized dimensions. Each instrument has its own function, and many types are available. A pneumatic S-SERIES TELEPNEU indicator, recorder, and controller are used to receive pneumatic signals. For electrical signals, an electric S-SERIES TELEPERM indicator, recorder (for direct input use), and IPSOPNEU controller are used.

All S-SERIES instruments, pneumatic (TELEPNEU) and electric (TELEPERM), are designed with standard dimensions and appearance. The method of handling and the mechanism are identical in these instruments, and combinations are possible. The operating signal of the controller is a pneumatic pressure of 0.2 to 1.0 kg/sq cm, and this is used to drive the operating terminal of the pneumatic system.

Various computing devices are used if required, but these are not illustrated in the figure. Devices are available which provide for calculations such as square root extracting, adding and subtracting, and ratio.

2. Transmitters

Transmitters and detectors with electrical output are well known, and hence only the TELEPNEU Force-balance System and TELEPNEU ABGRIFF System are described here. Generally, a force-balance system has high sensitivity and is suited for measurement of low pressures and low differential pressures. The TELEPNEU ABGRIFF System is suited for measurement of variables, high pressure, and high differential pressure, which are easily converted to displacement. This is due to the fact that a displacement-balance system is employed.

Various features including a direct moving site indicator are included. These two types are used respectively according to the nature of process and measured variables. Ease of installation, adjustment, and maintenance is one of the main aims in designing of every transmitter.

Specifications are standardized as shown below :

Accuracy :	Force-balance system	$\pm 0.5\%$
	ABGRIFF system	$\pm 0.75\%$

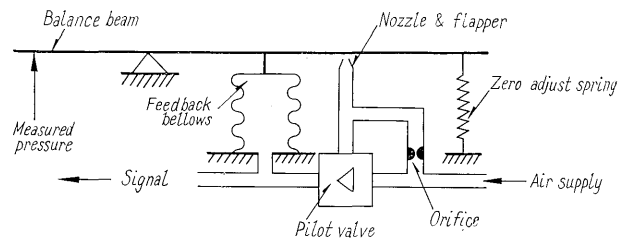


Fig. 3 Principles of force-balance system

Output signal :	0.2 to 1.0 kg/sq cm
Pneumatic pressure :	1.4 kg/sq cm
Housing :	All-weather type
Color :	Silver
Mounting system :	Pipe mounting (2 B) Wall mounting
Ambient temperature :	-10° to $+60^{\circ}\text{C}$
Ambient humidity :	0 to 95 % RH
Zero and span adjustments :	Continuously adjustable
1) Force-balance transmitters	

These include pressure transmitters, differential pressure transmitters, and level transmitters (flange mounted).

Fig. 3 shows the principles of conversion. The pressure (differential pressure) is converted into a force through diaphragm, bellows, and Bourdon tube. The force is applied to the end of a balance beam, and a small displacement is detected by nozzle flapper mechanism and pilot valve.

After amplification, the output pressure of the pilot valve is transmitted. At the same time this is delivered to the feedback bellows in order to force balance the input.

2) ABGRIFF type conversion

The TELEPNEU ABGRIFF (Type P-A) is a displacement balance converter. The measured quantity is converted into angular motion between 0 to 22.5 degrees, and this is applied as input to the TELEPNEU ABGRIFF. The TELEPNEU ABGRIFF converts this input into a standard pneumatic signal of 0.2 to 1.0 kg/sq cm. The conversion principle is shown in Fig. 5. Angular motion of the input shaft is transferred to the nozzle flapper of the feedback lever through the link mechanism. Detection is made by back pressure change of nozzle. This is amplified to

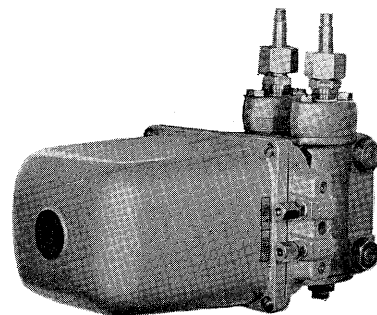


Fig. 4 TELEPNEU differential pressure transmitter (force-balance system)

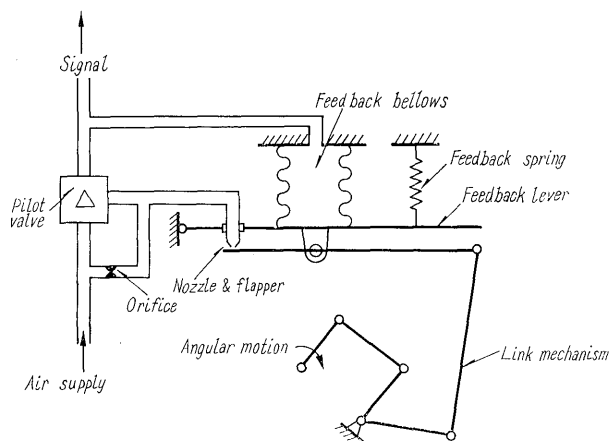


Fig. 5 Principles of TELEPNEU ABGRIFF

a transmitting pressure by the pilot valve and simultaneously applied to the feedback bellows. The feedback lever is displaced in proportion to the transmitting pressure by pneumatic pressure (transmitting pressure) in the feedback bellows and spring. Thus displacement balance which corresponds to the input angle is obtained.

Such types include pressure, differential pressure (dual bellows type), flow rate (area type), level (displacement type), and other transmitters.

Portions which convert the measured variable to an angular motion between 0 to 22.5° are the same as those of TELEPERM transmitters which use the TELEPERM ABGRIFF conversion principle. These portions are equipped with a direct moving site indicator. Transmitters are listed in Table 1.

In addition, TELEPNEU "air set" and TELEPNEU site indicator (transmitting pressure indicator) are included with the transmitters. Housing, color, and ambient conditions are the same as those of the transmitter.

Table 1 TELEPNEU Transmitters

Conversion System	Description	Type	Applications
Force-balance System	TELEPNEU force balance pressure transmitter	PDF II	Pressure
	TELEPNEU differential pressure transmitter	P-DTD	Differential pressure
	TELEPNEU flange mounted level transmitter	P-LTD	Level
ABGRIFF System	TELEPNEU pressure transmitter	P-PTH (B, V)	Pressure
	TELEPNEU dual bellows differential pressure transmitter	P-DTB	Differential pressure
	TELEPNEU area flow rate transmitter	P-FTT	Flow rate
	TELEPNEU displacement level transmitter	P-LTF	Level

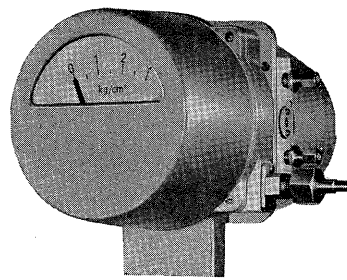
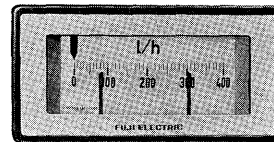
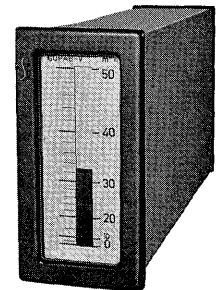


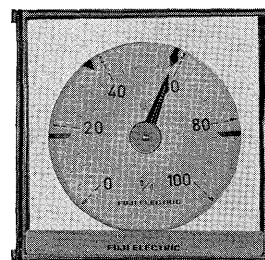
Fig. 6 TELEPNEU pressure transmitter (ABGRIFF system)



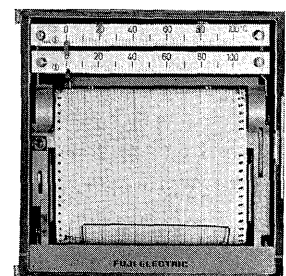
(a) S-SERIES TELEPNEU indicator



(b) TELEPNEU screen type indicator



(c) S-SERIES TELEPNEU wide-angle indicator



(d) S-SERIES TELEPNEU recorder

Fig. 7 Indicators and recorders

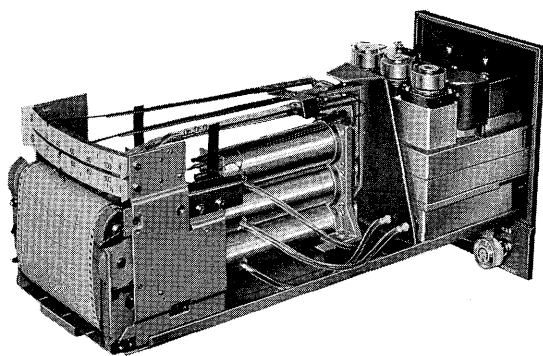
3. Receiving Instruments

Receiving instruments having standard front dimensions of 160 mm are unified square or rectangular and panel mounted types. Various units equivalent to earlier types are available. Common specifications of S-SERIES TELEPNEU receiving instruments are listed below.

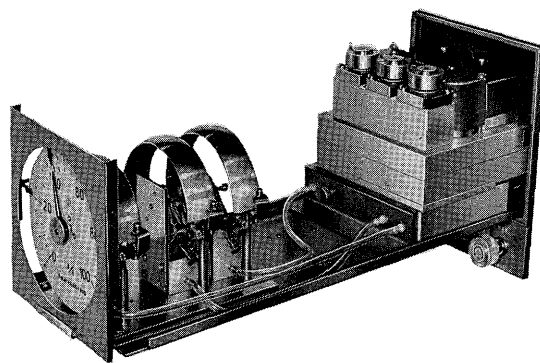
Accuracy: Indicator $\pm 1.0\%$
 Recorder $\pm 0.5\%$
 Input: 0.2 to 1.0 kg/sq cm
 Ambient temperature: 0 to 50°C
 Ambient humidity: 0 to 90% RH
 Color: Munsell 7.5 BG 4/1.5
 Power: 100 v ac (50 or 60 cps)
 (Except for the recorder, both 50 and 60 cps may be used.)

1) Indicators and Recorders

S-SERIES TELEPNEU indicators and recorders can be removed from the front, and both items have optional upper and lower limit alarm facilities. There are flat flange horizontal type (S-PIU), flat flange vertical types (S-PIU-V), screen types (QPAB-



(a) Recording controller



(b) Indicating controller

Fig. 8 S-SERIES TELEPNEU indicating controller and recording controller

V), wide-angle types (S-PIWU), and many more. The flat flange and wide-angle types are equipped with Bourdon tubes as the pressure receiving elements.

Screen type indicators and recorders have a combination of bellows and spring. Top workmanship and high-quality materials are used.

2) Controller

TELEPNEU controllers are usually plugged-in in the case of wide-angle indicators and recorders. These are used as an indicating controller or recording controller in combination with TELEPNEU manual selectors. Versatility in installation is expanded with an independently mounted controller. The circuit diagram is shown in Fig. 9. As seen from the figure, differential calculation is made through both the D restrictor and D relay in the measurement input side. Thus overshoot produced by reset wind-up at the start of the process is prevented. As a non-bleed pressure dividing system is used to provide proportional setting, the supporting point of the force-balance mechanism of the deviation detecting portion is fixed, resulting in high stability and sensitivity. For manual operation, the I relay is operated. This causes the restrictor used for integral calculation to be bypassed. Hence, a 1:1 relay is applied by manual operating pressure in order to make operating pressure follow automatically and immediately manual operating pressure. The dual pointer output indicator makes it easy to confirm balance in the event of manual automatic switching.

Manual selectors are equipped with various functions such as fixed value control, ratio cascade control, selecting and setting. These are shown in Table 2. These selectors can be mounted so that the selector and indicator or

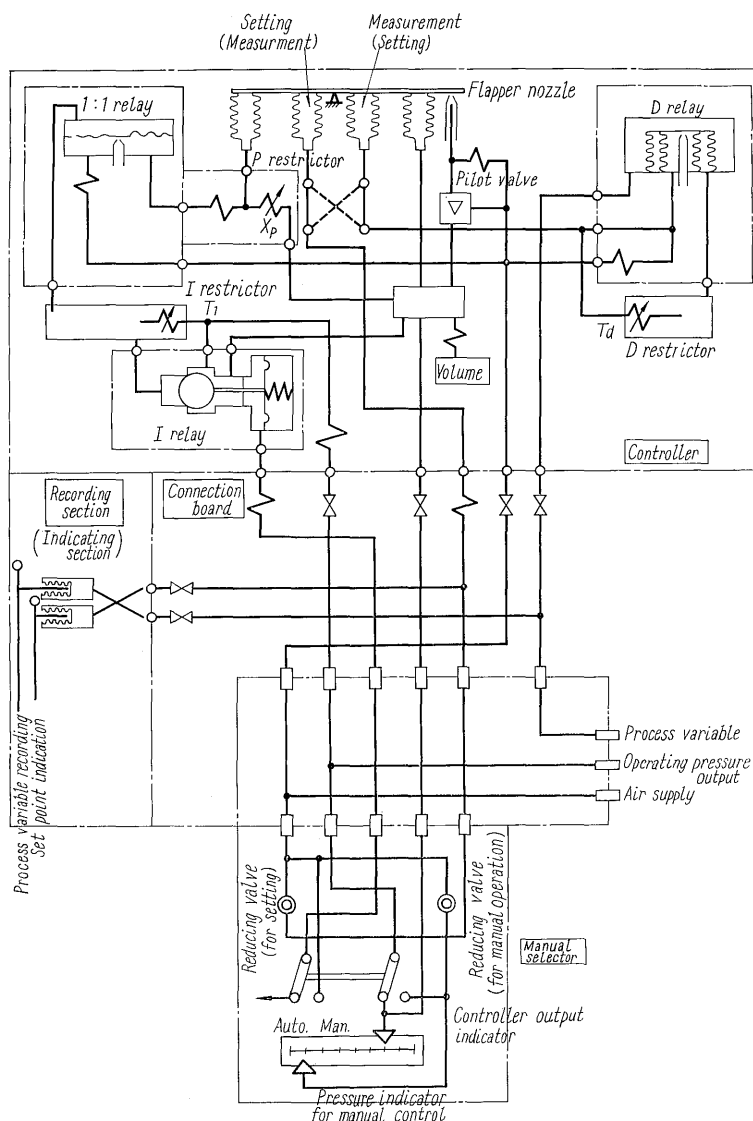
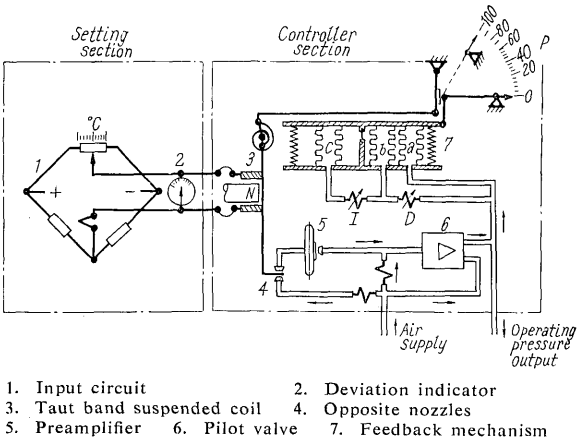
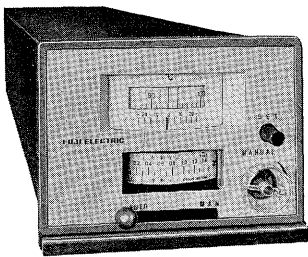


Fig. 9 Circuit diagram of S-SERIES TELEPNEU recording (indicating) controller

recorder can be located side by side on the panel, and so that only the selector is separately located on the desk. Control operation covers the ranges necessary for process control under PID, PI, P, and PD operation. Proportional ranges of 5 to 300% and 20 to 700%, integrating times of 0.1 to 50 minutes and 0.01 to 5 minutes, and differential times of 0.05 to 25 minutes are available.

The IPSOPNEU controller is an electropneumatic type. An external view and operating principles are shown in Fig. 10. The controlling deviation is detected electrically and a small deviation current flows in the taut band suspended coil placed in the field of a permanent magnet.

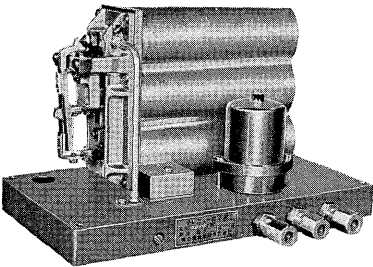
The shielded wing located between the opposite nozzles housed in a unit with the coil is displaced by electromagnetic force. This results in an internal



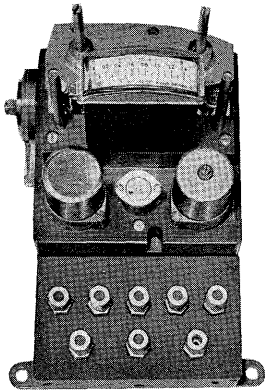
1. Input circuit 2. Deviation indicator
3. Taut band suspended coil 4. Opposite nozzles
5. Preamplifier 6. Pilot valve 7. Feedback mechanism

Fig. 10 S-SERIES IPSOPNEU controller

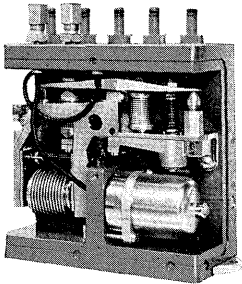
pressure change of the nozzle on the receiving side. This change is amplified in two stages to obtain operation output. This output is then fed back in the coil through PID calculation. The coil has a taut band system which assures no friction and high sensitivity. In addition this portion has effective damping characteristics which prevents errors caused



(a) Root extractor



(b) Adding relay



(c) Multiplying relay

Fig. 11 TELEPNEU computing elements

Table 2 S-series TELEPNEU Instruments

System	Description	Type	Dimension (mm) (H×W)
Indicator	S-SERIES TELEPNEU indicator	S-PIU	80×160
	S-SERIES TELEPNEU indicator (vertical type)	S-PIU-V	160×80
	S-SERIES TELEPNEU wide-angle indicator	S-PIWU	160×160
	S-SERIES TELEPNEU screen indicator	QPAB-V	144×72
Recorder	S-SERIES TELEPNEU recorder	S-PRB	160×160
Controller	S-SERIES TELEPNEU indicating controller	S-PIC	160×160
	S-SERIES TELEPNEU recording controller	S-PRC	160×160
	S-SERIES TELEPNEU controller (independent mounting)	P-PC-D	Wall-mounting
	S-SERIES IPSOPNEU controller	S-ECP-N	120×160
Control Unit	S-SERIES TELEPNEU manual selector (for fixed point control)	S-PH -2GS	50×160
	S-SERIES TELEPNEU manual selector (for combining with multiplying relay)	S-PH -2GS-R	50×160
	S-SERIES TELEPNEU manual selector (cascade, ratio)	S-PH -IGS	50×160
	S-SERIES TELEPNEU manual selector (manual)	S-PH-IG	50×160
	S-SERIES TELEPNEU manual selector (switching)	S-PH-S	50×160
	S-SERIES TELEPNEU manual selector (switching)	S-PH-GS	50×160
	S-SERIES TELEPNEU manual selector (setting)	S-PH-2G	50×160

by external vibration and shock. For a temperature control system, high precision which is often very desirable for control is assured since the detecting element and controller have neither hysteresis nor dead-band. The controller is a panel-mounted type housed together with setting and manual selector, due to the fact that it has a deviation indicator and is mostly used as an indicating controller. It is also used in combination with a multipoint recorder. When the IPSOPNEU controller is used together with another indicator or recorder to receive signals on the detector directly, the temperature detector is a dual-element type.

The input has a range of more than six millivolts dc, and 30 deg (Pt 100 Ω), and TELEPERM signal current (10~50 ma dc). Control operation is made by P, PI, PD, and PID mode. Proportional range is 3 to 300% or 10 to 1000%. The differential time and the integrating time are the same as those of the TELEPNEU controller.

4. Computing Elements

The following three types are provided for square root extracting, adding and subtracting, and ratio calculations necessary for process control. All types have no sliding parts such as sliding support center, and are based on special operating principles which assure high sensitivity and stability.

TELEPNEU root extractor	P-POR
TELEPNEU multiplying relay	QPVS
TELEPNEU adding relay	QPDU

V. CONCLUSION

The New TELEPNEU System S-SERIES Instruments, accompanied with the New TELEPERM S-SERIES Instruments, can offer highest quality and most economical instrumentation in various process control fields. Expanded application is expected over a wide range in the control field.