ENERGY CENTER IN IRON AND STEEL INDUSTRY

By

Toshio Suzuki

(Instrumentation Engineering Sect., Central Technical Dep't)

I. PREFACE

Rapid progress is being made in the manufacturing process with the use of automation. Some of the first plants to realize and take advantage of this new manufacturing process, to name some of first plants, were the chemical plants, iron and steel works, cement plants and other kinds of manufacturing plants.

The most vitally important advantage of autmation is, the "curtailment of necessary energy", which speed-up in manufacturing, higher quality of goods, stablity of manufacturing process and safe operation etc., are just several advantages, to say the least, are regarded the most remarkable achievements obtained in the field of manufacturing process. This holds especially true for iron and steel works where various sources of energy are essential. And because of this, greater importance is being attached to centralized supervision of the various sources of energy, generated and consumed, in the course of their production. This is being planned or realized under the name of energy center.

The following chapters take up the functions, necessity and systems that can be gained through the use of energy center.

II. NECESSITY AND IDEA BEHIND ENERGY CENTER

As after-mentioned, all type of manufacturing equipment are being confronted and changed to automation. Up to now, "Automation" has, in almost at every instance, proved effective against the conventional methods of manufacturing. The major factor behind "automation" is cost down of production. Lets take a look at the iron and steel industry, for instance, up to now, the idea of using one whole plant, using automation, to handle raw materials to final products was not thought of. It can be said that, up to now that is, the sphere of autmation is limited with blast furnace, open hearth furnace and soaking pit furnace.

Therefore, we have decided to go a step further by enlarging the visual scale from the standpoint of "Supervision of Automation", and combining the entire plant and the various types of equipment together, to discuss measures in reaching on how automation can be supervised.

Machinery will take over equipment and be automatically driven; and precise, compared to what could be achieved by the use of man-power, with equilibrium as first the object; not just with the various equipment, but the plant judged as a whole, and can be widen under unified supervision on the face, so called, supervision of automation.

Supervision of manufacturing process should be:

(1) Supervision of production and materials
(2) Supervision of tests for half completed products
(3) Supervision of energy including control of workmanship

can be devided up into these three large groups. In this way of thinking, the length of time required, from time of obtaining the necessary data, until how they will be treated, is big broblem. Even right now, individual automations are highly advanced, and if uesd, can help speed-up in obtaining the necessary data, but the treating of the data is still done all by man-labour. This requires many days and many hours are wasted against a difinite way on how to supervise or command. And one other things, if man-labour is to be used, many extra workers would be necessary in order to speed the treating of the data obtained.

But just recently, instrumentation and automatic control technic has developed, especially in these last few years, the telemeter, tele-control, computer and data logger were developed mainly for, and being used, in the manufacturing process by automation. With these meters adequately arranged and grouped together, equipment can be made to supervise and operate under automation which is

forever becoming a reality.

But at this time, the three functions to be supervise have not reached to the automatic treating of data which has alreay been previous states. Now, to divide the three groups of supervision of automation into simplier and understandable groups, they are:

(1) Supervision of energy
(2) Supervision of production and materials
(3) Supervision of quality

It only natural to consider, namely, the data that can be treated easily, and the data can be obtained under fixed quantity condition. From this, the object of supervising energy was decided.

As shown in Table 1, for supervision of energy, each kind of measuring technic is accomplished, and it is easy to obtain the fixed quantity in the supervision.

And because we have had long experience in measuring technics, this technic, which is the first step of manufacturiug process control, is going to plan, or have already been put into quick common use.

Table 1. Measurement system for energy sources

Classification	Energy source	Ouantity	Measuring meter
Energy amount used	Watt-hour	kwh	Watthour meter
	Fuel gas (B gas, C gas)	Nm^3	Integrating flow meter
	Liquid fuel (heavy oil)	ton·k*l*	
	Steam	ton	
	Oxygen	Nm^3	
	Water	ton	
Percent of energy used	Power	kW	Watt meter
	Percent of amount used for each liquid flow	Nm^3/h·t/h·l/h	Flow meter

III. ORGANIZATION OF ENERGY CENTER

From the function standpoint of element organization of energy center:

(1) Detecting transmitter of each measured value and their measuring values sending appartus to the energy center
(2) Main graphic panel at the energy center
(3) Telecommunication apparatus and group operation switch for remote control
(4) Data logger

are necessary. The ability of each of these apparatus and their mutual relations are as follows:

1. Detecting transmitter of each measured value and measuring values sending apparatus

For these equipment, first of all, required elements must be measured at the designated places, and these measured values must be transmitted instantly. The kinds of measuring values are as abovementioned energy elements, and besides these, pressure, temperature, remaining hight to supervise, these are:

1) As there are various kinds of values to be mesured, it is requested that the various measuring units to a unified unit (i. e., the limited range current is 0∼5 mA, or voltage), because the exchanging ability of measuring value receiving apparatus and easy maintenance of these apparatus.
2) Because the measured values must be transmitted for a great distance, induction interference must be prevented and any error due to variation of conductor resistance caused by variation of temperature, must alse be prevented.
3) Because the cable necessary for sending measaed values must not only be long in length, but also many, the cable used must be small in diameter and the number of wire-cores must be as few as possible.
4) Measured values must not be affected by either voltage or frequency of auxiliary power source.

It is necessary to combine the detecting transmitter and the measuring values sending apparatus to satisfy the abovementioned conditions.

In order to satisfy the abovementioned conditions, the following two systems are considered as detecting measuring values sending apparatus of each kind of measuring value:

1) The method of measuring values sending, i.e., an output of each kind of transmitter, heretofore in use, is connected to a torque balance type measuring values sending apparatus, and a measured value is changed into DC current to simplify its unit.

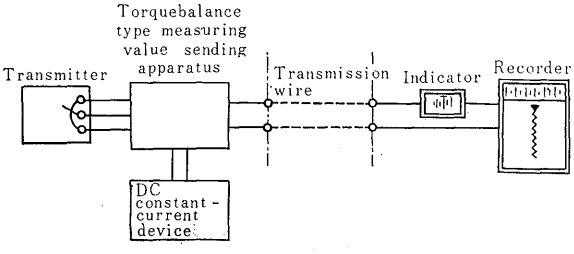

Fig. 1. Principle of torquebalance type telemeter

2) The system of carring out measuring values sending, can be done with a Teleperm, which has been developed by our company, just recently.

The former measuring values sending system is shown in Fig. 1, and each measared value can be modulated into resistance variation by the detecting transmitter and connected to torqueblance type measuring values sending apparatus.

Torquebalance type measuring values sending apparatus including feed-back circuit, which the principal is shown in Fig. 2, can modulate accurately the measured value to the limited current.

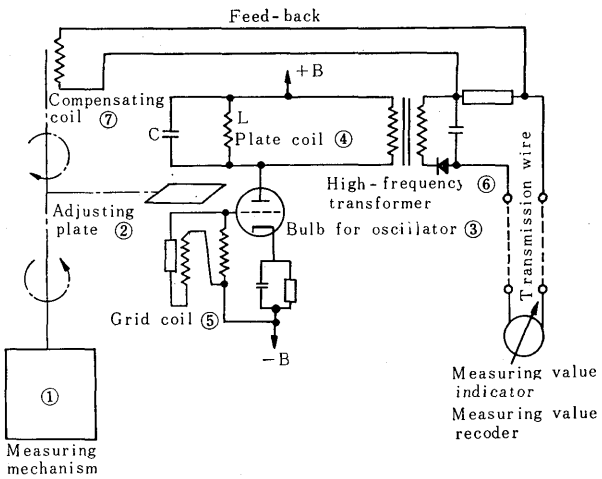

Fig. 2. Principle of torquebalance type transmitter

This characteristics and merits are as follows:

(1) It is possible to send the values regardless of the sending distance.
(2) The measured value is not effected by either the voltage or frequency of auxiliary power source.
(3) Measured value is not effected by temperature variation on transmission circuit.
(4) Totalized measurements of a number of values can be done easily.
(5) Tolephone-wire, power cable and micro-circuits can be used easily as transmitting circuits.
(6) As a measuring value receiving apparatus, there are a recorder and an indicator, which is directly connected and can record or indicate a valued with quick response.
(7) Operation is stable, inspection and maintenance are made easy, and minimum moving parts, and because of these, they can be used for a long time.
(8) High load resistance up-to 5 kΩ can be connected.

Now on the latter, Teleperm transmitter is consisted of detecting apparatus of low, pressure etc., and DC current transmitter. As shown in Fig. 3, because the torquebalance system between pressure receiving part and output current part are adopted, the measuring value can be modulated into the limited current accurately as well as the former torquebalance type. Principals of Teleperm pressure transmitter are shown in Fig. 3, the relation between the pressure difference and flow in the method, which can be obtained a flow, by measuring pressure differences before and after the head producer, are explained as follows:

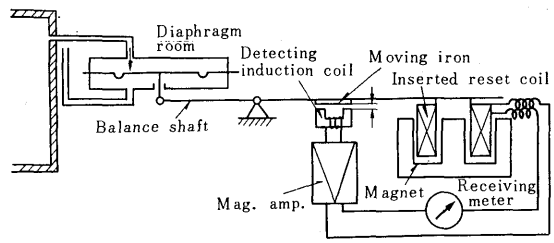

Fig. 3. Principle of Teleperm pressure transmitter

$$Q \propto \sqrt{p_1 - p_2}$$

where Q : Flow
P_1 : Pressure before head reducer
P_2 : Pressure after head reducer

Consequently, in order to obtain output current in proportion to flow Q as shown in Fig. 4, double coils are connected with a magnetic coil in series and a output current is flowed in the circuits, then an output current can be obtained by making balance of the diaphragm between the output current and the flow. The Teleperm transmitter has the following outstanding merits:

(1) Because of DC output current of the amplifier is large, tele-control and telemetering of computing circuit, digital circuit and scanning circuit are made easy.
(2) Because the output current is DC, induction noise will not effect this apparatus caused by the power cable.
(3) The response of the transmitter is extremely quick and there is no lagging in transmitting.

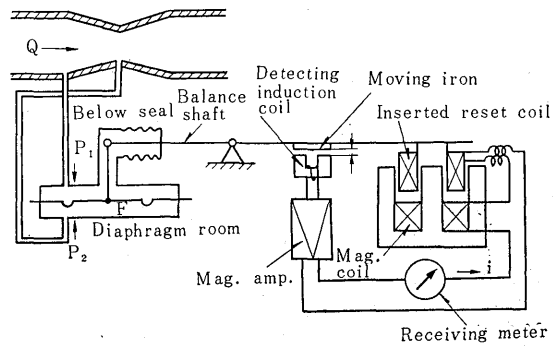

Fig. 4. Principle of Teleperm flow transmitter

(4) Because of torquebalance type is adopted in the apparatus, there are no moment of inertia or friction, high accuracy can be obtained.

(5) This apparatus is not effected by load-resistance variation caused by adding a receiver and temperature variation of the transmission wires.

(6) Because it uses magnetic amplifier, it has long life and easy maintenance.

(7) It is not necessary to adopt air or oil power sources in this system, the installation cost is very economical.

(8) Because it has dust proof and drip-proof protection, the installation is easy.

Table 2. Specifications of Teleperm pressure transmitter

Type	MUF—0.2/14	MUF—10/40	MUF—25/160	MUF—25/640
Measuring range capable of continuous adjust	0~36···0~144 mmAq	0~100···0~400 mmAq	0~400··· 0~1,600 mmAq	0~1,600··· 0~6,400 mmAq
Standard range	0~ 36 mmAq 0~ 81 〃 0~144 〃	0~100 mmAq 0~150 〃 0~200 〃 0~400 〃	0~ 400 mmAq 0~ 600 〃 0~1,000 〃 0~1,600 〃	0~1,600 mmAq 0~2,500 〃 0~3,600 〃 0~6,400 〃
Max. pressure to be used (Calling pressure)	0.2 kg/cm²	10 kg/cm²	25 kg/cm²	25 kg/cm²
Output current	DC 0~200 mA	DC 0~200 mA	DC 0~200 mA	DC 0~200 mA
Permissible resistance of output circuit	below 100Ω	below 100Ω	below 100Ω	below 100Ω
Response sensibility	0.1% of max. range	0.1% of max. range	0.1% of max. range	0.1% of max. range
Response time	below 1 sec.	below 1 sec.	below 1 sec.	below 1 sec.
Accuracy	±1% of max. range	±1% of max. range	±1% of max. range	±1% of max. range
Power source	AC 100/110 V or 200/220 V, 50/60 c/s	AC 100/110 V or 200/220 V, 50/60 c/s	AC 100/110 V or 200/220 V, 50/60 c/s	AC 100/110 V or 200/220 V, 50/60 c/s
Permissible torelance of source voltage	±10%	±10%	±10%	±10%
Permissible torelance of source frequency	+1~−2 c/s	+1~−3 c/s	+1~−3 c/s	+1~−3 c/s

Table 3. Specifications of Teleperm flow transmitter

Type	MMF—0.2/14	MMF—10/40	MMF—25/160	MMF—25/640
Measuring range capable of continuous adjust	0~36····· 0~144 mmAq	0~100····· 0~400 mmAq	0~400····· 0~1,600 mmAq	0~1,600····· 0~6,400 mmAq
Standard range	0~ 36 mmAq 0~ 81 〃 0~144 〃	0~100 mmAq 0~150 〃 0~250 〃 0~400 〃	0~ 400 mmAq 0~ 600 〃 0~1,000 〃 0~1,600 〃	0~1,600 mmAq 0~2,500 〃 0~3,600 〃 0~6,400 〃
Max. pressure to be used (Calling pressure)	0.2 kg/cm²	10 kg/cm²	25 kg/cm²	25 kg/cm²
Output current	DC 0~200 mA	DC 0~200 mA	DC 0~200 mA	DC 0~200 mA
Permissible resistance of output circuit	below 100Ω	below 100Ω	below 100Ω	below 100Ω
Response sensibility	0.1% of max. range	0.1% of max. range	0.1% of max. range	0.1% of max. range
Response time	below 1 sec.	below 1 sec.	below 1 sec.	below 1 sec.
Accuracy	±1% of max. range	±1% of max. range	±1% of max. range	±1% of max. range
Power source	AC 100/200 V 50/60 c/s	AC 100/200 V 50/60 c/s	AC 100/200 V 50/60 c/s	AC 100/200 V 50/60 c/s
Permissible torelance of source voltage	±10%	±10%	±10%	±10%
Permissible torelance of source frequency	+1~−3 c/s	+1~−3 c/s	+1~−3 c/s	+1~−3 c/s

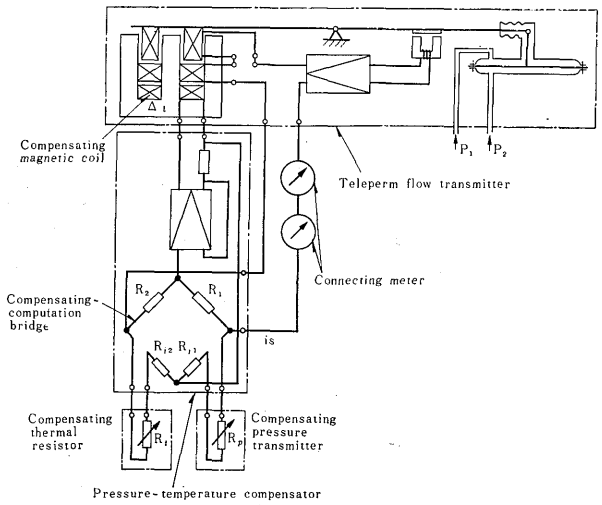

Fig. 5. Principle of Teleperm flow transmitter with pressure-temperature compensator

Please refer to table 2 and 3 for complete detailed specifications of Teleperm pressure transmitter and flow transmitter.

One other merit of the Teleperm transmitter is that it can compensate flow pressure and temperature. Namely, each kind of gas and air etc., in the measured liquid, will extremely change its volume caused by temperature and pressure. As shown in the principal drawing Fig. 5, in order to compensate these, the transmitter is attached with a pressure-temperature-compensating transducer and a compensating-pressure-temperature transmitter (both are resistance out put). In this way, remote transmitting is possible. Moreover, Teleperm current transmitter is used for measuring value sending of pressure and flow of high pressurized liquid, which can not be measured by the above stated Teleperm pressure-flow transmitter, or for measuring value sending of temperature and gas holder level.

The above means are to modulate all electrical measured value to $0 \sim 50$ mA of DC current in the process measurement and control. Their principals are shown in Fig. 6.

Outstanding merits; Stability and linear characterstics are extremely good, because self-balance type

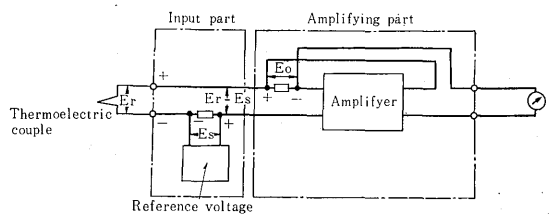

Fig. 6. Amplifying part

circuit is used in the amplifying parts, the voltage in proportional to output current is always negative feed back to the input of the amplifying part, the amplifying part is compared with a voltage difference.

Because of magnetic amplifier is adopted, it has the following excellent characteristics; long life, mechanically strong, high accuracy and quick response. Two stage amplifier is adopted when its detecting valtage is $10 \sim 100$ mV, but for one stage amplifier for above 200 mV. There are many kinds of input parts according to detecting system and measured quantity. Generally they can be divided as follows:

(1) One includes bridge circuit, detecting value (flow, pressure etc.) can be obtained by a ringtube transmitter or other electrical resistance variation.

(2) One includes bridge circuit, detecting value can be obtained by means of a resistance thermometer based on temperature transmitting.

(3) One includeds potentiometer circuit, detecting value can be transmitted upto 200 mV of voltage.

(4) One includes potentiometer circuit, detecting value can be obtained by a thermocouple.

(5) Others, like a O_2 potentiometer circuit, have very fine detecting voltage transmitting.

The classification for these, the various kinds of Teleperm current transmitters and their characteristics, are shown in Table 4.

Two systems are stated as mentioned above, which are considered in each measured values detecting transmitter and measuring values sending apparatus, but they have merits and demerits. That is, in

Table 4. Specifications of Teleperm current tranmitter

Input	Bridge circuit composed of ring tube and resistance	Bridge circuit composed of resistance thermometer	Potentiometer having detecting voltage of more than 200 mV	Potentiometer having detecting voltage 10~100 mV (thermocouple)
Output	0~50 mA	0~50 mA	0~50 mA	0~50 mA
Amplifier	First magnetic amplifier	Second magnetic amplifier	First magnetic amplifier	Second magnetic amplifier
Permissible resistance of output circuit	200Ω	200Ω	200Ω	200Ω
Accuracy	0.5%	0.5%	0.5%	0.5%
Power source	AC 100 V 50/60 c/s	AC 100 V 50/60 c/s	AC 100 V 50/60 c/s	AC 100 V 50/60 c/s

case measured values must be transmitted to a long distance, it is better to adopt the torquebalance type measuring values sending apparatus, which has a large load resistance (approximately 5 kΩ) for economizing transmission line. Then again if the measured values are transmitted to a comparatively short distance, it is better to adopt the Teleperm system, because it is more acculate in transmitting —measuring values sending, it is not necessary to adopt a special measuring values sending equipment (measuring values sending panel and other accessories), it can send, without the use of any other apparatus, the value from a detecting point to the energy center. Therefore, for planning an installation, way of detecting-measuring values sending, it should be built in consideration of; its object, geographical condition and other necessary conditions.

2. Main Graphic Panel

Each measured value is transmitted into the energy center, as mentioned above, so that its values can be quickely and easily understood or again, the precise operating condition of each installation. The main meter panel, which a whole plant is symbolized graphically, would be very suitable. Namely, measured values are recorded in analogical or in digital, accordingly as may be required, and furnished with a upperdown limited alarm switch. It is the best and most reasonable way to find out the following conditions in the whole plant, is to equip analoque indicators at a suitable point in the graphic panel. That is, we can check by this, the approximate percent of the measured value over the scale, and the flow direction in a pipe line, to know at what position or what kind is measured value.

Operators in the energy center should understand the operating condition of each installation, at the time, or in the near future.

One of the most difficult problems for an oxygen plant, boiler plant, power station and substation is to know whether or not: (*a*) the converter is blowing, (*b*) the converter boiler is operating, (*c*) the strip mill is operating. The above can also be said, at the generating side and consuming side of B gas and C gas. In this reason, on the graphic panel, each equipment is symbolized, an operating condition is indicated by, light on-off of these symbolized lamps. Inprovement can be obtained in having the on-off signals sent automatically from the measured point.

3. Telecommunication-ordering Apparatus

From the point of view of totalized control, it is unnecessary to obtain a data from each section. Operating conditions and operating schedules should be studied, while urgent damage should be informed to the related section, in order to obtain a rational balance between consuming and supplying. It is necessary to equip the interphone, as a telecommunication-ordering apparatus, to the main-apparatus and is equipped in the energy center, and sub-apparatus are in the each related point

The mechanism as follows:

1) Must be capable to send informations between main-apparatus and to one or more selected sub-apparatus. (Simultaneous sending-receiving system is desirable)
2) Must be capable to order from main-apparatus to all sub-apparatus.
3) Must be capable to send mutual information between sub-apparatuses.
4) Must be capable when an emergency arises to connect with force, both main and sub-apparatus.

The above listed abilities are the most essential. Because the telecommunication apparatus will be demended more during a power shortage, a non-power shortage-emergency generator is required.

4. Data Logger

Data logger taken in a wide sense is, roughly divided into two kinds of mechanisms. One is the daily report type, and the other is the instant value supervising type.

The former is so designed that a integrating flow meter and watt hour meter etc., record with numerically each time, moreover, addition, subtraction or efficiency of synthesized value per 8 or 24 hours, and also, more than two kinds of value can be caluculated at the same time. And these values are daily reported numerically. And an operator will not be required to be on duty here, during any 24 hours period. And this has the ability to treat a daily data quickly and accurately, and is the foundation for a new control system. In this case, it is a very economical and reliable method, the pulse signal of input in direct proportional to the value to be measured, i. e., m^3, is memorially recorded in this apparatus. Caluculation ability of this type can only be utilized, only when it caluculates according to a program, designed in advance. Therefore, it is incapable to caluculate, as a universal computer, by setting the caluculation program in demand. Namely, it does not have ability to caluculate as a single computer.

The latter is to supervise each item, the instant value of pressure, temperature and max. or min. limited flow, and can scan a input with the speed of approximately 0.1$\sim$1.0 sec. per channel. If the value goes over the scale, more than the upper or lower limit, setted in advance, a warning alarm will go off and indicate the over or under value. Therefore, many values can be supervised economically, and also, space can be minimized, because

the traditional indicating-alarm meters of each measured value will be not required. At the same time, with the warning alarm, all channel's values are automatically recorded numerically.

By this way, it is possible to keep a reference data, which can be used later, to check how many degrees were abnormal, and also how great the related values were changed.

Many samples must be taken in order to record a instant value at a specified time or to obtain the max., min. and mean value as well as the former with this system.

IV. MERITS OF ENERGY CENTER

As mentioned above, the energy center is being planned in many large industries, as a part of automatic supervision. Advantages and merits adopted with this system are as follows:

1) Because necessary data can be assembled in several short minutes, and orders can be expedited, so it is posible to control a whole plant quickly.
2) Because the data logger is far superior than man power, it can reduce man power to a minimum, so it is possible to resolve a contradiction of "increasing man power due to rationalization".
3) Because of its accuracy and easy operation, data logging errors made by men are completely eliminated.
4) If, besides the data logger, an automatic computer is adopted, not only primary data, but secondary data or complicated control system can be carried out during extremely short time.

V. EXAMPLE OF ENERGY CENTER

As a example, we would like to introduce the energy center installed at the Tobata Plant of Yawata Works, Yawata Iron & Steel Co., Ltd. which started in September 1, 1960 as a modern raw material-fine product plant.

1. Outline of Installation

The aim of this installation is to control the balance between supply and demand of energy at the premises of Tobata Plant, and the elements to be controlled at the energy center are, B, C gas, steam, oxygen and electric power. This installation is consisted of telemetering apparatus, telecommunication apparatus and other incidental apparatus.

2. Specifications of Installation

This installation is designed as follows; first each measured value to be sent to the energy center is measured at the designated point, which is divided up into several groups at the Tobata Plant, measured values are assembled, per each group, at the place which is called the substation. A measuring values sending panel is installed here, and then, each measured value is transmitted by means of this measuring values sending apparatus.

1) Detecting method of each measured element

(1) Detecting method of flow

There are B, C gas, steam, oxygen etc. as flow elements to be measured. As B, C gas pressures are low, the ringbalance type flow transmitter must be used. And also, for high pressure liquid, such as steam and oxygen, the mercury float type flow transmitter must be used. Differences before and behind the orific, is modulated from pressure into resistance value by the ringtube, after that, these values will then be sent to the masuring value sending apparatus installed in the substation by the use of the three wires transmitting system. The reason the three wires system is adopted, in this case, is that measured value errors will never occur due to any variation of conductor resistance caused

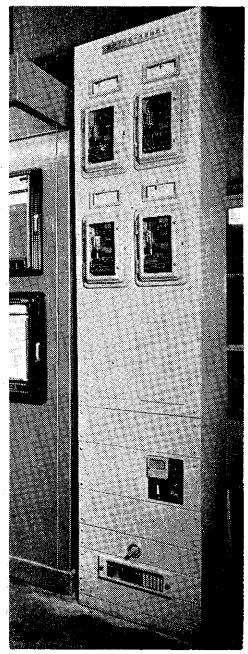

Fig. 7. Indoor measuring values sending substation

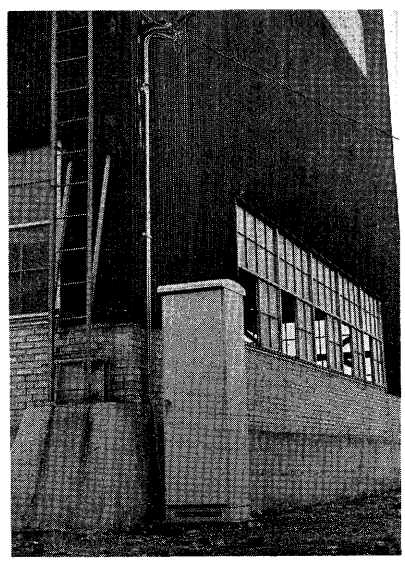

Fig. 8. Outdoor measuring values sending substation

by temperature variations. For flow measuring elements, which is connected with the data logger's input, the transmitter must be attached with a pulse generator which will send pulses to the data logger in proportional to flow.

(2) Pressure detecting method

The bourdon tube type transmitters are to be applied to the oxygen line, especially for the oxygen ball type holder. The pressure can be modulated into resistance value by means of the ringtube and sent to the messuring values sending apparatus in the substation based on the three wires system.

(3) Height detecting system of the gas holder

In order to detect a height of B, C gas holder, the height transmitter was attached with the existing wire type reduced scale indicator. The height transmitter will act in accordance with the height of the gas holder. And the height is modulated into resistance value by means of the last shaft which is driven by a reducing gear mechanism, and is able to transfer the over all range of height. This telemetering is the three wires system, as well as the former. And as this height is modulated into resistance value, and connected with the output of the data logger, symbol modulation mechanism of "2 out of 5" system should be mounted with the transmitter.

(4) Power and reactive power detecting method

For detecting power, the existing main PT and CT were used, and this current circuit was connected with the primary side of the auxiliary CT, while the secondary side was connected with the measuring values sending panel with a 8 mm^2 cable. In order to reduce errors on the line, this measuring values sending panel was installed in the substation or the power station, so as to shorten the the distance from the main CT. Suitable turn-ratio of auxiliary CT is selected according to max. indicating range of the instrument. Thus the main PT was connected with the power measuring values sending apparatus, and the main CT was connected also with the apparatus through the auxiliary CT. And also, when the power was applied the logger, a precision pulse transmitter type watthour meter was used, and the power was transmitted as a figure at pulse.

(5) Voltage and frequency detecting system

Voltage and frequency were taken from the secondary side of the existing main PT.

As frequency telemetering was difficult, so voltage was step down, by auxiliary PT, and sent to the energy center, which is connected directly with voltmeter and frequency meter.

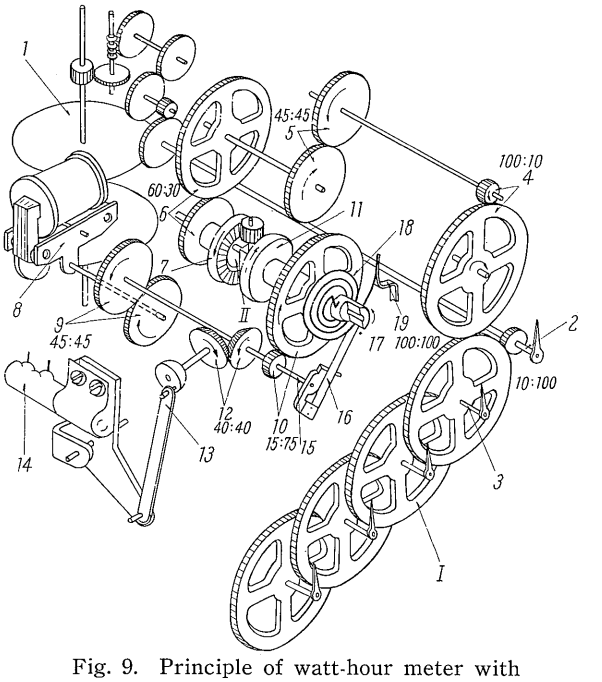

Fig. 9. Principle of watt-hour meter with pulse ending mechanism

(because the enegy center was second floor of the power station, so the distance was short.)

2) Measuring value sending apparatus

As mentioned above, flow, pressure and height of the gas holder were modulated into the resistance variations by the ringtube, and the values were sent to the measuring value sending apparatus in the substation. One of the longest cables between each substation and the energy center is over 3,000 m, if the consideration is taken on round about cable. Therefore, for transmitting a mearured value to this distance without any trouble, the torque-balance type measuring values sending apparatus was used. Principle of this is as shown in Fig. 2 and 3, a measured value is to be modulated into a equivalent to 0~3 mA of DC current. If a resistance of output is less than 5 kΩ, very accurate values are transmitted, regardless of the resistance value. All necessary terms of the abovementioned item III·1 are satisfied by this, and it can be said that this apparatus was the most suited for this plant.

At each substation, measuring values sending paneles are installed, which are mounted with measuring values sending apparatus belonging to the substation, constant voltage apparatus to be serviced for ringtube measuring circuit, indicator for supervising of measuring values sending, arrester, power switch and etc. All of these values are collected together and sent to the energy center.

3) Measuring values receiving apparatus

Measuring values receiving apparatus can be roughly divided into three groups, i. e., main graphic panel, measuring values receiving-recording panel

and data logger.

(1) Main graphic panel

As mentioned above, each measured element is collected together at the substation near the point to be measured and is transmitted to the energy center. In this case, it can be done, regardless its kind, such as B, C gas, steam and oxygen.

Main graphic panel is also devided as follows

Graphic panel for gas
Graphic panel for steam
Graphic panel for oxygen
Graphic panel for electric power

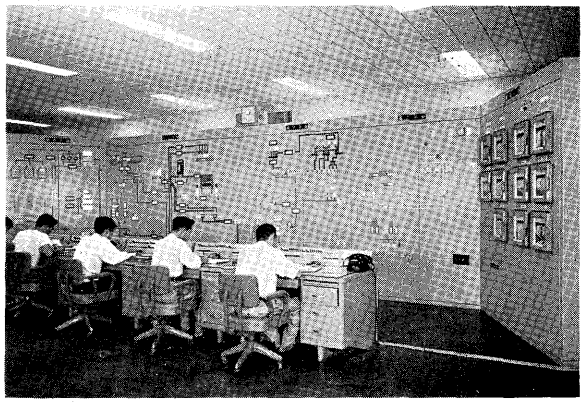

Fig. 10. Energy Center main graphic panel

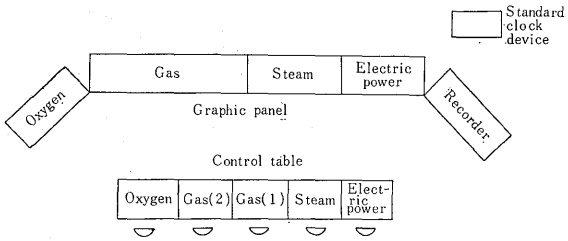

Fig. 11. Disposition of equipment for Energy Center

On the graphic panel, main power generating terminal, comsuming terminal and pipe line between them are symbolized. Indicators are equipped on a designated position on the graphic panel so as to make flow, pressure, height and power, graphically visible (miniature-flat frame-moving iron type indicator; front dimension 72×144 mm).

For convenience of understanding the actual state of a pipe line and a power cable, symbolized pipes are arranged in miniature, according to actual size (transmittion lines are according to actual voltage), B and C gases are symbolized with painted colors, according to the kind of gas, moreover C gas distinguished further with a difinite color for "calorie before control" and another color to symbolize "calorie after control".

Major generating terminals and consuming terminals are symbolized, and the operating conditions are indicated by on and off flashes from lamps. Some lamps are connected directly with the measured point, but those that can not be connected directly are connected to the control switches at the control desk installed in the energy center. And also, individual operating conditions can be indicated clearly with the use of colored lamps, such as "normal", "reduced pressure", "boiler stop" for the blast furnace, and "preparation", "top blow start", "top blow stop" and "stop" for the converter.

(2) Measuring values receiving-recording panel

This panel is mounted together with recorders for steam, oxygen and power line. As the recorder, the electro-self balance type continuous recorder, having one or two pens, is used. And a wide 18 mm chart is used (model KES II–118 or KES II–218).

(3) Data logger

Data logger is not installed in this plant as yet, but is being made ready (this will be complete by November 1960). The logger to be installed is to be highly accurate and is going to be combined together with the previous daily making type and the alarm type.

Apparatus is arranged in the energy center as shown in Fig. 7, five supervisors (two men for gas) will be required to operate the control desk for each system. Operation indicating lamp control switches and interphone control switches are grouped on the left and right respectively on the cotrol desk of the front panel, and a hand-set microphone is set at the left side of the desk.

4) Telecommunication-ordering apparatus

For communications between the energy center and its related main equipment. One interphone (two for gas) is required per each system, oxygen and power system, main interphone is instabled at the energy center and is fixed on the control desk. The control desk is installed with a telecommunication ordering panel which can correspond with any of its five sub-interphone.

For telephoning, when main telephone calles sub-telephone, main telephone sends unit cycle signal sound (800 c/s) to the sub-telephone speaker. When the sub-telephone rings the main telephone, lamp and buzzer of the main telephone lights and rings. It is also possible for the main telephone to communicate with sub-telephones either individually or by communicating to all five of its sub-telephones simultaneously and uses the micro-telephone system. Sub-telephones can not communicate directly with each other. They must first psss through the main telephone and the system is known as the "press talk system".

This installation is also included with a non-power shortage power source of the inverter system, and is produced by FUJI TSUSHINKI SEIZO K.K.

VI. OTHER APPARATUS

1. Standard pulse generator (Master clock)

This apparatus is installed at the energy center, and sends standard pulses to all the clockes in the major installation at the Tobata Plant. It indicates accurate time, which is a accurate standard pulse oscillator based on crystal oscillator. The panel, 700(W)×400(D)×2,350(H), is mounted and equipped with all of its necessary apparatus, and is built in a metal-clad cubicle. The apparatus generates pulse per 1 sec, 30 sec, 15 mimetes and 1 hour. The generated pulse is sent to the chart round pulse clockes on the recorders in the energy center, and the clock mechanism of the data logger.

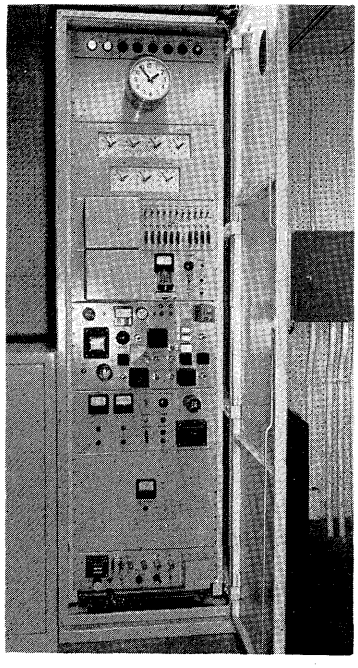

Fig. 12. Standard pulse generator

And alse, this apparatus is included with a DC source battery having a automatic floating battery charger, capable of operating for 24 hours, when and if the power is cut off.

2. Radio micro telephone apparatus

The merit of this apparatus is that the distance between each detecting transmitter and measuring values sending apparatus and measuring values receiving apparatus is extremely long. For maintenance and adjusting of these apparatus, mutual information must be carried out. Therefore, portable radio micro telephone apparatus were installed, these are FM modulation system having 0.5 W of output and equipped with a hand-set having an antenna and a spiral cord with a press talk button. The microphone and receiver are included in a box.

The above is an outline and an example in regards to an energy center. It is our belief that the applications of these equipment will be adopted more and more in various fields and aimed at factory supervision with the development of data logger, automatic computer and telemeter.