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FUJI PROGRAMMABLE SEQUENCER "PROGIC"

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I. SYNOPSIS

The Fuji " PROGIC " is an IC-circuited sequencer, applicable not only for auto-switching and/or auto-starting sequence control, but also for tool machine control. It consists of 5 different IC logic cards, and a cabinet with a console panel in front. The programming system, combining a jumper patch board with a diode matrixed pin-board, simplifies sequence control design techniques (*Fig. 1*).

II. SPECIFICATIONS

(1)	Programming	
	Input circuit :	Jumper patch board system
	Output circuit :	Diode matrixed pin-board system
(2)	Logic :	Negative logic circuit
(3)	Sequence step :	24 steps
(4)	Input :	Less than 24 dry contacts
(5)	Output :	Less than 12 transfer contacts of control relays typed HH52P
(6)	Built-in timers :	2 timers each having 3 seperate trimmers
		Trimming time : 0.3～3 seconds
		〃 1～12 seconds
		〃 5～60 seconds
(7)	Power source :	AC 100/200 V ±10%, 50/60 Hz
(8)	Ambient temperature :	0～50°C
(9)	Size :	352H × 286W × 307D (mm)

III. COMPOSITION

From functional point of view, " PROGIC " consists of 8 circuits. (*Fig. 2* and *Fig. 3*)

(1) Input coupling circuit (logic card " A ")
(2) Input programming circuit (logic card " B ", jumper patch board)
(3) Sequence step circuit (logic card " C ")
(4) Output programming circuit (logic card " D ", dioded matrixed pin-board)
(5) Common circuit (logic card " E ")
(6) Console panel (panel in front)
(7) Built-in timers (logic card " E " and 6 trimmers)
(8) Power source circuit
(9) Output relays

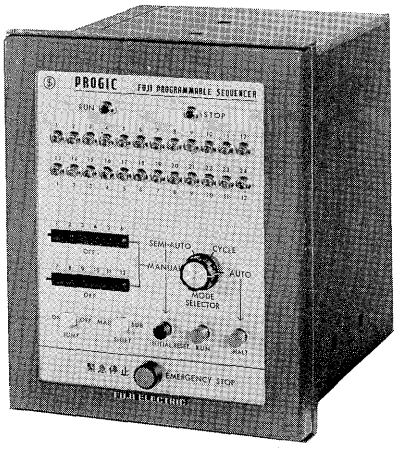

Fig. 1 Outerview of PROGIC

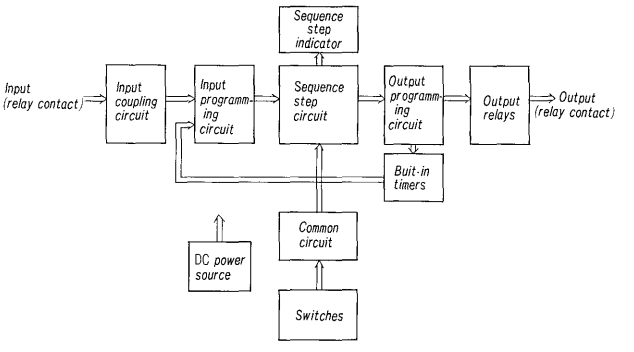

Fig. 2 Block diagram of PROGIC

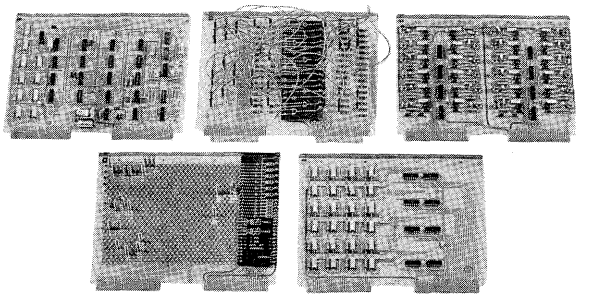

Fig. 3 Logic cards

IV. CIRCUIT IN DETAIL

Previously mentioned, the Fuji " PROGIC " is composed of 8 circuits. Influent contact signals are converted into IC-leveled logic signals, after being

Table 7 **Specifications of positioners**

Input signal and input resistance	4 to 20 mA DC and approx. 200Ω (at 20°C); 10 to 50 mA DC and approx. 55Ω (at 20°C)	
Types	Single acting type (ZLA1) for diaphragm valve	Double acting type (ZLA2) for operating cylinder
Output signal	0.2 to 1.0 kg/cm²	0 to 4……6 kg/cm²
	0.4 to 1.2 kg/cm²	
	0.4 to 2.0 kg/cm²	
Accuracy	under ±1%	under ±2%
Lift adjusting range	10 to 100 mm	30 to 90° (rotary angle)
Ambient temperature	−20 to 80°C	−10 to 60°C
Ambient humidity	under 95% RH	under 95% RH
Pressure of feed air	1.4±0.2 kg/em²	4 to 6 kg/cm²
	1.6±0.2 kg/em²	
	2.4±0.2 kg/em²	
Standard air consumption	27 Nl/min (at feeding pressure of 1.4 kg/cm²)	112 Nl/min (at feeding pressure of 5 kg/cm²)
Waterproof structure	All-weather type (JIS F 8001 class)	All weather type (JIS F 8001 class)
Explosionproof structure	Intrinsic safety, explosionproof structure	Intrinsic safety, explosionproof structure

There are many types of computing elements and devices with a permissible difference of ±0.25% can be used for all types of computing elements and converters.

4. Electro-pneumtic Positioners

The electro-pneumatic positioners are of the single acting type with operating pressures of up to 2 kg/cm² and the double acting type with operating pressure of up to 6 kg/cm² which employ large output operating cylinders. *Fig. 7* shows outerviews of positioners and *Table 7*, specifications respectively.

Both types of positioners for 4 to 20 mA DC are designed for intrinsically safe explosionproof construction and have passed official inspections. The input resistance for the 4 to 20 mA DC units is approximately 200 Ω and that for the 10 to 50 mA DC units is approximately 55 Ω. For each controller output, a maximum of three or four positioners can be connected.

filtered. 24 input signals, logically combined to each other by several AND, OR and NOT logic gates, are connected by jumper wirings, so that every sequence step is programmed to proceed by combinations of input conditions. This input programmable jumper patch system is one of the most remarkable characteristics of "PROGIC", since it dispenses with another sequence circuit.

Sequence step circuit, which is essential to those sequencers such as " PROGIC ", is a 24-staged ring counter each having its individual input gate. On the diode matrixed pin-board, output sequence program may be settled by simply screwing dioded pins into pin holes in order to fix relations between sequence steps and output signals. Output signals out of pin-board are amplified to energize control relays. Built-in timers are available to be set also on output program board, outputs of which are internally connected to the input program circuit, resulting in 24 inputs not to be wasted.

Common circuit consists of an initial reset circuit, a clock pulse generating circuit, a skipping circuit and other common circuits to control " PROGIC " generally.

A DC power source for IC circuits is supplied by the transistor-stabilized DC power source.

(1) Input coupling circuit

It consists of 24 amplifiers with C/R filtering elements which filter to delay input signals by 10 miliseconds when they turn on and by 30 miliseconds when they turn off (*Fig. 4*).

(2) Input programming circuit

It decides program how to proceed the sequence, in accordance with various status of input signals. It includes eight 2-input AND gates, four 2-input OR gates and four NOT gates, which are available to connect signals out of the input circuit to the sequence step circuit.

Fig. 5 illustrates an example in which the sequence steps from the first step to the second step, the instant the input of No. 2 turns on, by connecting the input terminal, No. 2, to the stepping terminal, No. 2, by means of a jumper wire. Since the sequence progresses in such an order as $1 \rightarrow 2 \rightarrow 3 \cdots\cdots$, the signal to proceed the step to 2, is not influential when the sequence step stays at 3.

In case where the sequence is expected to step from 2 to 3, as soon as both input signals 3 and 4 turn on, one of those sandwitched ANDs is available to program AND logic (illustrated as broken lines in *Fig. 5*). Symbols of these logic gates are printed on a sticker of the jumper patch board, which facilitates logical programming, using jumper wires tips on both ends. Moreover, the patch board mounts 2 tip-mouthes for each input terminal of the logic gates and of the sequence step counter. This means no other extra input signal is necessary, although a single input signal may be used in several logic gates (illustrated as the broken line C). As mentioned before, the outputs of the built-in timers internally connected to the identified terminals on the input programming board, they are utilized as the input signals. 4 out of 12 output signals are ready for feed-back use onto input programming board, while 4 signals may be transmitted to the output programming pin-board regardless of the sequence step.

Skipping of sequence is one of " PROGIC's " remarkable factors, the programming of which is also carried out on these programming boards.

(3) Sequence step circuit

The sequence step circuit of " PROGIC ", differing from other conventional counters, has 24 individual input gates for every stage of the counter. This prevents " PROGIC " from being forced to step by unfavorable noise pulses, because input signals including noises into another input gates does not influence the sequence stepping (*Fig. 6*). As a matter of course, outputs of whole steps of the counter not only are taken out to the output programming circuit, but also are utilized to turn one of 24 sequence step lamps on. The step counter is designed to be separable into two, each having 12 flip-flops. Accordingly, it is ready for use as two 12-step counters separately and as a 24-step counter combining them in series.

(4) Output programming circuit

It consists of a diode matrixed pin-board which fixes a pattern of output in every sequence step, and 12 amplifiers of output relays. As illustrated in *Fig. 7*, the output relays are energized at their

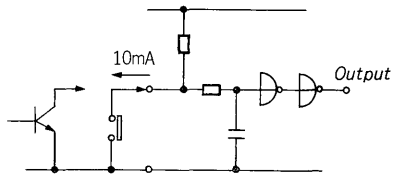

Fig. 4 Input coupling circuit

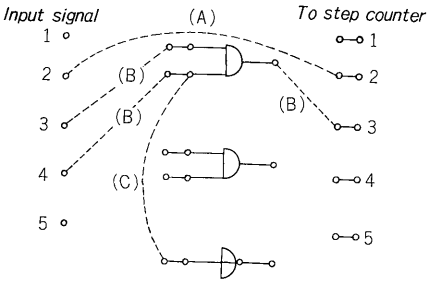

Fig. 5 Input programming circuit

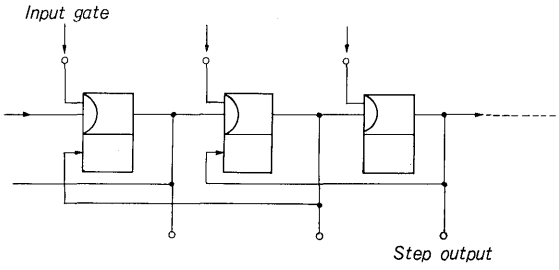

Fig. 6 Sequence step counter

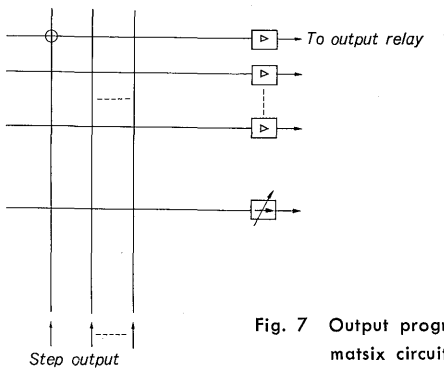

Fig. 7 Output programming matsix circuit

corresponding steps, by screwing dioded-pins at the cross points of step axes and output axes. It is possible to lock up output signals for specified 6 outputs out of 12, resulting that the output signals are forced to turn off by inserting pins into holes on the locking lines, even if there exist driving signals for output relays. In other words, it is possible to interlock output signals. In parallel with step axes, 4 axes are so conveniently prepared for use, into which the signals from input programming circuit are transmitted, that by setting pins at the cross points on these lines, the output signals are controllable, regardless of the sequence step itself. 6 axes are available on the same pin-board for deciding how to start built-in timers corresponding to the sequence steps, resulting in 6 different timer settings possible. Moreover, shuttling point of the sequence step is also ready to be set on this board, so that it is possible for the step to turn when no full use of 24 steps is necessary.

(5) Common circuit

It consists of an initial reset circuit, a clock pulse circuit, a skipping control circuit, a manual stepping circuit and other circuits concerning to operations of " PROGIC ".

(6) Console panel

On the upper part of front panel, 24 step lamps are mounted in order to indicate the stage of the sequence. Besides these lamps, there are a change-over switch of operation modes, a pair of start and stop push buttons, an initial reset button, an emergency stop push button and 12 manual control switches.

(7) Built-in timers

Two timers, based on charging and discharging characteristics of C/R, are built in, each having 3 individual trimmers for timer settings, 6 in total. They are a short range setting, 0.3～3 seconds, a medium range setting, 1～5 seconds, and a long range setting, 5～12 seconds. Fundamentally, these timers should be used alternately corresponding to every sequence step, since successive use of one timer in neighboring steps causes unfavorable errors in timer settings.

V. OPERATIONS

(1) Automatic operation

Depressing a start push button in " AUTO " mode of a change-over switch, the sequence repeats itself cyclically in accordance with a program arranged in advance. Depressing a stop push button, the sequence stops after returning to the first step.

(2) Cyclic operation

In " CYCLIC " mode of operation, the sequence stops automatically at the first step, after completing a cyclic operation, just same as the automatic operation.

(3) Semi-automatic operation

In " SEMI-AUTO " mode of operation, the sequence steps one by one by every depressing of a start push button. However, the output pattern in every step is valid as in the automatic mode.

(4) Manual operation

In " MAN " mode of operation, every output is manipulated by its corresponding control switch mounted on the console panel in front, regardless of the sequence step and the output program. In this case, the sequence step of " PROGIC " can be progressed by depressing the start button, which has nothing to do with output signals.

(5) Emergency stop operation

In any case of operation, depressing an emergency stop button, the sequence stops instantly and all of the output signals are basically turned-off except for the outputs particularly programmed not to be turned-off.

VI. APPLICATIONS

" PROGIC " may be applied to programmed sequence controls such as auto-switching of batch processes in various plants, rather than to logic sequence controls such as inventory control in warehouses. The machines and the processes, the sequence control of which may be adapted, are machine tool control, manipulating robot control, injection machine control of plastics, press control, various sequence controls in water plants and batch process controls in chemical plants. Compared with the conventional sequence design using relays and timers, it is easy to build up and to revise any kind of sequence control in " PROGIC ", and moreover, it is remarkable that no special techniques in programming is requested, since combination of input and output programming boards makes the seqnence control design intuitively. Though the number of inputs, outputs and sequence steps of " PROGIC " is limited in a standard model, expansions in inputs, outputs and/or sequence steps are possible, which enables "PROGIC" to widen its range of application.