

TECHNICAL TENDENCY OF CONTROL APPARATUS AND NEWLY DEVELOPED PRODUCTS

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1 FOREWORD

Automation, FAation, and OAation of various industries, facilities, and apparatus is noticeable, and the demand for control apparatus meeting this trend is expanding. The state of production of control apparatus in Japan is shown in Fig. 1. Despite stagnation of the economical environment in the past several years, control apparatus have shown a high growth and can be called a field in which continuous high growth is expected in the future.

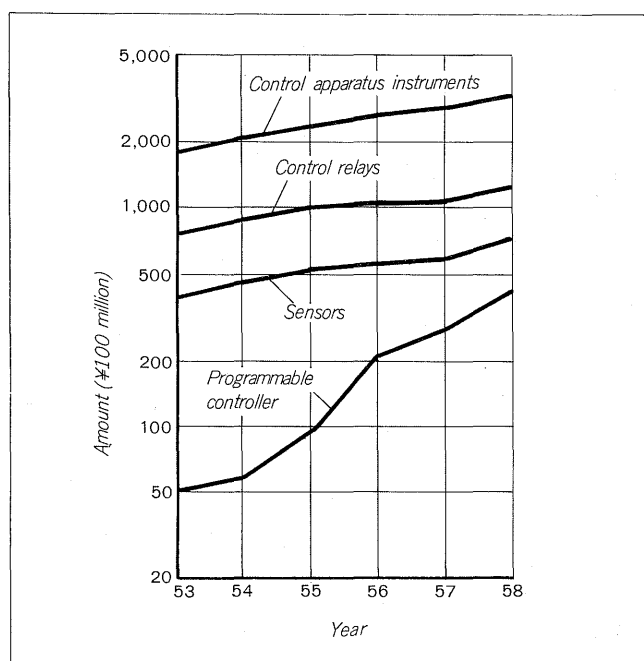
Recently, the introduction of microcomputers or IC-applied microelectronics in various electric apparatus or facilities, including control apparatus, has advanced and miniaturization and functionalization of apparatus and devices, as well as computerization of systems, is progressing. This situation is reflected most, and a noticeable change is taking place, in the FA, OA, and information related fields. Electronicization and MEization of apparatus

and devices used in these fields are the prime movers behind the technological revolution and expansion of the market. Control apparatus is playing an important role in automation and high functionalization as the main type of apparatus even in this field.

Control apparatus and a general-purpose control system comprised of them are shown in Fig. 2.

The control system consists of command apparatus or sensors as the input section, fixed program type relays, timers and variable program type programmable controller and program timers as the operation and control section, relays and displays as the output section, and magnetic contactors and solid state contactor as the load drive section, and multiplex transmission apparatus for various signal transmission, and other control apparatus. Because these control apparatus are interrelated, matching between various apparatus is featured. Besides, high reliability, high functions, small size, or low price is demanded of each. From this, Fuji Electric has taken the actual situation into account and undertaken development of new products based on a consistent design concept of development of apparatus for the market which uses it.

Fig. 1 Transition of control apparatus (Japan)

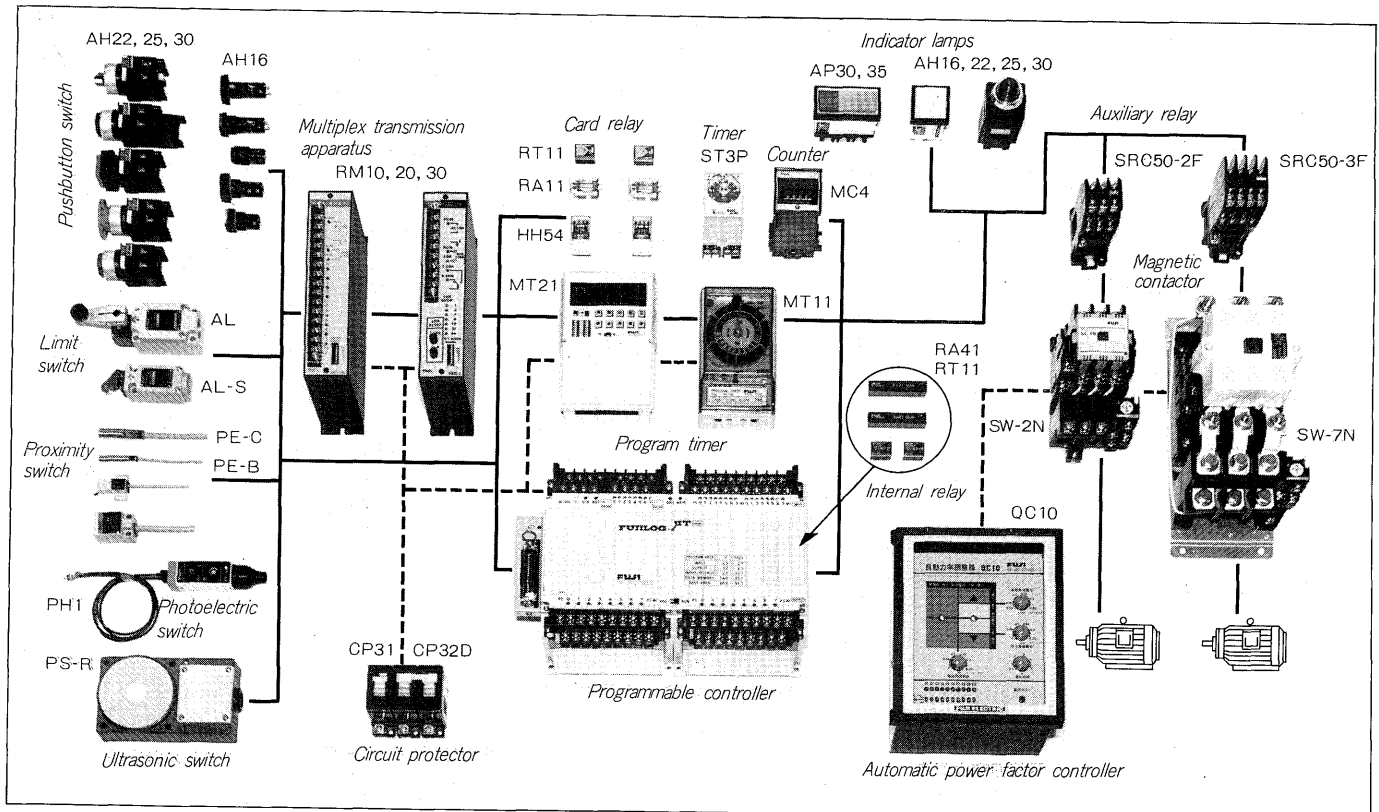


2 TECHNICAL TENDENCY OF CONTROL APPARATUS

The technical tendency of control apparatus is represented by detection devices which have been noticeably MEized or programmable controller, etc. That is, high functionalization, miniaturization, high reliabilityization, and price reduction by the application of microprocessors, ICs, etc. are necessary and the technical trends of control apparatus are:

- (1) System oriented
Matching of specifications with related apparatus in the system used.
- (2) High reliability
High operation of contact reliability. Besides the protection level needed in use.
- (3) High functions
Apparatus provided with numerous functions suited for use by MEization.
- (4) Small size, light weight

Fig. 2 General purpose control system and control apparatus



So called, light, thin, short, and small.

(5) Excellent operability and safety

Ease of handling at the user side further improvement of efficiency from the standpoints of production and transport distribution by the use of modularized block construction, etc.

(6) Resources saving, energy saving

Low power consumption and effective load operation should be possible.

Fuji control apparatus is developed with items such as the above as the common basic concept and development of products which can contribute to total value engineering (VE) of customers who use them as a result is our aim.

As a method of realizing such contents suitable electronic correspondence of various control apparatus is an important point in product development. Electronicization corresponds has the following modes:

- Electronicization and MEization of the entire apparatus.
- Electronicization and MEization of only part of the apparatus.
- Matching to the specifications of other electronicized apparatus.

The types of electronicization of apparatus like this are diverse. However, regarding the individual apparatus those which are electronicized or those which have mechanical contacts, in either case, are a total unit and matching of specifications among related apparatus in the system must be provided and conditions which enable improvement of the overall functions and the securing of reliability as a system must be satisfied.

From the standpoint of electronicization correspondence, regarding control apparatus with a contact switching mechanism, the main technical conditions of control apparatus are:

- (1) The switching contacts must have ample switching reliability even at switching of low-level currents.
- (2) Suitable withstand capacity against surges, noise etc. must be provided.
- (3) Operating voltage (current) range must be amply wide. moreover, power consumption must be low and operating characteristics suitable for a DC voltage control circuit system and other specifications must be provided.
- (4) Suitable environment resistance, superior protection level (IP construction etc.), etc. must be provided, and total operation reliability must be high.

3 DEVELOPMENT AIMS OF EACH NEW PRODUCT AND SPECIFICATION POINTS

New products recently developed by Fuji Electric are products developed by conscientiously studying and grasping market trends and technical trends, and we are confident that they amply meet the evaluation of consumers regarding specifications, performance, construction, etc.

Moreover, the side which provides diverse models and specifications so as to meet the needs of the diversifying market and, at the same time, manufactures them gropes with modularized product composition and considers the

design which allows manufacture based on the most effective production system. The points which should be specially mentioned are described below by type of apparatus.

3.1 Pushbutton switch, limit switch, and proximity switch

3.1.1 Pushbutton switch

The international standards (IEC) mounting dimensions product $\phi 22$ series has been newly added and, together with the $\phi 16$, $\phi 25$, and $\phi 30$ series already on sale, an abundant line up of models has been completed as pushbutton switch mechanisms for apparatus operation so that diverse needs can be amply met. The new $\phi 22$ series is provided with the following features, from the specifications standpoint, and meets diverse needs to the highest degree and will be the central type of Fuji pushbutton switch in the future. It has a beautiful design and variations in abundant specifications and is also widely used in office machines and other indoor facilities apparatus, etc.

- (1) Perfect water resistance and oil resistance by high sealing characteristic packing construction.
- (2) High contact reliability (failure rate about 10^{-8} at low level load switching 5V, 5mA) by the adoption of special sliding contacts.
- (3) Small size, space saving
- (4) Safe construction with the terminal section shielded by live parts cover.

However, its special feature is in product composition. Pushbutton switch, selector switch, indicator lamp, and other basic types can be combined from the standpoint of operating system, button color, shape, contact configuration, transformer voltage, and other specifications, and apparatus of the desired specifications is assembled by selection and screwless snap fit installation of the necessary items from the operation section, contact section, and transformer basic variations. This is a unique design structure which incorporates modularization of component elements and block-buildingization of products to a high degree. This is said to be a product structure in which the maintenance of a conformity system from the standpoint of delivery is considered for diverse variations of product specifications which are ordered from the customer.

The announcement and period of the $\phi 22$ series were made one and an LED indicator lamp series was added to all series of Fuji Electric pushbutton switches. A brightness equalizing that of the incandescent bulb was realized by connecting high brightness LED chips in series.

3.1.2 Limit switch

Limit switches are familiar as detection apparatus for position control of machines, but there are very few high performance limit switches which can maintain high precision and high reliability in use over a long period when the usage conditions are severe. The new type limit switch type AL (JIS dimensions) and type AL-S (small type) announced by Fuji Electric this time are new products which are matched difficult technical problems which are currently demanded of limit switches for machine control to a high degree.

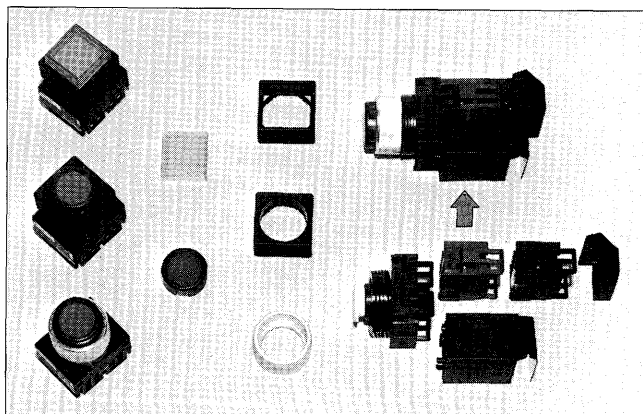
Their main features are:

- (1) Adoption of double seal construction provides superb oil resistance and sludge resistance, and ample operation position precision and high reliability are maintained for a long time under severe usage conditions.
- (2) Output contacts have a high contact reliability (failure rate approximately 10^{-8} at 5V, 2~10mA load switching) which allows direct input to low level electronic circuits.
- (3) From the standpoint of safety in machine control, a mechanism which forcefully separates the fused contacts when the switching mechanism is reversed if the contacts should be fused together is provided. West German VDE standards contain a standard related to this forced separation mechanism for power switches for machine control, etc., and it is also becoming a technical condition of application of this type in Europe.

3.1.3 Proximity switch

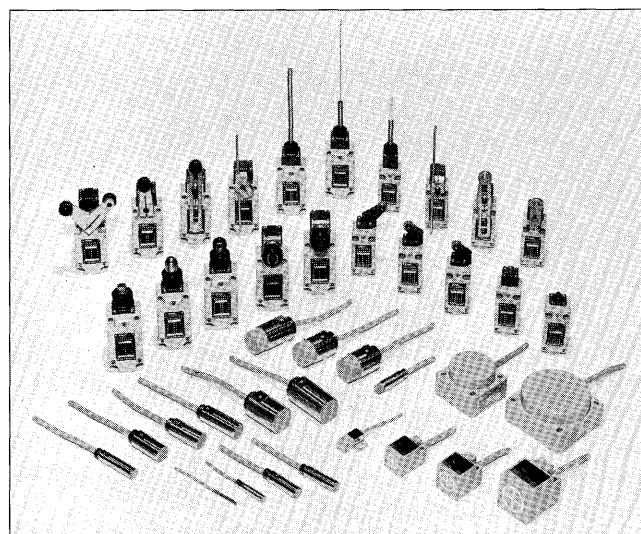
Many proximity switches are used with various automatic machines, automation facilities, etc. as the most

Fig. 3 Block modularized $\phi 22$ pushbutton switch



SK-424

Fig. 4 Detection apparatus (limit switch, proximity switch)



SK-423

common type of contactless position sensor, and their importance is steadily increasing with the growth and popularity of mechatronics. At the same time, the technical demand for miniaturization and high functionalization is becoming stronger. Fuji Electric has developed a new series of cylinder type and square type proximity switches which completely change the conventional type. These new type proximity switches have been made exhaustively lighter, thinner, shorter, and smaller and use dedicated IC. The entire circuit, including the IC chip, is accommodated on a hybrid IC to achieve a characteristic functionalization.

- (1) Abundant types. Types covering DC 2-wire system, shielded type, unshielded type, subminiature type, wide range detection distance, etc. and ease of use have been serialized.
- (2) Especially, the miniature type ($\phi 4$ or M5 mounting) is a built-in amp type which is perfect for position detection in narrow places as a position sensor for robots, etc.
- (3) Wide usage power supply voltage range. The same product can be used over a wide range of voltages from 12 to 24V for DC and 100~200V class for AC.
- (4) All types are equipped with an operation indicator lamp.

3.2 Card relay, timer

3.2.1 Low capacitance type card relay

Small card relays are used in control systems containing electronic control circuits as the interface between the electronic control circuit (logic) and high voltage circuit at the output side for isolation and control between the two circuits. Long life, small size, low power consumption, high reliability, etc. are essential conditions of the card relay used in this application. Furthermore, as a condition which should be considered, it is necessary to recognize that the value of the inherent electrostatic capacitance which exists between the relay coil and contacts has a large affect on the reliability of the control system.

That is, noise and surges generated at the high voltage circuit enter the electronic circuit through the coupling capacitance with the high voltage circuit and electronic control (logic) circuit and obstruct its functions in various ways. Consideration from the standpoint of printed circuit board pattern spacing, the use of shielded wire and other circuit considerations are necessary and at the same time, attention should also be focussed on the importance of minimizing the coupling capacitance between the coil and contacts of the card relay used.

Fuji Electric is proceeding with research aimed at the development of a card relay which does not obstruct the electronic circuit even if 1500~2000V level noise and surges enter, and has commercialized the type RA41 low capacitance card relay which has a coil-contact coupling capacitance of 1pF or less.

3.2.2 Super timer

Timers are used as the main of equipment in general

purpose control systems. In the past, motor timers using the isochronism of a motor were the main-stream and electronic timers using a CR circuit were used at some parts.

However, motor timers have disadvantages, such as limited precision, they are affected by frequency, the manufacture of short time rated products is difficult, they cannot be used in DC operation circuits, etc. Besides, since CR type electronic timers can only be manufactured for time limits of 3 minutes or less, they have such disadvantages as that they can only be used in some applications, etc.

The super timer uses a CR oscillation counting system dedicated IC as an electronic timer and was the first timer series having numerous new features as a high precision timer which eliminated the defects of conitional timers to be developed in Japan.

The standard series is compatible with conventional timers and is suitable for high precision and high frequency use and is a multirange type which can be used up to 4~8 standards at the conventional one standard by switching an external switch.

In addition, since it has various features, besides ease of use, from the standpoint of high precision and high functions as a general purpose timer, its expansion into the timer market is noticeable.

Besides the standard series (ST3), there is a small size series (ST6) and economical type series (ST5). Types with functions grouped by application are available with each series.

3.2.3 Program timer

The program timer is effective in automating load operation or in energy-saving.

A series of systems using a motor as the driver source and a quartz motor as a high precision type have been available as program timers, but recently high precision and high function products using a microcomputer have been developed as an electronic type.

Fuji Electric is developing types of each series. This time we have developed a high functions and inexpensive general purpose program timer with a built-in microcomputer and two circuit output which allows programming for one week as the type MT21. It is also small and can also be accommodated in a distribution panel. The high quality MT80 is available as an electronic type. This product has 8 circuits and 3 patterns in 24 steps, and is a high function product which allows load setting by day or input from various sensors, etc.

3.3 Circuit protectors for control circuit protection

In the past, plug type fuses were exclusively used as overcurrent protectors for the control system circuits of various apparatus. However, the high functionalization and sophistication of equipment has been accompanied by a strengthening of the trend toward maintenance-saving and there are many cases where a circuit protector also provided with a switching function which can repeatedly trip over-

currents is used. Fuji Electric has commercialized the types CP31 and 32 circuit breakers with excellent operability and protection characteristics to meet this technical trend.

The protection characteristic of circuit protectors resembles that of circuit breakers for wiring. Technologically, they are manufactured to conform to small type circuit breakers for wiring. In control circuits, besides electric circuit protection, there are cases where they are also used for apparatus protection of small motor and solenoids, etc. Besides, they are also used to protect semiconductor elements in the limited overcurrent region range. Of course, since one step is not yielded to the current limiting fuse as overcurrent tripping characteristic, when protection of semiconductor elements is performed, when a noticeable current limiting tripping characteristic is necessary, it must be used with a current limiting fuse for semiconductor protection.

3.4 Automatic power factor controller

The automatic power factor controller types QC10 and QC02 were developed as one control apparatus for energy saving. This equipment is provided with a capacitor tripping function at light loads, and can perform appropriate power factor control in the general load region. The purpose of the automatic power factor controller is to save energy by controlling reactive power. As with past systems, equipment with a function which only inserts the capacitor at lagging power factor becomes a leading power factor at night, on holidays, and other light loads and generate leading reactive power and the load end voltage tends to become an overvoltage, and is otherwise undesirable.

Taking suitable leading power factor countermeasures is extremely important to both the consumer and power company. The new type automatic power factor controller was developed along such lines.

The type QC02 was developed cooperatively with the Tokyo Electric Power Co., Ltd. and is provided with two bank control output for medium and small consumers. The type AC10 permits sequential switching control of up to 10 banks of capacitors. The connected capacitors are cyclically sequentially controlled. For example, for 6 bank connection, since operation is performed by skipping the output circuits of the 4 banks not used, an objectionable response delay is not produced.

4 CONCLUSION

The recent technical trend of control apparatus and newly developed products were outlined above. The scale of the market in the control apparatus field is becoming larger with the automation, FMS application, etc. of facilities. Besides, as a result of the noticeable high functionalization and higher precision of the apparatus itself due to the development of electronic technology, production technology, etc., the demand for control apparatus, including programmable controllers, is increasing.

Since Fuji Electric will continue to introduce market needs and develop new technology in the future and is conducting research and development on control apparatus, the guidance of consumers and readers in the future is requested.