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# FUJI STANDARD SILICON CONTROLLED RECTIFIER CELL

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## I. PREFACE

Our company, after conducting manufacturing development research on silicon controlled rectifier cells, has completed a cell that is comparable in efficiency to the well-known Fuji silicon rectifier elements; serialization according to capacity has been completed and mass-production already started. Experiments on this cell's application to various equipment and devices have been conducted at our factories; for its wider application, the single controlled rectifier cells have been placed on the market.

The authors of this article have selected as their theme the introduction of the useful characteristics of Fuji Silicon Controlled Rectifier Cells. Therefore, its working principle, manufacturing techniques and general features have only been touched upon lightly, but the practical data (cell's ratings, characteristics, testing method and breakdown limit test, etc.) will be described in detail.

The silicon controlled rectifier cell, as a *PNPN* four-layer device, is made either by diffusion-alloy method or double diffusion method; the Fuji cell, however, is manufactured by the diffusion-alloy method. The cell construction, as shown in *Fig. 1*, the anode (*P* layer) of the four-layer device is on the stud side and the cathode (*N* layer) is on the lead side; the gate is attached to the *P* layer that is adjacent to the cathode and together with the cathode is led out through a glass bushing. Fuji SCR series, as shown in *Fig. 2*, is composed of cells of six different external shapes; these are designated, starting with the smallest, as GSi 5, GSi 7,

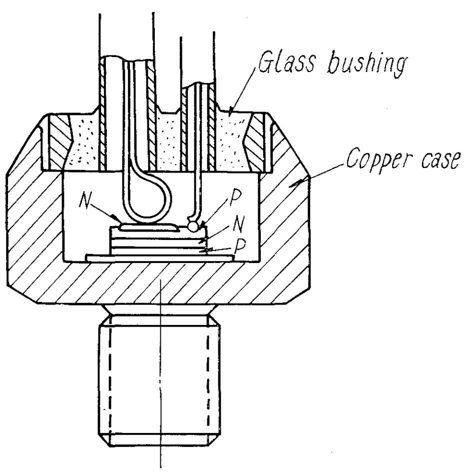



*Fig. 1* Construction of Fuji SCR GSi 12

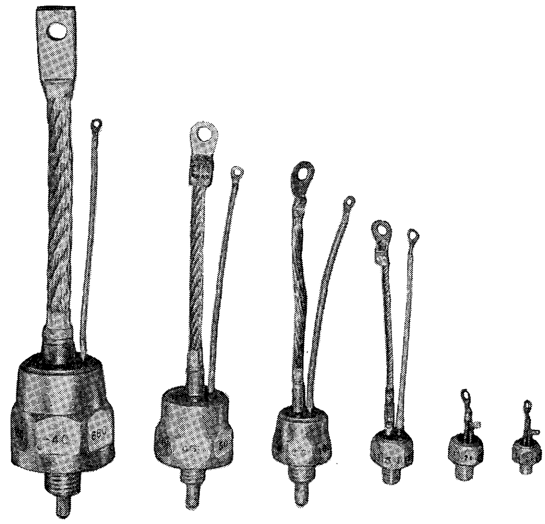


*Fig. 2* Fuji SCR series

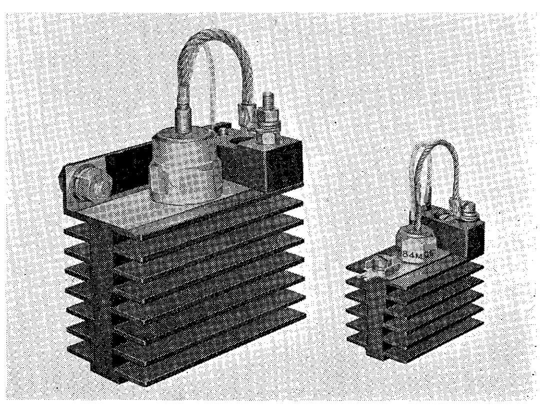


*Fig. 3* Fuji SCR GSi 50 and GSi 12 with cooling fins

GSi 12, GSi 25, GSi 50 and GSi 150. *Fig. 3* shows the external views of Fuji SCR with standard cooling fins. SCR with peak forward voltage of up to 600 v are available ; no other manufacturer, in Japan, has so many kinds of high efficiency silicon controlled rectifier cells in stock at all times. The performance of Fuji cells will be described below.

## II. RATINGS

As the basis for rating semi-conductors is not standardized because of the different uses of the semi-conductors in electronic and high power equipment and the different view points of the makers and users, rating methods are inter-mixed. I.E.C gives the following three methods for rating semi-conductors:

(1) Absolute maximum rating system
(2) Design center rating system
(3) Design maximum rating system

The reason for this is that the application of semi-conductor devices is so wide and the working conditions and reliability, etc., so varied that it is difficult to standardize the normal working values like those of ordinary equipment.

The absolute maximum rating system of (1) above is to indicate the capacity limit ; the design maximum rating system determines the useful limit. According to IEC, when semi-conductors are rated by (1), the responsibility regarding their application is on the user's side ; in the case of (3), the responsibility is with the manufacturer provided the application condition does not exceed the application limit under steady and transient conditions. The design center rating of (2) is the working values under practical application : values for which the deviation of input voltage, output current, ambient temperature and other conditions has been taken into consideration ; values that correspond to the ratings on the name plate of the equipment into which SCR is attached. Since these vary according to application and are difficult to standardize, I.E.C keeps these for inter-company use.

The values shown on Fuji SCR characteristics table are based on the design maximum rating system. The *Table 1* refers to the voltages ; repetitive peak forward voltage, repetitive peak reverse voltage and reverse surge breakdown voltage are all based on the design maximum rating. Therefore, during operations, these voltages must not exceed the values indicated.

However, it is not practical to assume or actually measure the transient surge voltages and determine the cells accordingly. On the other hand, if a cell can be selected on the basis of a value several times larger than the normal working voltage can be, it is more convenient in practice. Based on this idea, the normal working a-c input voltage of the popular phase control rectifier has been given, as a rated a-c voltage (r. m. s.), to the cell's voltage ratings.

Groupings of voltage ratings as shown in *Table 1* will be explained using the cell with a repetitive peak forward voltage of 400 v as an example. The rated a-c voltage (r. m. s.) of this voltage class is 220 v.

If the voltage deviation is assumed to be +10%, the peak value of repetitive forward voltage becomes

$$\sqrt{2} \times 220 \times 1.1 = 342 \text{ v}$$

and since the repetitive forward voltage is 400 v, it is 1.17 times the peak value. This margin of 17 % is for wave form distortion and commutating oscillation, etc. When an external surge that is impressed in the cell's forward direction reaches a certain value higher than 400 v, a breakover occurs as a matter of course. A breakover is not a permanent collapse of the cell ; it is, as shown in *Fig. 4,* merely a contol phase angle deviation for only one pulse of a rectifier with phase control and its effect can be ignored in most cases. However, if the breakdown is due to a surge voltage impressed in the reverse direction of

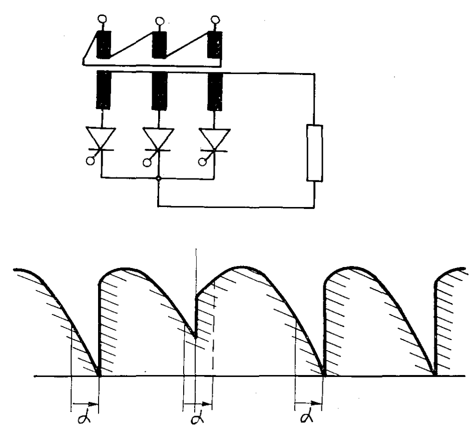



*Fig. 4* One pulse breakover wave form due to transient surge voltage in phase control rectifier

*Table 1* Fuji SCR voltage ratings

| Voltage class symbol | | −2 | −5 | −10 | −15 | −20 | −25 | −30 | −40 | −50 | −60 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Repetitive forward peak voltage | (v) | 25 | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 |
| Repetitive reverse peak voltage | (v) | 38 | 75 | 150 | 225 | 300 | 375 | 450 | 600 | 750 | 900 |
| Transient reverse surge voltage | (v) | >220 | >220 | >220 | >330 | >440 | >550 | >660 | >880 | >1100 | >1320 |
| A-c input voltage | (v) | 14 | 28 | 55 | 85 | 110 | 140 | 165 | 220 | 280 | 330 |

the cell, a permanent collapse occurs. Consequently, a cell must withstand a reverse surge voltage that can be considered to be reasonable from the standpoint of the rated a-c voltage.

Our company has been advancing the theory that if a voltage 2.5 times larger than the normal working voltage is taken as the surge voltage, it would be conciliatory in equipment designing. We have produced many silicon rectifier devices on this idea, justified many times in actual operation. If the surge voltage of a circuit with an effective voltage of 200 v is computed in the same way, the following is obtained :

$$2.5 \times 342 = 855$$

Consequently, the surge breakdown voltage for this voltage class has been set at 880 v. This is very different from other manufacturer's method of determining the forward and reverse voltage.

When SCR is used in other applications such as a relay or inverter, an on-state condition in its forward direction is mis-operative and cannot be permitted. A rated a-c voltage must be determined separately, case by case.

Next, for the cell's current capacity : an abnormal current difficult to predict is non-existent as long as the condition at the time of current flow is shown. At present, there are two methods of determining the current capacity. One is by maintaining the cell's case temperature at 25°C and the other is by keeping an ambient temperature of 40°C or 50°C in the cell by means of cooling fins. The current capacity of Fuji cells is indicated by the values obtained by both of the above methods. The first is Japan Electronic Industries Association's standard method which is a maximum rating and the second is the method which we have been applying to silicon rectifier cells and is a design center rating. Consequently, with the current value of the second method, after continuous current flow at that value, short interval overcurrent is added along the capacity curve. *Table 2* shows the current ratings and characteristic of Fuji SCR. Semi-conductor devices are required to be registered with the Electronic Industries Association ; a comparison of Fuji SCR registered numbers and the characteristics of each type is shown in *Table 3*.

## III. CHARACTERISTICS

The characteristics of GSi 5∼GSi 150 types are shown in *Table 2*. A continuous allowable watt loss, as shown in the table, means a forward loss due to the cell's internal forward voltage drop, determined by the cell forward current value and its wave form ; for GSi 150, for example, this becomes as shown in *Fig. 6*. One-cycle surge current is the peak value of a sinusoidal half-wave, only one to the cell. An $I^2t$ limit value is the value related to the short duration allowable generating total thermal energy which is determined by the cell's permissible temperature limit and thermal capacity of the semiconductor tablet itself to indicate a permissible overload of short duration which is shorter than a sinusoidal half wave, computed in the form of $\int i_2\, dt$, expressed in the units of $A^2S$. This can be used, especially, as a comparison index of coordination with fuses.

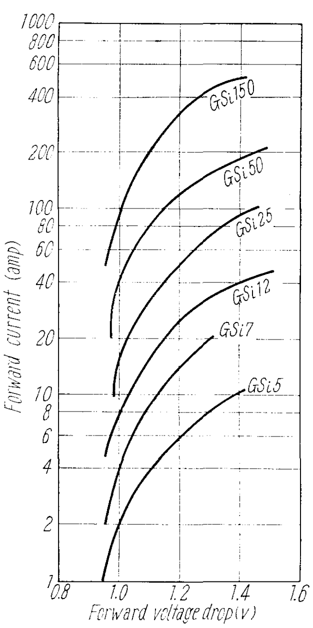
The holding current shows a large standard value. The rated current limit is set at approximately four times this value. The gate firing voltage indicates a

**Table 2 Fuji SCR characteristics and current ratings**

| Type | | GSi 5 | GSi 7 | GSi 12 | GSi 25 | GSi 50 | GSi 150 |
|---|---|---|---|---|---|---|---|
| Mean forward current (amp) | When case temperature is held at 25°C | 8 | 12 | 16 | 40 | 80 | 150 |
| | With standard fins. Ambient temperature 50°C | 3 | 5 | 7.5 | 15 | 25 (50) | 50 (100) |
| Allowable continuous loss (w) ( ) air cooled. With standard fins. Ambient temperature (50°C) | | 5 | 8 | 12 | 23 | 37 (85) | 70 (150) |
| One cycle surge current (amp) | | 60 | 140 | 320 | 600 | 1000 | 2000 |
| $I^2t$ limit value ($A^2S$) $I^2t$ ($A^2S$) | | 12 | 70 | 360 | 1300 | 3500 | 14,000 |
| Thermal resistance between junction and case °C/w | | 3.0 | 1.8 | 1.2 | 1.0 | 0.5 | 0.3 |
| Standard holding current (ma) | | 8 | 10 | 10 | 15 | 20 | 25 |
| Gate firing voltage (v) | | < 3 | < 3 | < 3 | < 3 | < 5 | < 5 |
| Gate firing current (ma) | | <80 | <80 | <80 | <80 | <80 | <80 |
| Turn-on time (μsec) | | 1∼2 | | | | | |
| Turn-off time (μsec) | | 6∼10 | | | | | |
| Storage temperature (°C) | | −40∼150 | | | | | |
| Operating temperature (°C) | | −40∼120 | | | | | |

***Table 3*** **Comparison of Fuji SCR types and types with Electrical Industries Association of Japan**

| Fuji type | CES registered | Fuji type | CES registered | Fuji type | CES registered |
|---|---|---|---|---|---|
| GSi 5– 2 | 2 SF 140 | GSi 12– 2 | 2 SF 160 | GSi 50– 2 | 2 SF 180 |
| GSi 5– 5 | 2 SF 141 | GSi 12– 5 | 2 SF 161 | GSi 50– 5 | 2 SF 181 |
| GSi 5–10 | 2 SF 142 | GSi 12–10 | 2 SF 162 | GSi 50–10 | 2 SF 182 |
| GSi 5–15 | 2 SF 143 | GSi 12–15 | 2 SF 163 | GSi 50–15 | 2 SF 183 |
| GSi 5–20 | 2 SF 144 | GSi 12–20 | 2 SF 164 | GSi 50–20 | 2 SF 184 |
| GSi 5–25 | 2 SF 145 | GSi 12–25 | 2 SF 165 | GSi 50–25 | 2 SF 185 |
| GSi 5–30 | 2 SF 146 | GSi 12–30 | 2 SF 166 | GSi 50–30 | 2 SF 186 |
| GSi 5–40 | 2 SF 147 | GSi 12–40 | 2 SF 167 | GSi 50–40 | 2 SF 187 |
| GSi 5–50 | 2 SF 148 | GSi 12–50 | 2 SF 168 | GSi 50–50 | 2 SF 188 |
| GSi 5–60 | 2 SF 149 | GSi 12–60 | 2 SF 169 | GSi 50–60 | 2 SF 189 |
| GSi 7– 2 | 2 SF 150 | GSi 25– 2 | 2 SF 170 | GSi 150– 2 | 2 SF 190 |
| GSi 7– 5 | 2 SF 151 | GSi 25– 5 | 2 SF 171 | GSi 150– 5 | 2 SF 191 |
| GSi 7–10 | 2 SF 152 | GSi 25–10 | 2 SF 172 | GSi 150–10 | 2 SF 192 |
| GSi 7–15 | 2 SF 153 | GSi 25–15 | 2 SF 173 | GSi 150–15 | 2 SF 193 |
| GSi 7–20 | 2 SF 154 | SGi 25–20 | 2 SF 174 | GSi 150–20 | 2 SF 194 |
| GSi 7–25 | 2 SF 155 | GSi 25–25 | 2 SF 175 | GSi 150–25 | 2 SF 195 |
| GSi 7–30 | 2 SF 156 | GSi 25–30 | 2 SF 176 | GSi 150–30 | 2 SF 196 |
| GSi 7–40 | 2 SF 157 | GSi 25–40 | 2 SF 177 | GSi 150–40 | 2 SF 197 |
| GSi 7–50 | 2 SF 158 | GSi 25–50 | 2 SF 178 | GSi 150–50 | 2 SF 198 |
| GSi 7–60 | 2 SF 159 | GSi 25–60 | 2 SF 179 | GSi 150–60 | 2 SF 199 |



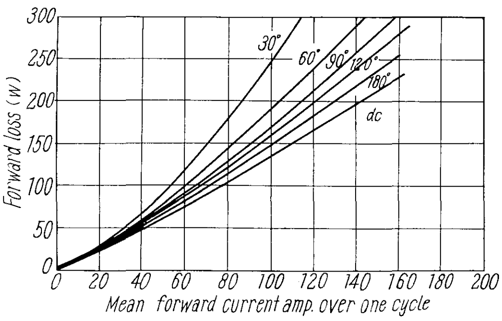




*Fig. 6* **Forward loss by rectangular wave current for GSi 150**

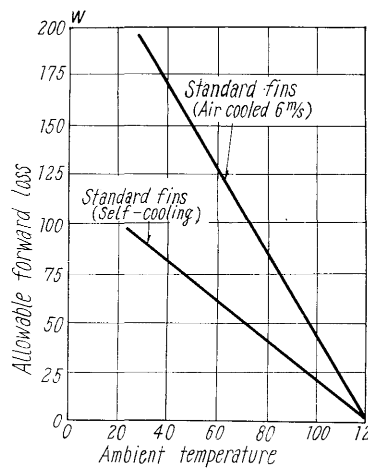



*Fig. 5* **Forward on-state characteristics (Junction temperature 120°C)**

*Fig. 7* **Ambient temperature and allowable forward loss for GSi 150**

voltage at which all cells can fire and the limit at which all cells do not fire without fail is 0.25 v. This value is the noise voltage permissible in the gate circuit and is determined at the cell temperature of $-10\sim120°C$. The cell's forward on-state characteristics are shown in *Fig. 5.* The forward voltage drop is greater than that of a simple silicon rectifier cell; its allowable mean forward current changes according to the wave form ratio. This is illustrated in the figure using GSi 150 as an example. *Fig. 6* shows the relationship between the forward current and forward watt loss; *Fig. 7* shows the relationship between the ambient temperature and allowable forward watt loss.

## IV. ROUTINE TEST METHOD

Because many semiconductor devices are new, the testing method (especially for SCR) used by the manufacturers is not standardized. The standard testing method for silicon rectifier diodes and silicon controlled rectifiers is being deliberated by Japan

Electric Machine Industry Association and Japan Electrical Committee. Since the characteristics of a cell are affected by the testing method, our testing method will be described.

The test includes a type test to ascertain the collapse limit and a routine test that covers all phases; it is the same in the case of a selenium rectifier element or silicon rectifier element. Out of the test items covered in a routine test, these will be described in detail:

(1) Forward voltage drop test
(2) Rated reverse peak voltage test
(3) Rated forward peak voltage test
(4) Break-over voltage measurement
(5) Gate firing characteristic measurement
(6) Holding current measurement

## 1. Forward Voltage Drop Test

There are three test methods: a method in which a sinusoidal half-wave current of commercial frequency is passed through a cell and the forward voltage drop (mean value) is measured over one complete cycle with a meter; a method in which the same current is passed and the forward voltage drop (instantaneous peak value) is measured with an oscilloscope; a method in which direct current is passed and the forward voltage drop (dc) is measured. Our company, with consideration on the problem of forward current wave form distortion and measuring accuracy, is using the circuit shown in *Fig. 8* as an all-figure testing method because of its simplicity and dependability.

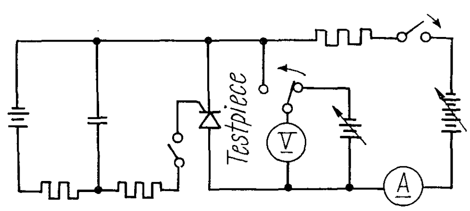



*Fig. 8* Measuring circuit for forward voltage drop (dc method)

## 2. Rated Reverse Peak Voltage Test

A sinusoidal half-wave voltage of commercial frequency is impressed on a cell and the mean reverse leakage current is measured to determine rated repetitive reverse peak voltage. The test is performed at a case temperature of 20°C and 120°C. For measuring the leakage current, there is a method in which a cathode ray oscilloscope is used to measure the peak value but because of the measurement accuracy and ease of re-forming the test circuit, meters are used in routine testing. The repetitive reverse voltage measuring circuit is shown in *Fig. 9*.

## 3. Rated Forward Peak Voltage Test

The characteristic measuring by a repetitive forward voltage is performed using practically the same measuring circuit as in (1.) above (*Fig. 10*). The rated forward peak voltage is determined by the forward leakage current measurement. The test is performed with a case temperature of 20°C and 120°C. During a leakage current measurement, a breakover may occur even before a predetermined forward leakage current value is reached; for this reason, the ammeter inserted in the circuit to measure the leakage current requires protection. Contacts $K_1$ are relay connections for that purpose.

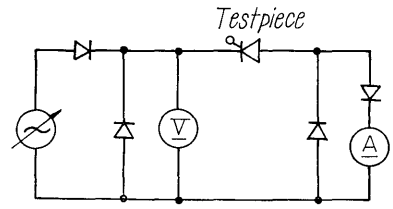



*Fig. 9* Measuring circuit for repetitive reverse voltage

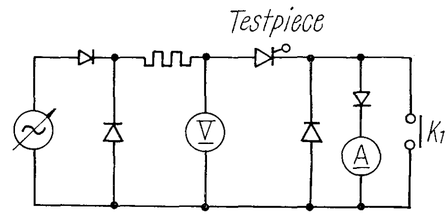



*Fig. 10* Measuring circuit for repetitive forward voltage (also measures breakover voltage)

## 4. Breakover Voltage Test

The breakover voltage is tested by raising gradually the test voltage of the circuit of *Fig. 10* and the voltage read just before it reaches breakover. The cell case temperature at which the test is performed is 20°C and 120°C.

## 5. Gate Firing Characteristics Measurement

This measurement is made using the circuit of *Fig. 11*. D-c voltage is used for the anode and cathode voltage and gate voltage. Firing characteristic is measured with a voltage of 5 v applied between the anode and cathode.

## 6. Holding Current

For measuring the holding current, a reading is made of the forward current of the cell (which is still in on-state after the gate firing characteristic measurement using the circuit of *Fig. 11*) is lowered gradually by lowering the power supply shown by $E_{d1}$ in the figure and the forward current value just before the cell goes into an off-state condition.

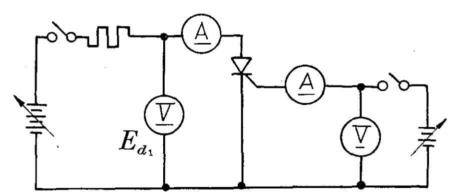



*Fig. 11* Measuring circuit for gate firing and holding current

Routine test, besides these, includes an operating test for quality guarantee.

## V. RESULTS OF SPECIAL TESTS

A portion of collapse tests and life test conducted on all types of Fuji SCR to determine their capacity limit will be described.

### 1. Destruction due to Forward Overcurrent

In order to determine allowable short duration overload, an over current was passed for a time set after continuous passing of the rated forward current, the current gradually increased until the destruction value was reached. With Fuji SCR, the limit at which the forward blocking character is lost temporarily and the limit at which the cell is completely destroyed by shorting are reached with approximately the same value of overcurrent. However, there are some instances in which the former occurs at a slightly lower current value. The test results of GSi 5 and GSi 150 cells are shown in *Fig. 12*. In the diagram, the broken line indicates the allowable overload curve.

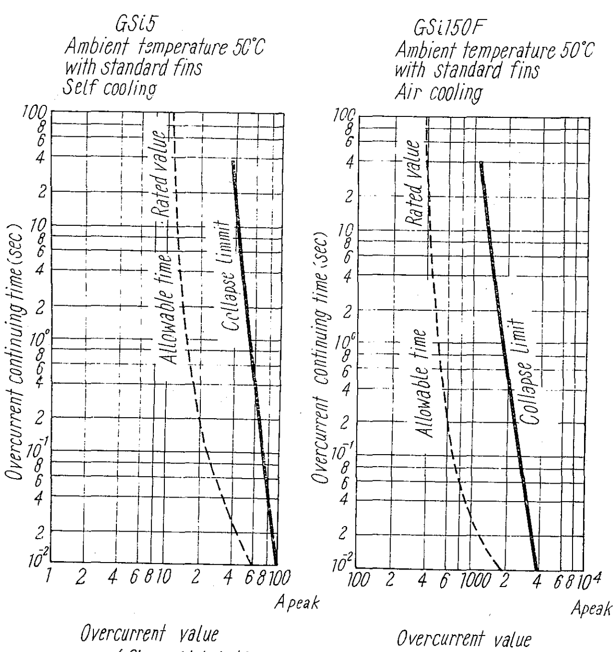



Fig. 12 Overcurrent capacity of GSi 12 and GSi 150

### 2. Destruction of Gate due to Excessive Gate Power

The gate voltage or current necessary for firing can be of pulse type; the value of the voltage or current, too, can be 3 v (5 v for GSi 50 and above) or 80 ma for sure firing. Thus there is less chance of applying especially large voltage on the gate; the result of test conducted to find the destruction limit is as follows:

The testpiece used was GSi 12. The gate overpower at which destruction of the gate occurs was computed for one cycle and for eleven cycles after 7.5 amp of single phase half wave has been applied to the gate of the cell in an on-state condition (a mean gate loss of 0.5 w is already applied to the gate) with the circuit shown in *Fig. 13*.

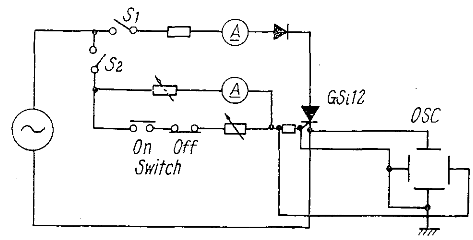
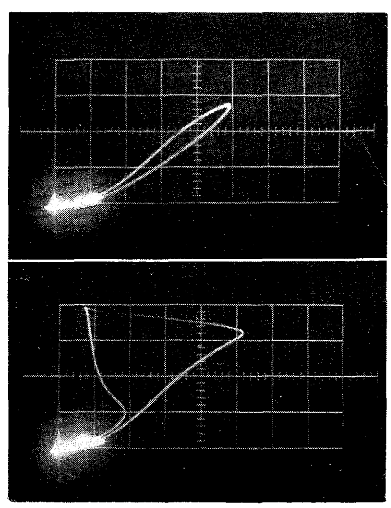



Fig. 13 Gate overload test circuit

The results showed that the gate destruction current for one cycle was 3.0～5.0 amp, the gate destruction voltage was 20～60 v and the gate destruction power was 70～140 w. For eleven cycles, the destruction current, voltage and power were 2.5～4 amp, 13～30 v and 50～80 w respectively. Deviation of the cell characteristic after destruction was this: the gate firing required greater fiiring power, the breakover voltage was lowered exceedingly, or the forward blocking characteristic was lost. *Fig. 14* shows an oscillogram of gate voltage-current characteristics of a cell on the gate of which one-cycle overpower has been applied. (a) shows a case in which a limit value has been applied just before destruction and (b) is an oscillogram at the time of destruction.



(a) Horizontal axis: 5 V/Div
Vertical axis: 1.67 amp/Div
Limit of gate not collapsing when overpower is applied for one cycle only

(b) Horizontal axis: 5 V/Div
Vertical axis: 1.97 amp/Div
When gate has collapsed with application of overpower for one cycle only

Fig. 14 Characteristics of gate when overpower is applied

### 3. Life Test

For life test, we utilized, in the case of silicon rectifiers, the contact mechanism of a mechanical converter and performed an equivalent load test using separate voltage and current sources. Since an inverter operation is possible with silicon controlled rectifiers, life tests are conducted with one set as rectifier and another set as an inverter, back-feeding power to the power supply. The circuit is shown in *Fig. 15;* the characteristic development is shown in *Fig. 16.* At the present, tests are made for the

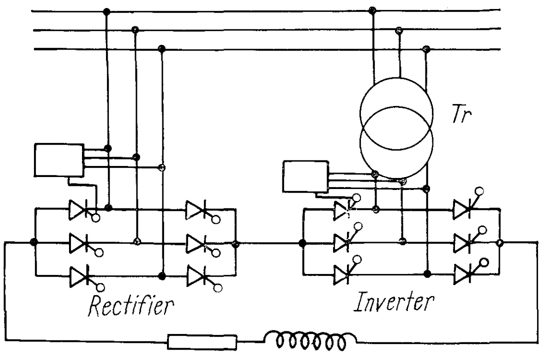



*Fig. 15* SCR life test circuit

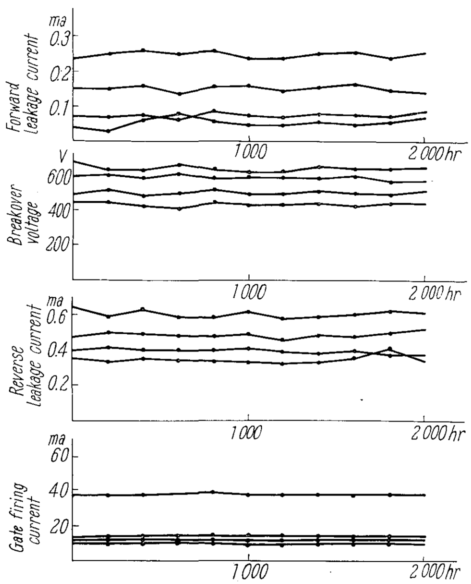



*Fig. 16* Life test result of GSi 12

purpose of detecting initial fault; the test is not conducted for long duration but as a method for handling many test-pieces. As can be seen from the diagram, the characteristics are quite stable. As a proof of their longevity, there are some cases of rectifiers which have been tested in electric railway equipment for approximately two years.

Since the principles used in the manufacture of silicon rectifiers can be applied directly to the construction, surface protection, airtightness, etc., of the silicon controlled rectifier cells, Fuji's controlled rectifier cells can be said, in the same way as the Fuji rectifier elements, that they possess semipermanent life.

## VI. SCR CHARACTERISTICS FOR SPECIAL APPLICAION DESIGNS

Discussed below are the effects of Fuji cell turn-on and turn-off time characteristics under the following conditions: when SCR is being used at especially low temperatures; when operating at high frequency with series-parallel connection; when operating at high speed.

### 1. Temperature Dependency of Gate Firing Characteristic

Without going into a theoretical explanation, the result of actual measurement of the temperature dependency of gate firing characteristic of GSi 12 and GSi 50 is shown in *Table 4.* These values are

*Table 4* **Gate firing voltages and temperature**

| Gate firing voltage-current (Average of 10 testpieces) | | | | |
|---|---|---|---|---|
| Junction temperature | GSi 12 | | GSi 50 | |
| | $V_g$ (v) | $I_g$ (ma) | $V_g$ (v) | $I_g$ (ma) |
| −40° C | 1.69 | 20.54 | 2.3 | 20.5 |
| 25° C | 1.40 | 11.89 | 1.9 | 11.78 |
| 120° C | 0.845 | 2.98 | 1.15 | 3.66 |

average values measured on ten cells. As has been stated before, the voltage impressed between the anode and cathode of the cell at the time of the gate firing characteristic test is d-c 5 v. For the anode-cathode voltage dependency of firing characteristic, refer to another article.

### 2. Temperature Dependency of Holding Current

The holding current standard values shown in *Table 3* are those when the junction temperature is 20°C. The deviation of the holding current at junction temperature change is as shown in *Fig. 17;* as in the firing characteristic, as the temperature falls, it tends to make current flow more difficult.

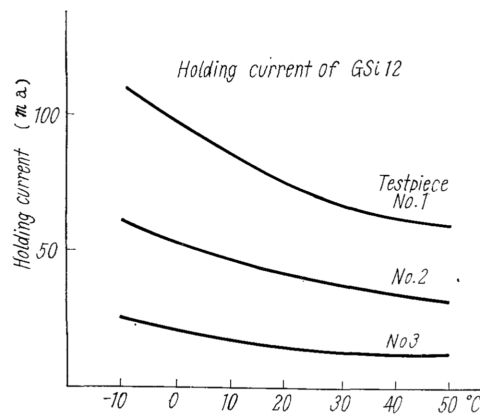



*Fig. 17* Relation between holding current and temperature

### 3. Series-parallel Connection of Cells

Because of the problem of simultaneous firing, series-parallel connections of SCR are more complicated than those of simple rectifier elements.

For firing the series-connected cells, there is a method in which an independent pulse is given to each cell by dividing the output windings of pulse transformer and another method in which the firing action of one cell is used to fire other cells successively. *Fig. 18* shows a firing pulse generator that can fire up ten cells connected in parallel; this is one of Fuji silicon controlled rectifier cell standard circuit parts series called PG 110. As shown in the photograph of *Fig. 19,* it is in printed circuit form. The pulse build-up speed is 0.6 $\mu$sec; its amplitude is 50 v. To produce this powerful pulse, the charge of $C_6$ of *Fig. 18* is discharged instantaneously through $CR_1$; this discharge voltage, through $T_1$, is impressed on the gate of each cell. (Patent is pending for the pulse generating circuit.) For parallel connections, the problem of current balance between the cells in on-state condition make

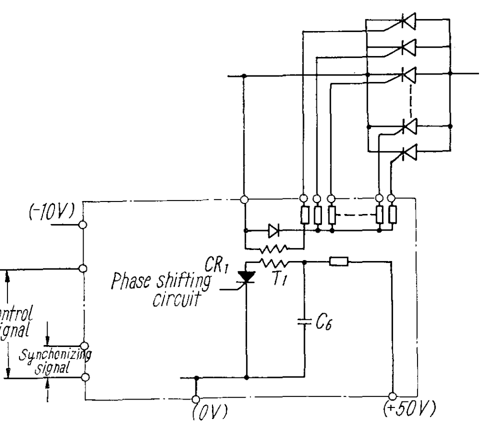



*Fig. 18* Pulse generator for parallel connected cells (Patent pending)

it necessary to use the cells with uniform forward current characteristic. The total current capacity of the cells connected in parallel must be decreased according to the degree of ununiformity as is true in the case of simple rectifier elements.

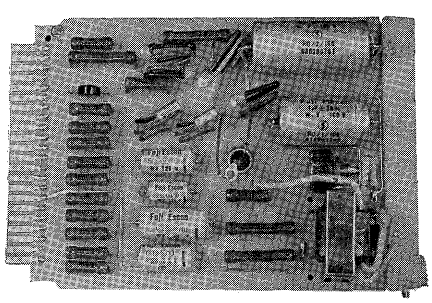


*Fig. 19* Pulse generator PG 110

### 4. Turn On-Turn Off Time

Turn on time of the silicon controlled rectifier cell is extremely short: it changes according to the value of gate current; the turn on shortens with increase of the gate current. The turn on time for Fuji cells is $1\sim2\mu$sec. The turn off time varies with the forward current, decreasing rate of the forward current, value of reverse voltage and temperature. An example of turn off time measurement will be shown. *Fig. 21* shows the measuring circuit; *Fig. 20* shows result of measurement. In this case, testpiece $S_1$ is placed in on-state and $S_2$ is fired. With the voltage of $C_1$ a reverse voltage is applied on $S_1$. $C_1$ is reversed and charged and the time until a forward voltage is applied on $S_1$ is adjusted and the limit which brings $S_1$ again into an on-state condition is obtained by adjusting the inverse charging time. From the result of *Fig. 21,* it can be seen that the larger the forward current and higher the temperature, the longer the turn-off time.

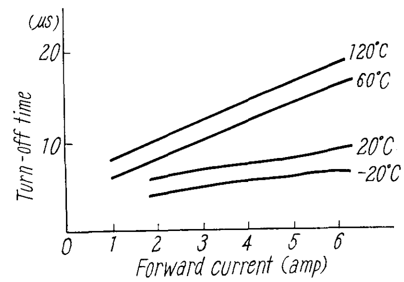



*Fig. 20* Turn-off time of GSi 5

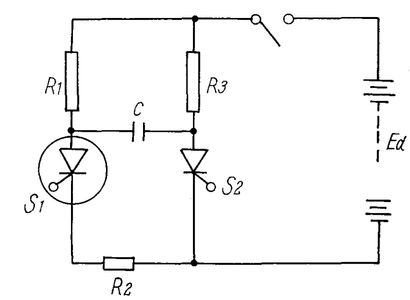



*Fig. 21* Measuring circuit for turn-off time

## VII. CONCLUSION

The silicon controlled rectifier cell (called Thyristor at I. E. C) is a kind of transistor that acts like a Thyratron; it is a combination of high power and low power techniques. Its field of application is expected to be extensive. The circuits which have used mercury rectifiers and Thyratrons can be used with this cell. Its short turn on and turn off time makes it suitable for use with high frequencies. Because of its small internal voltage drop, there is no back firing; because it has all other features which other semiconductors possess, special uses for it will be developed in the future.

Fuji SCR series includes many current types and high forward voltage types. Because of the utilization of high reverse voltage for greater safety, we believe that Fuji SCR will completely fulfill the user's requirements. We hope that this article will be of some help to the readers; please refer to our catalogs on Fuji silicon controlled rectifier cells and become a confirmed user of Fuji semi-conductors.