



Inter-Office Communication

RECEIVED

MAY 11 1960

TETRAONIX, INC.

N.I.

To: WILL MARSH

Date: May 8, 1960

From: KERM FLECK

SYRACUSE

Subject: 175

Dear Will:

We have received comments from at least three different groups lately which could concern our 175.

In addition to extra current being made available, there are several groups which could conceivably use this unit if we had much higher collector voltage available in the order of 1000 volts and appropriately reduced current. The 1000 volts collector supply would have applications in testing controlled rectifiers.

Mr. Pete Sylvan, who is pretty well known to Norm and John Kobbe, presents us with the enclosed Patent Disclosure Letter concerning Single Cycle and Multiple Cycle Firing Circuits for Silicon Controlled Rectifiers. Pete feels it may be something which we would like to build into the 175.

Best regards,

Kerm

KF/mm

nr

*Comments to:
Dick Rhys
C. Nelson
D. K. Hill
June 11*

Chuck

Kern Fleck
TEK Syracuse

June 13, 1960

Dick Winn for Customer Service
(your IOC to Chris Christensen 6/3/60)

Higher Collector Volts for 575

Hello Kern,

Thanks again for your feedback----we really do appreciate it.

We haven't anything in the mill for this mod at the present time----in fact this is the first request, for this much collector voltage, that we've received.

The high voltage rating of semi-conductors seems to be going higher and higher all the time, so we'll probably be receiving more requests in the future. If we do we'll definitely consider a field mod.

I've forwarded a copy of your letter to Chuck Nolan in case he might have something to add.

So long,

Dick

DW:ls

GENERAL ELECTRIC COMPANY
Semiconductor Products Dept.
Application Engineering
#7-217, Electronics Park
Syracuse, New York

March 14, 1960

cc: F. W. Gutzwiller-Auburn
R. A. Stasior-Syracuse
H. R. Lowry-Syracuse
E. E. Von Zastrow-Syracuse
D. V. Jones-Syracuse
J. Harnden-GEL-Schenectady
E. Manteuffel-MED-Ithaca
D. Borst, LVSD-Philadelphia
L. Foote, ICD-Roanoke
M. Goldenberg, SCE-Wayne

SUBJECT: Patent Disclosure Letter
Single Cycle and Multiple Cycle Firing
Circuits for Silicon Controlled Rectifiers

TO: J. J. Zaskalicky
Patent Attorney
Semiconductor Products Dept.
Bldg. #7, Room 222
Electronics Park
Syracuse, New York

ABSTRACT:

This patent disclosure letter describes a magnetic firing circuit for SCR's (Silicon Controlled Rectifiers and similar solid state devices) which can fire a SCR for any desired number of half cycles of the AC line. The firing sequence is initiated by closing a switch or relay contacts and the SCR will be fired at the same phase angle regardless of when the contacts are closed. The operation of the firing circuits is unaffected by contact bounce in the switch or relay.

PRIOR ART:

The circuits described in this disclosure make use of the basic magnetic firing circuits described in the patent disclosure letter of F. W. Gutzwiller and T. P. Sylvan dated December 23, 1959 assigned docket number 36-64D-218. The comments on prior art made in that letter will also pertain to the circuits described in this letter.

SINGLE CYCLE FIRING CIRCUIT:

The circuit used to fire an SCR for a single half cycle of the a-c line is shown in Figure 1. The firing action is initiated by closing the push button switch SW1.

During the positive half cycle of the a-c line (polarities are with respect to ground shown in the Figure) current will flow through D3 and R2. If the square loop core of transformer T1 is not saturated winding 1-2 will have a high inductance and a large part of the current from D3 and R2 will charge the capacitor C1. When the time integral of the voltage across the winding 1-2 becomes large enough the

core of T1 will be driven to positive saturation. The impedance of winding 1-2 will then drop to a low value and the capacitor will be discharged rapidly through winding 1-2 and R1. A positive pulse will be generated across R1 thus firing SCR1 which will conduct for the remainder of the positive half cycle.

If the core of T1 is in positive saturation at the beginning of the positive half cycle winding 1-2 will present a low impedance to the current through D3 and R2. The capacitor C1 will not be charged and SCR1 will not be fired provided that the voltage divider ratio of R1 and R2 is small enough to satisfy the condition:

$$\frac{R_1}{R_1 + R_2} < \frac{V_{GF(min)}}{V_{PK(max)}}$$

where $V_{GF(min)}$ is the minimum gate voltage at which the SCR can be fired and $V_{PK(max)}$ is the maximum peak value of the a-c line voltage.

Due to diodes D1 and D3, current can only flow through winding 1-2 in one direction so that normally the core of T1 will be in positive saturation and SCR1 will not be fired. When SW1 switch is closed, current will flow through C2, R3, D2 and winding 3-4 during the negative half cycle of the a-c line. The core of T1 is thus reset so that SCR1 will be fired on the following positive half cycle. Since the resetting of the core of T1 can take place only during the negative half cycle, the SCR will fire at the same phase angle θ_F , regardless of when the switch SW1 is closed. If the switch is closed between 0° and 180° (see Figure 1) the core will be reset between 180° and 360° and SCR1 will fire at $360^\circ + \theta_F$. If the switch is closed between 180° and 360° , the core will be reset between the time the switch closes and 360° and SCR1 will fire at $360^\circ + \theta_F$. If the switch is closed slightly before 360° , the line voltage may not be adequate to reset the core in which case the core will be reset between 540° and 720° and SCR1 will fire at $720^\circ + \theta_F$. If the switch is closed between 0° and 270° , the capacitor C2 will be charged through D2 to the peak of the line voltage at 270° . Once the capacitor C2 is charged to the peak of the a-c line voltage no additional reset current can flow through winding 3-4 of T1 during the negative half cycles so that SCR1 will not be fired on more than one positive half cycle. On opening switch SCR1, capacitor C2 will be discharged through R4 so that subsequent operation will be possible. The value of R4 should be large enough so that the core of T1 will not be reset between single cycles of the a-c line when the switch SW1 remains closed. This condition will be satisfied if:

$$R_4 > \frac{V_{PK}}{I_m R_3 C_2 f}$$

where V_{PK} is the peak voltage of the a-c line, I_m is the magnetizing current of winding 3-4 and f is the line frequency.

If the switch SW1 is closed between 270° and 360° the core will be reset, but capacitor C2 will not be charged to the peak voltage of the a-c line. Thus SCR1 will

fire at $360^\circ + \theta_F$, the core will be reset again between 540° and 720° when C4 is charged to the peak voltage of the a-c line at 630° and SCR1 will fire a second time at $720^\circ + \theta_F$. Diode D4 is used in the circuit to prevent this from happening. If the switch SW1 is closed between 270° and 360° , SCR1 will fire at $360^\circ + \theta_F$ and capacitor C2 will be charged to the peak voltage of the a-c line through D4 at 450° . Since the current through D4 does not flow through winding 3-4, the core of T1 will not be reset a second time and SCR1 can only be fired once each time the switch SW1 is closed.

The repetition rate of the circuit of Figure 1 is limited by the time constant C2R4. If a fast operating rate is desired, a SPDT switch can be substituted for SW1 arranged so that C4 is shorted out with the switch at the standby position. It is important that the center pole of the switch used should not bounce between one contact and the other, otherwise erratic firing will occur.

Diode D1 is used to prevent any ringing of the LC circuit when the core of T1 saturates. This diode can be eliminated in many cases.

MULTIPLE CYCLE FIRING CIRCUIT

The circuit used to fire an SCR for more than a single half cycle is shown in Figure 2. The operation of this circuit is similar to that of the preceding circuit with the following differences.

No diode is used in series with R6 so that the core of T2 will be reset by the current through R6 during the negative half cycles. If the core of T3 is saturated however, winding 1-2 of T3 will present a low impedance to the current through R6 during the positive half cycles and prevent C3 from being charged so that SCR2 can not be fired. If the core of T3 is reset by closing switch SW2 winding 1-2 of T3 will present a high impedance to the current through R6 and thus will allow C3 to be charged and SCR2 to be fired through the normal operation of R6, C3, T2 and R5. The number of cycles that SCR1 is fired will depend on the volt-time capacity of winding 1-2 of T3 with respect to winding 1-2 of T2. If T3 has slightly more than five times the volt-time capacity of T2, SCR2 will fire for five cycles after switch SW2 is closed. On the sixth positive half cycle, the core of T3 will saturate and capacitor C3 will be discharged through winding 1-2 of T3 before T2 has saturated. The number of cycles that SCR2 is fired can be varied by switching the number of turns on winding 1-2 of T3. Since the number of cycles that SCR2 is fired is determined primarily by the relative characteristics of the two cores and the relative number of turns on the windings this circuit should be very stable with respect to changes in ambient temperature, line voltage, and with life. The effect of the diode D5 can be compensated to a large extent by means of two diodes connected in parallel opposition in series with T2.

Full wave versions of both the circuit of Figure 1 and Figure 2 are possible by the use of suitable slaving circuits using the same basic firing circuits.

DOCUMENTATION:

The circuit shown in Figure 1 was built and successfully tested on March 12, 1960. Operation was witnessed by Dr. R. A. Stasior. This circuit is recorded on page 80 of my patent notebook #238 dated March 13, 1960.

TPS:fw

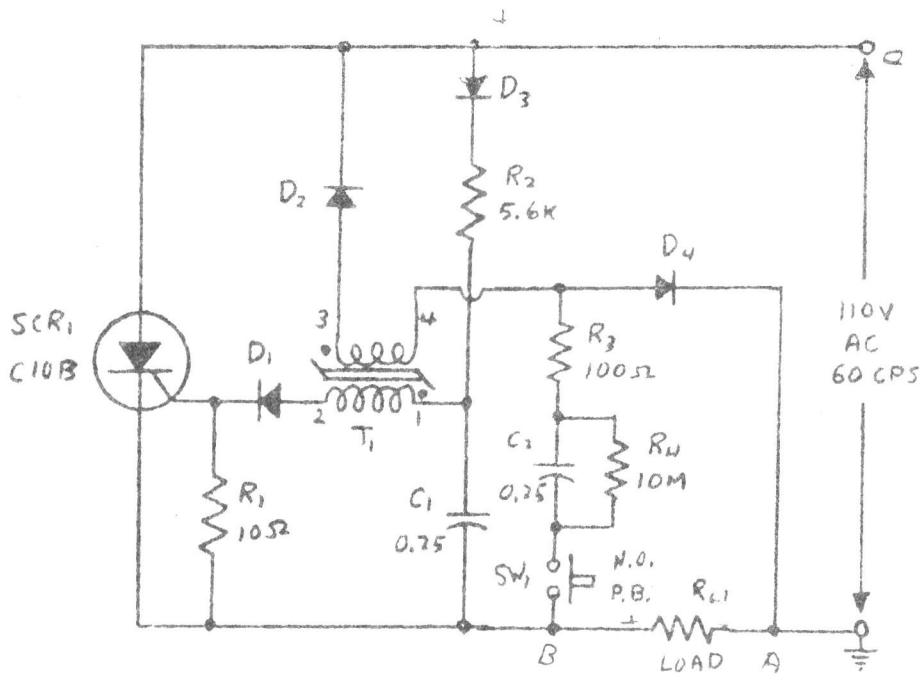
Signed: _____

Date: _____

Witnessed: _____

Date: _____

T. P. Sylvan
Bldg. #7, Room 217
Electronics Park
Syracuse, New York



T_1
 CORE
 MAGNETICS INC.
 ORTHONAL
 # 50000 - 1A
 1-2 = 300 TURNS #33
 3-4 = 100 TURNS #33
 $\theta_F \approx 35^\circ$

FIG. 1 SINGLE CYCLE FIRING CIRCUIT

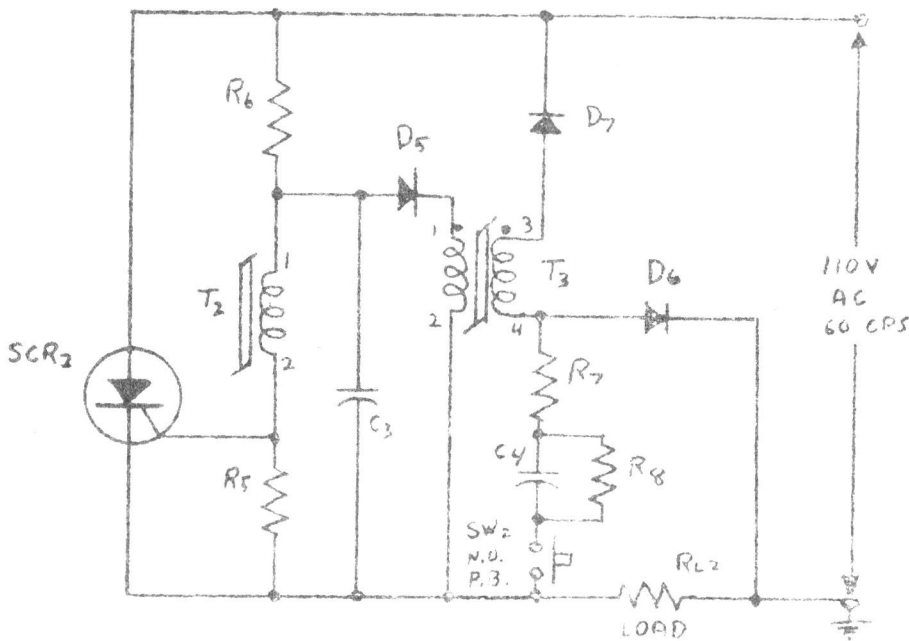
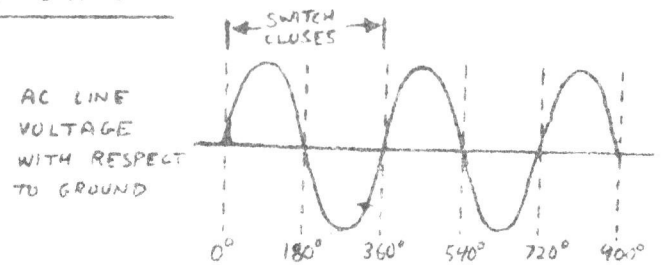


FIG. 2 MULTIPLE CYCLE FIRING CIRCUIT

Inter-Office Correspondence

CHRIS CHRISTENSEN

20 May 6, 1960

From: KERN FLICK

Subject: My IOC 6/3/60
Dick Winn's IOC of 6/13/60
Higher Collector Volts for 575

Dear Chris:

A little more feed-back on higher collector voltage on 575 for special breakdown applications.

In talking to the Quality Control people at General Electric in Auburn, I find they feel that the breakdown voltage on their new glass diode may eventually go as high as 3 KV. If not on the present device (which is still Engineering) it may go that high in the future.

At the present time there are about 3, possibly 4, Engineers who would welcome a modification for their 575. Again -- current is not real important -- 1 to 10 microamps would be quite sufficient.

Best regards,

/s/ KERN
K

7-17-60
SAIB
ACTION FIVE

Kerm Fleck
TEK Syracuse

July 15, 1960

Dick Winn for Customer Service
(your IOC to Chris Christensen 7/8/60)

Higher Collector Volts for Type 575

Hello Again Kerm,

Sounds like the G.E. people are real hot for this H. V. MOD. I sure wish we could help them out.

Chuck Nolan tells me that his group is working on a H. V. Mod that will go up to 1 or 1-1/2 KV. They're kind of limited on how far up they can go because of the arcing problems with the binding posts. *AND C.F. DIFFICULTIES*

If this mod that Chuck is working on can be used as a Field Mod and we get some more feedback from other areas, we'll bring it up before the Field Mod Panel for consideration.

So Long

Dick

DW:ls

cc: Chuck Nolan



Inter-Office Communication

To: Chuck Nolan

From: Harry Allison

Subject: Modified Type 575

RECEIVED

Date: August 18, 1958

AUG 20 1958

TEKTRONIX, INC.
PORTLAND, OREGON

UNION

Dear Chuck,

I have a request from John Szafranski, a project engineer for Bendix Aviation, for a higher collector voltage Type 575.

His request is to extend the voltage range between 500 to 1,000 volts with the current rating of 20 milliamps. This would be used to check high voltage, semi-conductor diodes.

If this is a possibility, he's in rather a rush since present means of making this test are rather crude.

I recall on my trip to Portland that Deane Kidd was working on a different voltage, which may fit in with this request.

Hoping to hear from you soon,

Regards,

Harry

HUA/mal

CC: Scotty Pyle

Union

Harry Allison

August 28, 1958

Chuck Nolan

Type 575
Your IOC of August 18

Dear Harry:

Regarding your request for high volts on a 575, it is not impossible, and you were right, Deane was working on a different voltage; but that turns out to be 400 volts, and this will probably be made available within six months. However, in the voltage range, 500 to 1000 volts, it would require specially designed transformer, additional rectifiers and switches, and the mere cost of parts for this mod may run well over \$150.

We certainly couldn't rush through this mod no matter what, since we are moderately crowded at the moment with specials. If 400 volts, however, will not satisfy him, this latter could probably be done at a fairly high cost. But if he is in a hurry for it, we might run into some difficulties.

Let me know if we can do any more for you.

Best regards,

Chuck

CN/dvm

cc: Scotty Pyle
BB/FAT
WM

5575 / 300 - 1000 ✓ collector

1. Transformer 20-0-20
200-0-200
500-0-500
0-1000 ✓ { 1 sec / leg in bridge rect ³²⁰⁰

2. Alternate with 100V/div added, 110V VOLTS/DIV

3. Cost Rect 32.00
SW (Peak Volt) 10.00
SW (att) 10.00