Silicon Controlled Rectifier (SCR)

Lecture – 15

TDC PART – I
Paper - II (Group - B)
Chapter - 5

by:

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- **SCR Turning-OFF Methods (PART – 3)**
- **Lecture Content :-**

- **(2) Forced Commutation**
- **(a) Anode Current Interruption Technique**
- **(b) Basic Forced Commutation Technique**

(2) Forced Commutation

- "In case of **DC circuits,** there is no natural current zero to **Turn OFF** the **SCR.** In such circuits, **forward current** or **Anode Current** must be **forced to zero** with an **external circuit** to **commutate the SCR** hence named as **forced commutation".**

- The process of **Turning OFF** a SCR (thyristor) by using **External Circuits** is known as **Forced Commutation.** This method of commutation is used for **DC Commutation.**

- When using **DC supply,** we make use of **External Circuit** and other **Active/Passive Components** to reduce the **Passing current's** value **below Holding Current.** That means we **force** the **Forward Current** to come to **Zero value.** Therefore it is called **Forced Commutation.** The circuit used for **Forced Commutation Method** is known as **Forced Commutation Circuit** and the components that are used in the circuitry are known as **Forced Commutating Components.**

- Unlike **Natural Commutation**, an external circuitry is required to forcibly bring the **SCR Anode Current below Holding Current or almost to Zero** and keeping SCR **Reversed Biased or Unbiased** for a period more than the **SCR (thyristor) Turn-OFF Time.** This technique is applied for **DC circuit.** The commutation circuitry for **Anode Current Interruption** and **Forced Commutation** comprises of **Transistor, Battery and Battery.**

- This Forced Commutating Circuit consist of components like **Transistor, Battery and Switch** called as **Commutating Components.** These **Commutating Components** cause to apply a **Reverse Voltage** across the **SCR** or **Interrupt Anode Current** of the **SCR,** that immediately bring the current in the **SCR** to **Zero** then **SCR Turn OFF.**

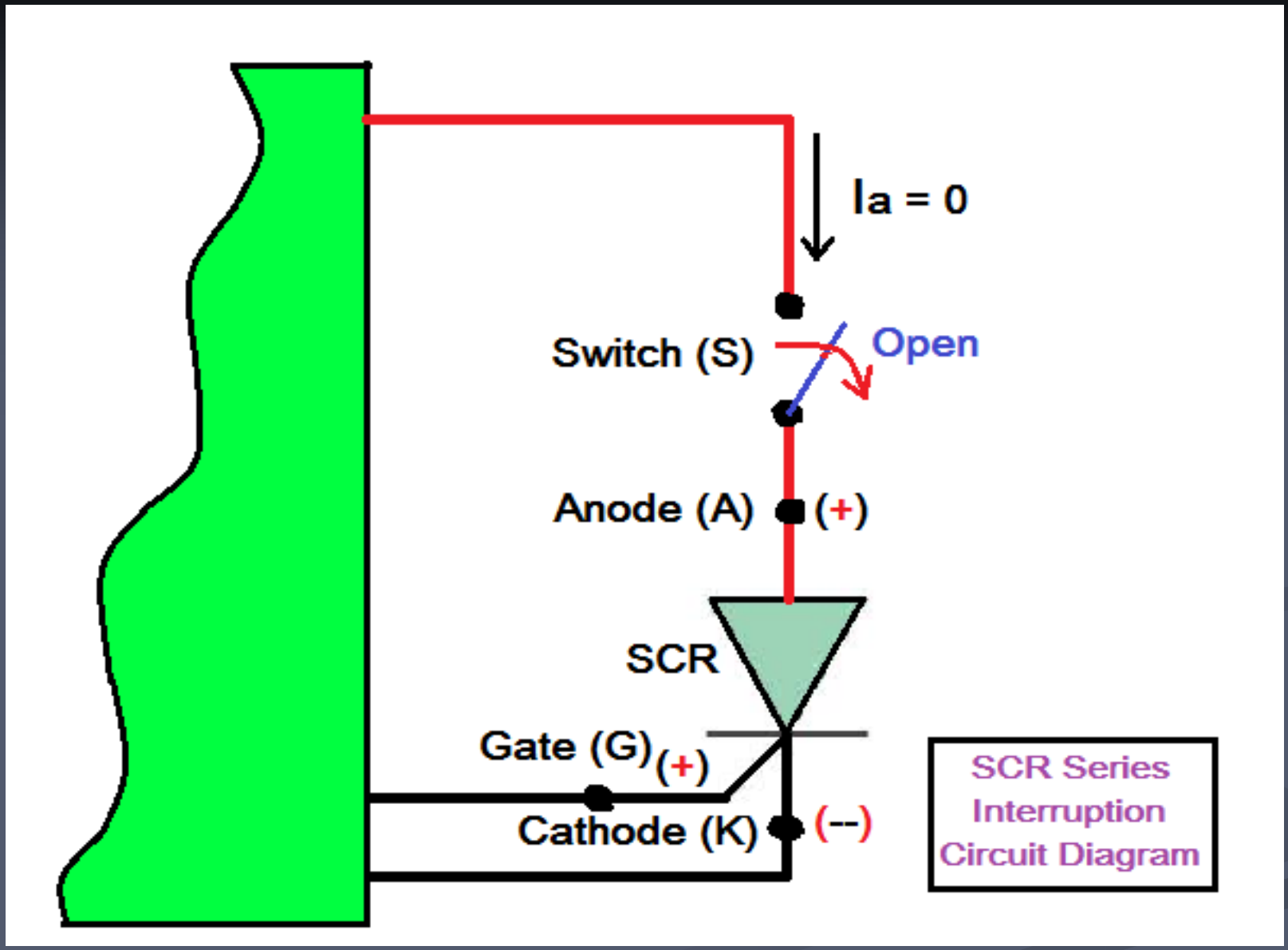
- Here next question of concern is; **how long it's the Turn-OFF time** and **how is Turn-OFF accomplished?** An **SCR** cannot be **Turned-OFF** by simply removing **the Gate Signal** at the **Gate Terminal** and only a special few can be **Turned-OFF** by applying a **Negative Gate Pulse (Ig)** to the **Gate Terminal.** In **Forced Commutation** there are **Two General Methods** for **Turning OFF the SCR.** Those are :-

- **(a) Anode Current Interruption Technique**
- **(b) Basic Forced Commutation Technique**

(a) Anode Current Interruption Technique

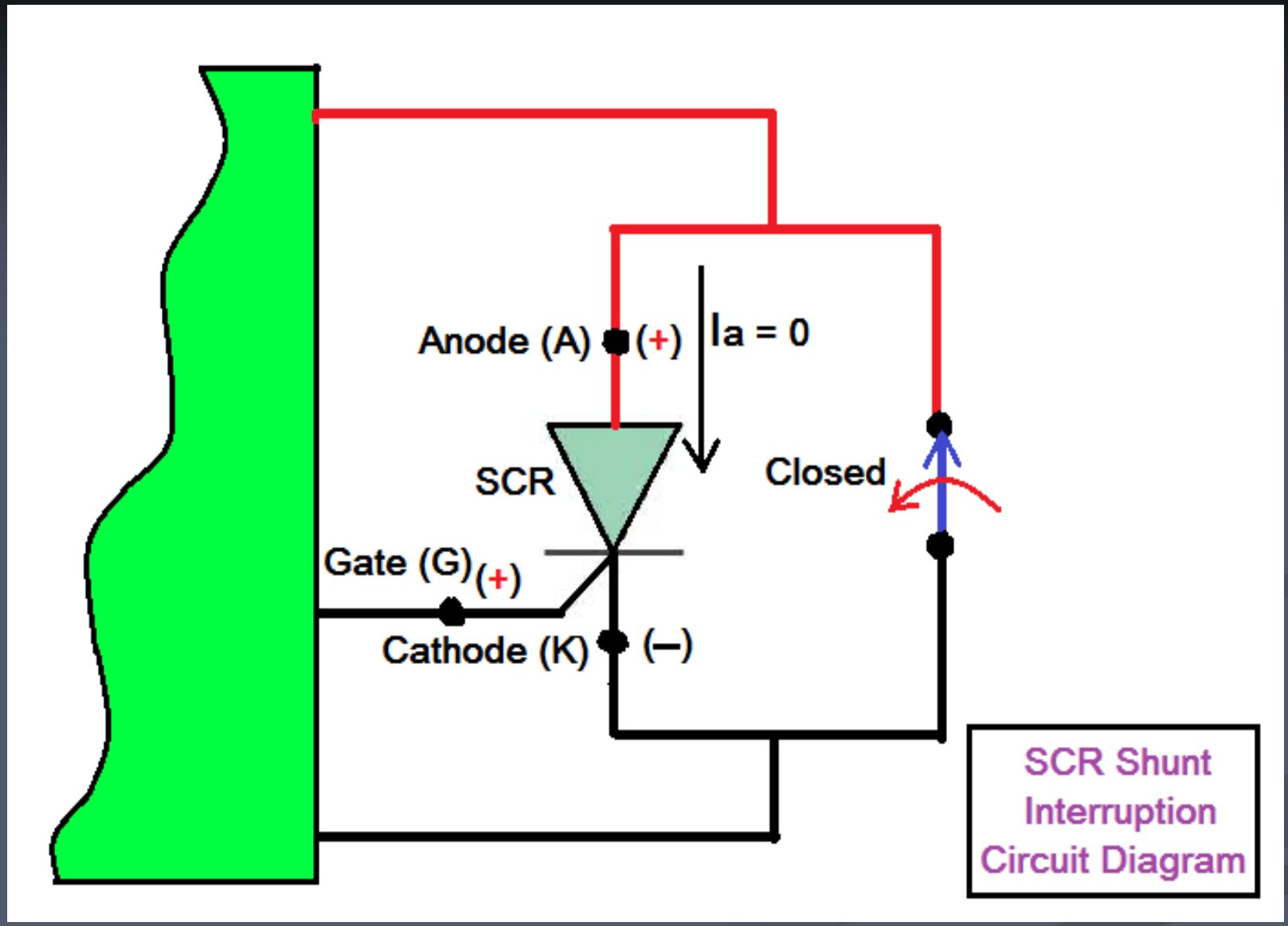
- When the **Anode Current (Ia)** is reduced be-low the level of the **Holding Current (IH) or almost to Zero,** the **SCR Turns-OFF**. However, it must be noted that rated **Anode Current (Ia)** is usually larger than **1,000 times** the **Holding Current (I_H)**. Since the **Anode Voltage (Va)** remains **Positive** with respect to the **Cathode (K)** in a **DC Circuit,** the **Anode Current (Ia)** can only be reduced to **Zero by Anode Current Interruption Technique".**

- **Anode Current Interruption Technique of SCR** commutation is also called **Forced Commutation. Anode Current Interruption Technique** of **SCR Commutation** is the process of **Turning-OFF an** SCR using **Additional External Commutation Circuitry.** This commutation technique only occurs in **DC Circuit.** For better understanding, let us consider an **SCR circuit** energized from **DC source.** The two possibilities for current interruption are shown in **Fig (77) and Fig (78) below.**



- **Fig (77)** Shown a Series Interruption Technique in which Anode Current (Ia) of SCR is interrupted to become Zero when the circuit Switch S is Opened.

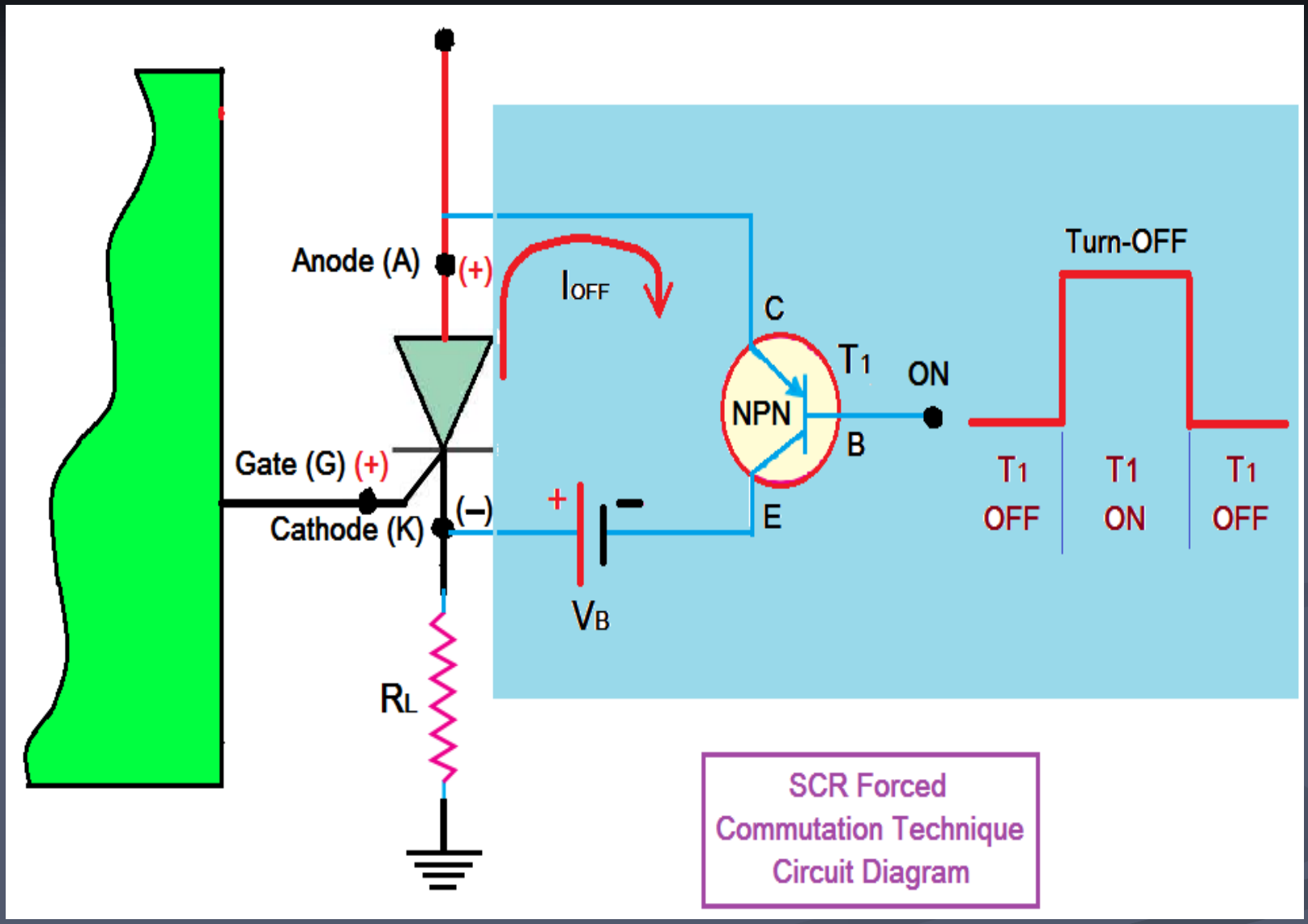
- In **Fig (77) Shown, Anode Current (Ia) of SCR** is **interrupted to make it to Zero** when the circuit **Switch S is Opened**, called **Series Interruption Technique.** While in **Fig (78),** the same condition is established when the **circuit Switch S** is **Closed called Shunt Interruption Technique.**



- **Fig (78)** Shown a Shunt Interruption Technique in which Anode Current (Ia) of SCR is interrupted to become Zero when the circuit Switch S is Closed.

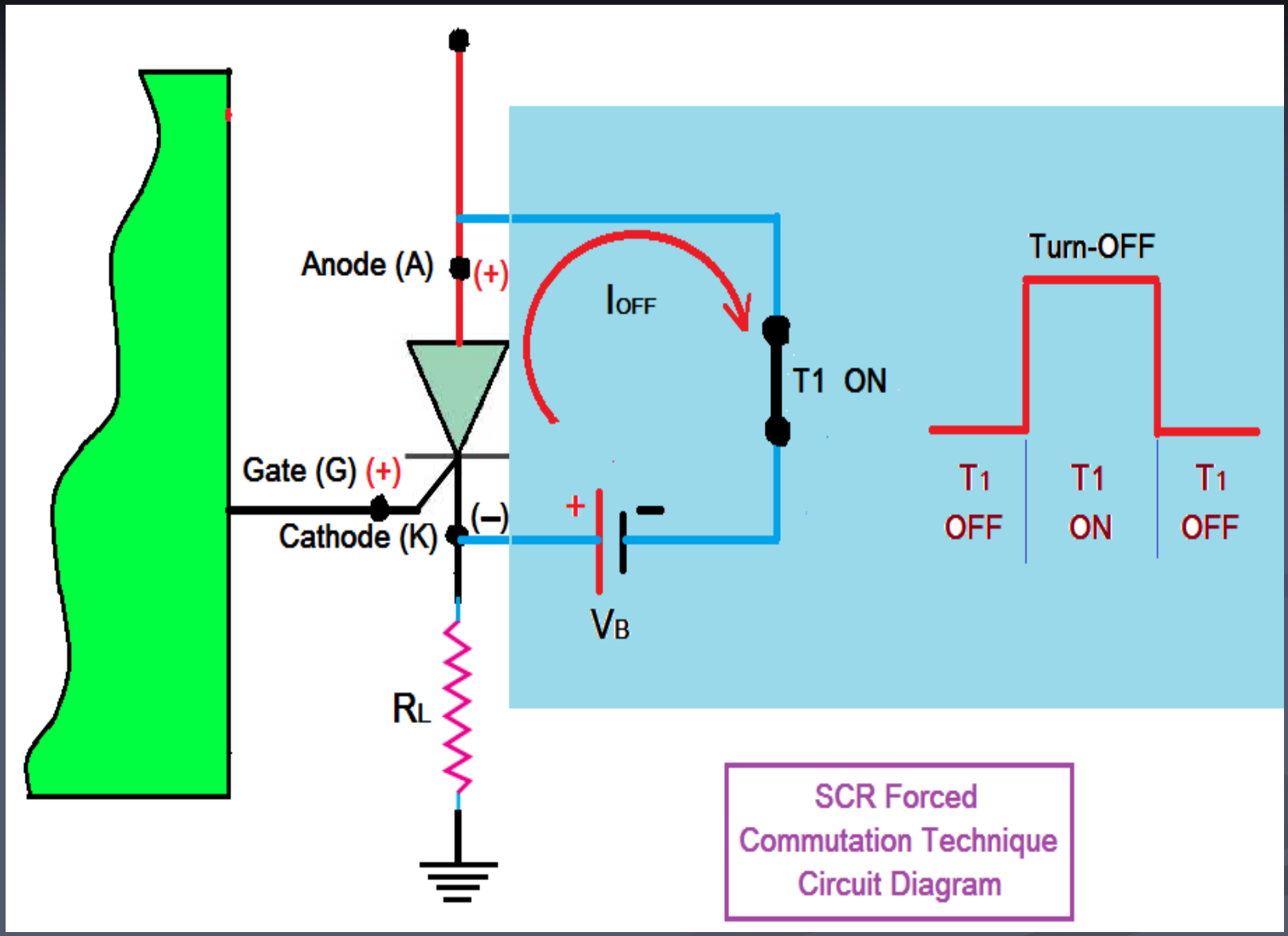
(b) Basic Forced Commutation Technique

- **Forced Commutation** is the **Forcing** of current through the **SCR** is the direction opposite to **Forward Conduction.** There are wide varieties of circuits for performing this function. One of the most **basic types** is shown in **Fig (79)** below. As indicated in the **Fig (79)** below, the **Turn-OFF Circuit** consists of a **NPN Transistor,** a **DC Battery V_B,** and a **Pulse Generator.** During **SCR Conduction,** the **Transistor** is in the **OFF-State** that is **Base Current $I_B = 0$** and the **Collector-to-Emitter Impedance is Very High** (for all practical purposes an open circuit).



- **Fig (79)** Shown a Basic Type of Force Commutation Circuit Diagram using NPN Transistor and a Battery.

- This **high impedance** will isolate the **Turn-OFF Circuitry** from affecting the operation of the **SCR.** For **Turn-OFF conditions,** a **Positive Pulse** is applied to the Base Terminal of the transistor, **turning it heavily ON,** resulting in **very low impedance** from **Collector-to-Emitter (short circuit representation). The battery potential** will then appear directly across the **SCR** as shown in **Fig (80)** below**, forcing current** through it in the **reverse direction** for **Turn-OFF.** Turn-OFF times of SCRs are typically **5 to 30 micro second.**



- **Fig (80)** Shown a Basic Type of Force Commutation Circuit Diagram using NPN Transistor and a Battery for applying Reverse Biasing across SCR.

to be continued .....