Multi-Vibrator (MV)
Lecture – 4

TDC PART – I
Paper - II (Group - B)
Chapter - 3

by:

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(3) Transistor Bistable Multivibrator (BMV)

- **A multivibrator which has two absolutely stable states, hence the name "Bi" meaning two, is called a bistable multivibrator (BMV).** The bistable multivibrator has two stable states. Both are the absolutely stable states. It will remain in whichever state it happens to be until a trigger pulse causes it to switch to the other state. It requires the application of an external triggering pulse to change the **Bistable multivibrator** operation from either one stable state to the other stable state. Again another **trigger pulse** is then required to **switch the Bistable multivibrator back** to its **First Initial Stable State** (**original state).**

- The discrete Bistable Multivibrator is a **two state non-regenerative device** constructed from **two cross-coupled transistors** operating as **"ON-OFF"** transistor switches. In each of the two states, one of the transistors is **cut-off** while the other transistor is in **saturation (ON),** this means that the **bistable circuit** is capable of **remaining indefinitely in either stable state.**

- To change the **bistable** over from one state to the other, the **bistable circuit requires** a **suitable trigger pulse** and to go through a **full cycle**, two triggering pulses, one for each stage are required. Its more common name or term of "flip-flop" relates to the actual operation of the device, as it **"flips"** into one logic state, remains there and then changes or **"flops"** back into its first original state.

- The **basic Transistor Version Bistable Multivibrator** circuit diagram is shown in **Fig. (17).** For instance, suppose at any particular instant, **Transistor Q1** is **CONDUCTING (ON)** and **Transistor Q2** is at **CUT-OFF. It is First Initial Stable State.** If left to itself, the bistable multivibrator will stay in this position forever. However, if an **external trigger pulse** is applied to the circuit in such a way that **Transistor Q1 is CUT-OFF** and **Transistor Q2 is turned CONDUCTING (ON)**. **It is second stable state.** Again, if left to itself, the circuit will **stay in the new position (Second stable state).** Another **external trigger pulse** is then required to **switch the BMV circuit back** to its **First Initial Stable State** (**original state).** Thus one trigger pulse is used to generate **half-cycle of output square wave** and another trigger pulse to generate the **next half-cycle of output square wave. It is also known** as a **flip-flop multivibrator** because of the two possible a**bsolutely stable states** it can assume.

- **BMV** is also called **Eccles-Jordan** or **flip-flop multivibrator**. The **basic Transistor Bistable Multivibrator** circuit diagram is shown in **Fig. (17),** as stated earlier, it has **two absolutely stable states**, hence the **name bistable multivibrator**. It can be **'FLIPPED' or switch** from **one state** to **another** by **external trigger pulses** and the **next trigger pulse** causes it to **'FLOPPED'** back to its **original initial stable state.** Bistable Multivibrators are one kind of multivibrators whose operation depends upon the external triggers pulse so as to switch between their two acceptable stable states. It can remain in either of these **two absolutely stable states** unless an **external trigger pulse** switches it from **one stable state** to the **other another stable state.**

- **Also point is noted that,** it can **stay in one of its two stable states indefinitely as long as power is supplied.** Obviously, **it does not oscillate between two stable states because it has no energy storage element.** When **BMV** receive an external trigger pulse in such way that then it switch the **BMV** from **First Initial Stable State** to **another Second Stable State**. If left to itself, the bistable multivibrator will stay in this position forever. Then the circuit will **stay in the new position.** When it receives **another input triggering pulse**, only then it switch the **BMV** back from **Second Stable State** to its **First Initial Stable State (original state).** These circuits are also called as **Trigger Circuits. It is also known** as a **flip-flop multivibrator** because of it switches back and fourth between the two possible **stable states,** it can assume.

- A bistable multivibrator (BMV) circuit diagram shown **Fig (17),** is an electronic circuit also referred to as a flip-flop or latch. It is a circuit that has two stable states and can be used to store one bit Binary information. Since one trigger pulse causes the BMV to **'FLIP'** from one stable state to another stable state and the next pulse causes it to **'FLOP'** back to its original stable state. By above this reason BMV is also popularly known as **'FLIP-FLOP' circuit**. Flip-flops and latches are a fundamental building block of digital electronics systems. One of their chief applications is in storing 1-bit binary data and as such they are widely used in digital computers, as registers in Micro-processor and flash memory devices.

- BMV has an output which can be in one of two states represented as logic 0 or logic 1. Output will stable in these two states: output LOW and output HIGH or logic 0 and logic 1. The key thing is that it is stable in either state, i.e. unless we do something to its inputs its output will stay the same. This is also called an S-R Flip -Flop. When S-R Flip Flop receives input pulse it changes states from 0 to 1 and back to it 1 to 0. The inputs may be **"Set"** and **"Reset".** An inputs pulse **“Set”** the output of BMV from logic 0 to logic 1 and another input pulse “Reset” it back to logic 1 to logic 0.

- **Detailed discrete circuit diagram of the BMV is discussed below :-**

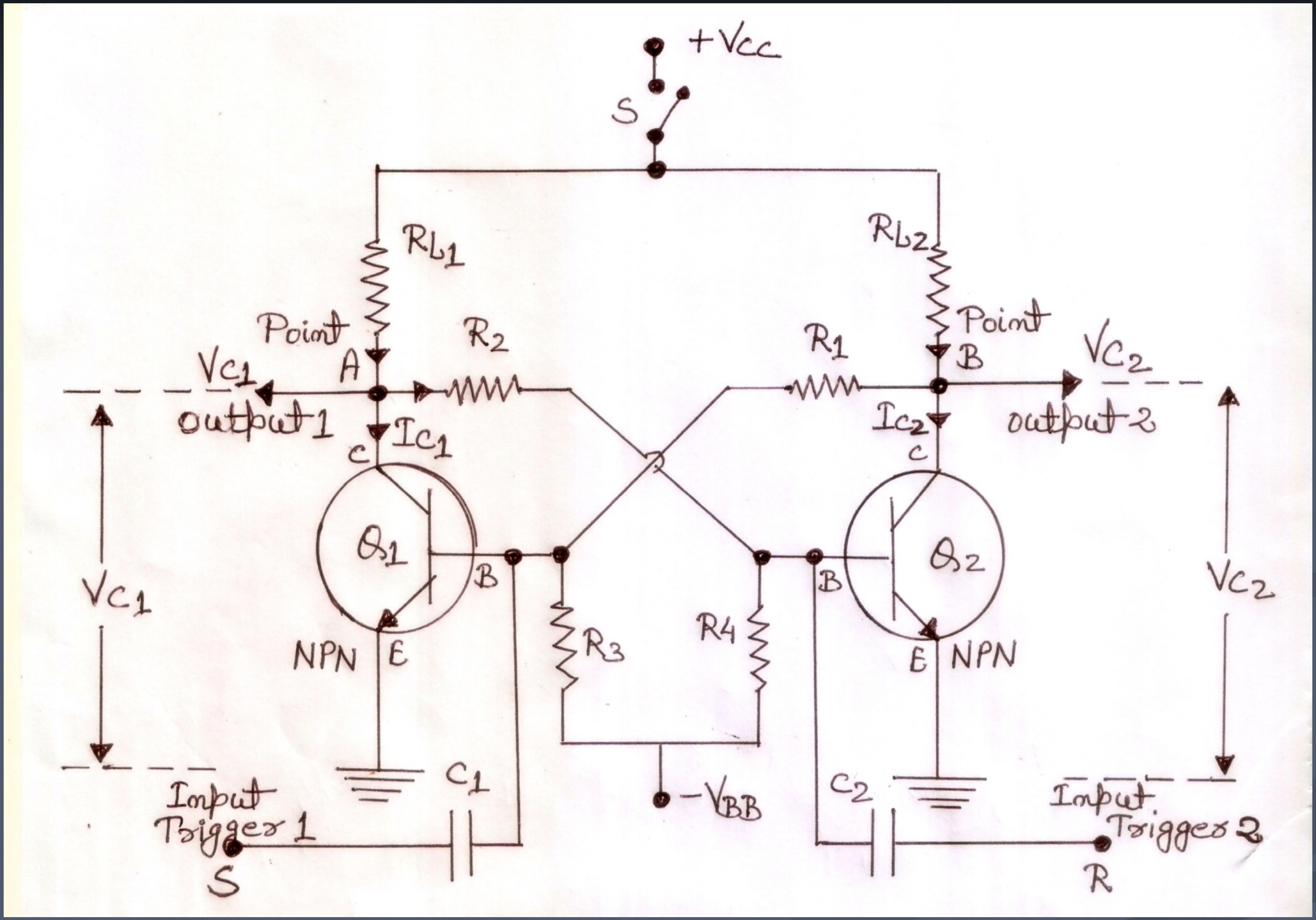
- The **BMV circuit diagram** shown in **Figure (17)** differs from the **AMV circuit diagram**, which shown in **Figure (12)** (from AMV Lecture – 3), in the following respects :-

  (1) The base resistors are not joined to Positive Source **+VCC** but joined to a common Negative Source –VBB.

  (2) The feedback is coupled through two **resistors R2** and **R1** (not capacitors).

Circuit Details of Bistable Multivibrator

- The **basic typical Transistor Bistable Multivibrator** circuit diagram is shown in **Fig. (17**) below. The following circuit designed using two NPN Bipolar junction transistor (BJT) namely Q1 and Q2 along with four resistors such as R1, R2, R3, and R4 and two input coupling capacitor C1 and C2. It consist two identical CE amplifier stages with similar transistors Q1 and Q2 along with load resistors RL1 and RL2 are connected in feedback to one another. It consists of two identical CE amplifier stages with output of one fed to the input of the other. The feedback is coupled through feedback resistors R2 and R1. Here, **Collector terminal of transistor Q1** is coupled to **transistor Q2** base through **resistor R2 and Collector terminal of transistor Q2** is coupled to **transistor Q1** base through **resistor R1.** It consists of **two similar NPN transistors Q1** and **Q2** with **equal collector loads resistor i.e. RL1 = RL2.**



- **Fig (17)** Shown a Basic Transistor Bistable Multivibrator (BMV) Circuit Diagram.

- Transistor Q1 and Q2 connected with common positive supply source +VBB through resistor RL1 and RL2. In the BMV circuit diagram the function of resistors RL1 and RL2 is to limit collector current of both transistors Q1 and Q2. The base resistors R3 and R4 are joined to a common negative source –VBB. The transistor Q1 is given an input trigger pulse at the base through the capacitor C1 and transistor Q2 is given an input trigger pulse at the base through the capacitor C2. The output can be taken across collector terminal of either transistor Q1 or Q2. To obtain **output**, it can be taken from **Collector terminal of NPN transistor Q1 at Point A (output 1) or NPN transistor Q2 at Point B (output 2).** The output can be taken across transistor Q1 is denoted as **VC1** and output across transistor Q2 is denoted as **VC2.**

Circuit Operation of Bistable Multivibrator

- The operation of the BMV circuit illustrated in **Fig (18), (19) and (20)** is as follows :-

- When the **BMV** power supply **+VCC** are switched **ON** by closing the switch S, both transistors Q1 and Q2 start conducting. Then one transistor starts conducting slightly more then the other due to small differences in their operating characteristics of the transistors. This starts a series of events.

- Assume arbitrarily that Q1 initially **conducts** more then **Q2**. This causes the collector voltage of Q1 to drop more rapidly then that of Q2. If Q1 is conducting (ON), then the fact that Point A is nearly 0 V makes the base of Q2 negative by the potential divider R2 – R4.

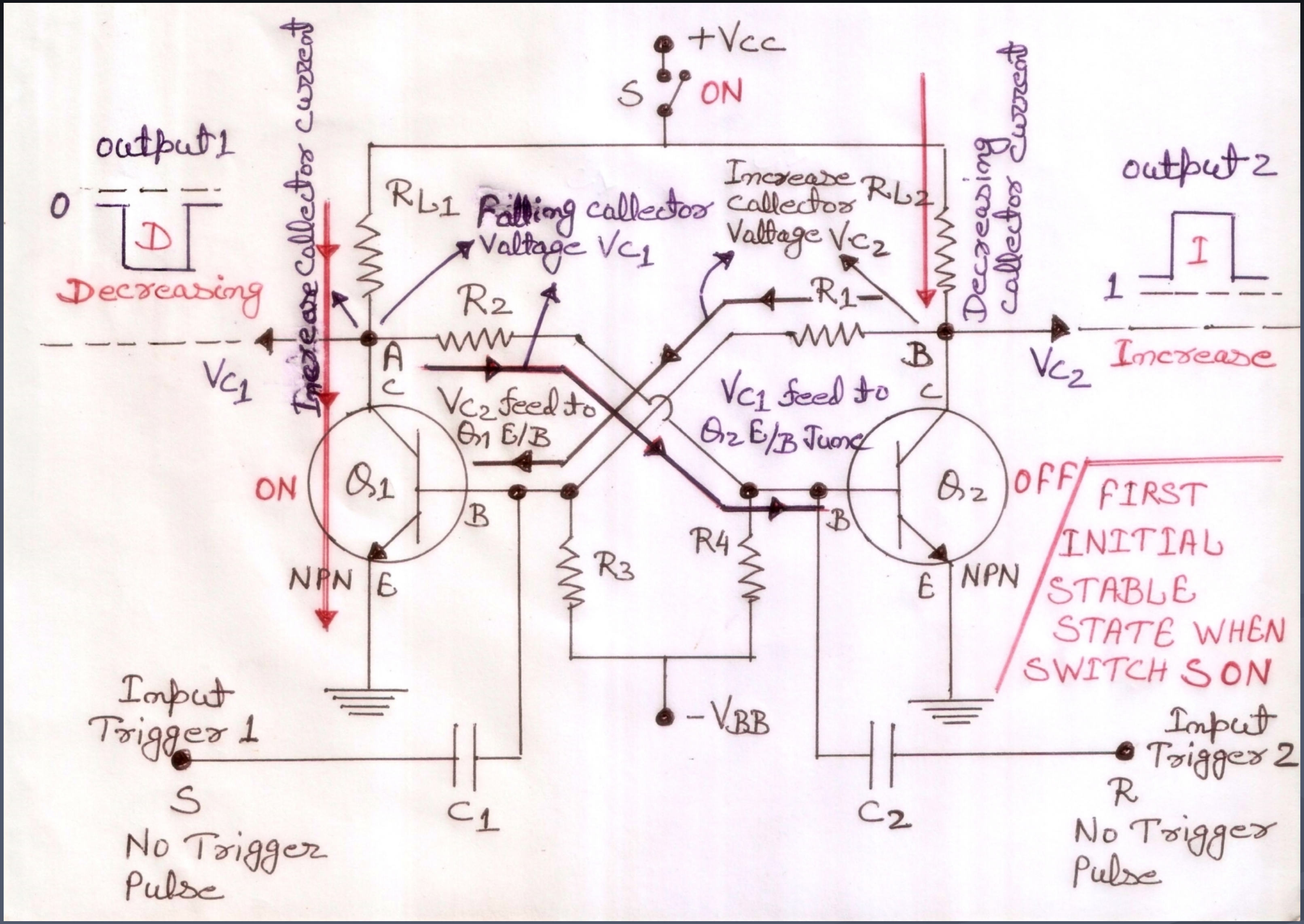
- The resulting negative signal is fed to the base of Q2 through R2 and derives it towards cut-off and HOLD Q2 cut-off. As a result the collector voltage of Q2 rises towards VCC. This change in collector voltage of Q2 is feed to the base of Q1 through R1. Similarly, with Q2 cut -off, the potential divider R1 – R3 is designed to keep base of Q1 at about 0.7 V. It is ensuring that transistor Q1 to go into saturation (ON). So Q1 will remain in saturation (ON) and Q2 in the cut-off (OFF) condition. Interestingly it is seen that Q1 (ON) HOLD Q2 cut-off (OFF) and Q2 (OFF) HOLD Q1 in saturation (ON). This drives one **transistor Q1** to the **saturation (ON)** and the other **transistor Q2** to the **Cut-off (OFF).** This is the **First Initial Stable State** of the bistable multivibrator which is shown in **Figure (18).**

The above whole process can be understand in different way, which is as follows :-

- When the **BMV** power supply **+VCC** are switched **ON** by closing the switch S of the circuit, currents in transistor Q1 and Q2 begin to flow. And due to the difference in characteristics of the transistors, current in one is slightly larger than the other. Suppose IC1 of the transistor Q1, is larger than IC2 of the transistor Q2. Larger IC1 will reduce the voltage of point A, which in consequence reduce the base voltage of Q2, and hence decrease in IC2 of the transistor Q2.

- Due to decrease in IC2, voltage of point B will be increased, which will increase the base voltage of Q1, thereby further increase in IC1. Ultimate Q1 will be conducting at saturation (ON) and Q2 is in cut-off. On the other hand if initially IC2 is larger than IC1, then finally transistor Q2 will be conducting at saturation (ON) and transistor Q1 will be in cut-off.

- If Q1 is conducting (ON), then the potential of point A is nearly zero. The negative supply -VBB reverse biases the base emitter junction of Q2 by the potential divider bias through resistors R2 and R4, so Q2 is in cut-off condition, and thus the potential of point B is +VCC. Thus Q1 is forward bias through the potential divider bias from VCC to -VBB (R1 – R3). So Q1 will remain in saturation (ON) and Q2 in the cut-off condition. So Q1 will remain in saturation (ON) and Q2 in the cut-off (OFF) condition. Interestingly it is seen that Q1 (ON) HOLD Q2 cut-off (OFF) and Q2 (OFF) HOLD Q1 in saturation (ON). This drives one **transistor Q1** to the **saturation (ON)** and the other **transistor Q2** to the **Cut-off (OFF).** This is the **First Initial Stable State** of the bistable multivibrator which is shown in **Figure (18) below.**



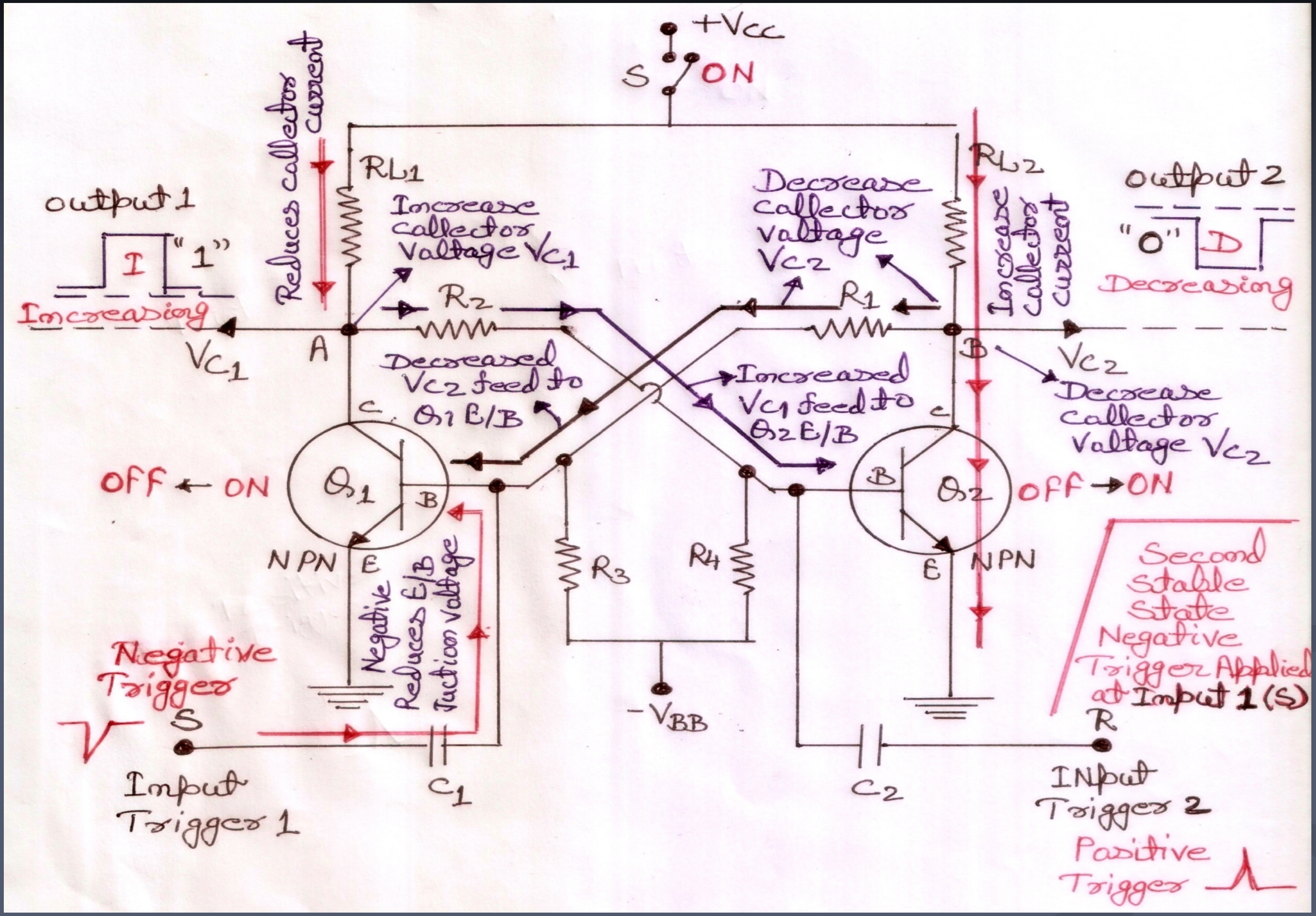
- **Fig. (18)** Shown First Initial stable State of the Multivibrator when BMV Power Switch ‘S’ **ON** and No Trigger Inputs applied.

- The multivibrator can be driven from the first stable state (Q1 ON and Q2 OFF) to the other stable state (Q1 OFF and Q2 ON) by applying either a negative trigger pulse to the base of transistor Q1 through Input Trigger 1 (SET) or a positive trigger pulse to the base of transistor Q2 through Input Trigger 2 (RESET). By applying a negative trigger at the base of transistor Q1 or by applying a positive trigger pulse at the base of transistor Q2, this stable state can be altered.

- **So, let us understand this by considering a negative trigger pulse at the base of transistor Q1 through Input Trigger 1 (SET).**

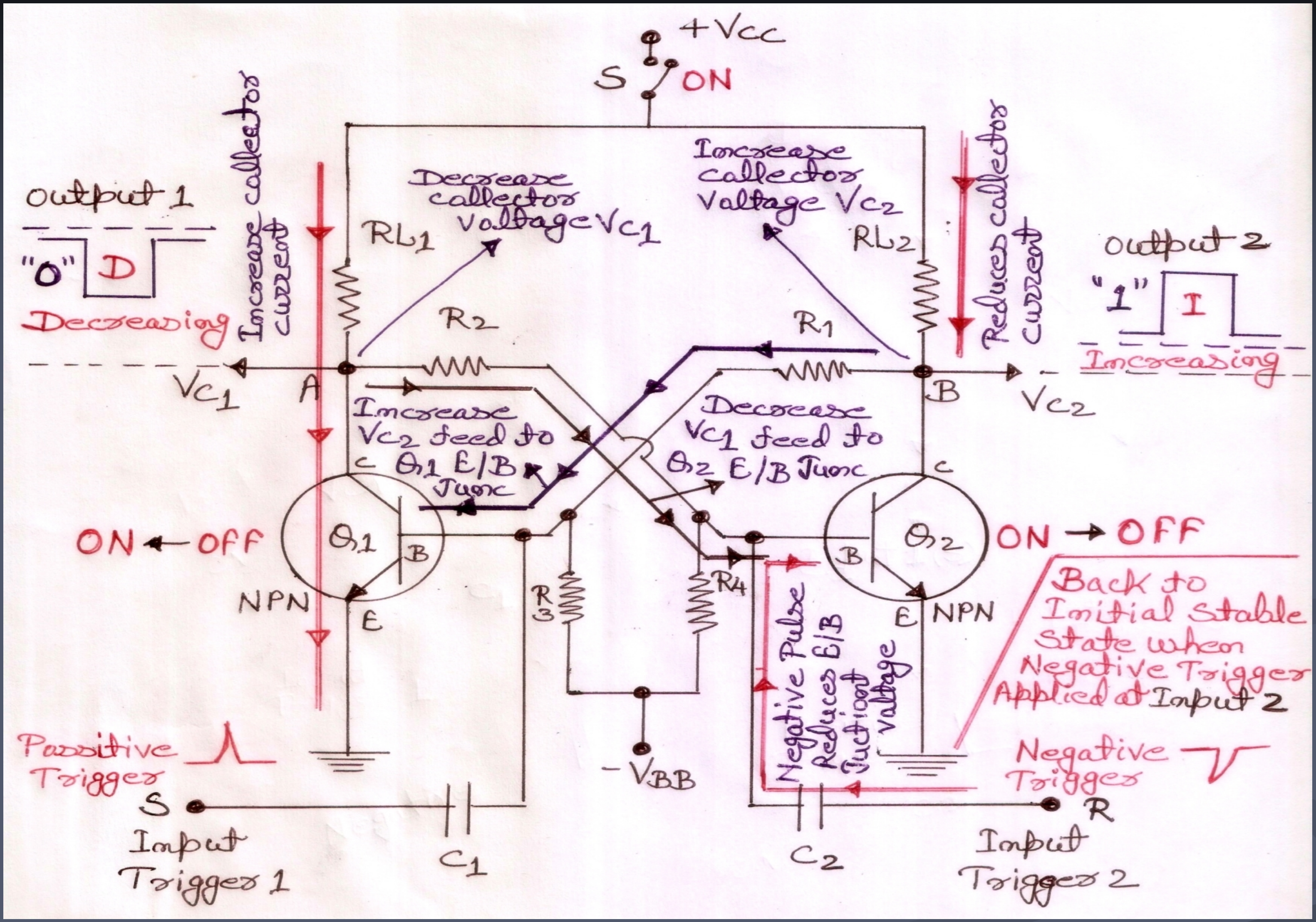
- Let a **negative trigger pulse** of short duration and sufficient magnitude be applied to the base of **transistor Q1** through **capacitor C1**. This negative trigger pulse reduces the forward bias on the transistor Q1 base terminal hence it reduces the **E/B junction voltage** of **Q1** then **transistor Q1 Cut-off (OFF)** and causes a **reduction** in **Q1 collector current IC1** and, thereby, **increases in collector voltage VC1 of its collector terminal of Q1 at Point A .** Now this **increased collector voltage VC1** feed to **E/B junction of transistor Q2**. The **rising collector voltage** appears across the **emitter-base (E/B) junction of transistor Q2** as it is connected to the **collector terminal** of **transistor Q1** at **Point A** via **resistor R2**. As rising **collector voltage** of **transistor Q1**, result **transistor Q2 saturated (ON),** then collector current IC2 of **transistor Q2 increase** and, therefore, its **collector voltage VC2 decreased.**

- The **decreasing collector voltage VC2 at Point B of the transistor Q2** appears across the **emitter-base (E/B) junction of transistor Q1** through **resistor R1** where it **further reverse biases the emitter-base (E/B) junction** of **transistor Q1** to make **transistor Q1 Cut-off (OFF)** then **collector current IC1 of transistor Q1** to **decrease** and **collector voltage VC1 of transistor Q1 to increase at Point A**. After few cycles, the transistor **Q2** is driven into **saturation (ON)** and **transistor Q1** to **Cut-off. This is the second stable state of the Bistable multivibrator.** The circuit will now **remain in this second stable state (Q1 OFF and Q2 ON).** Second stable state when negative trigger pulse applied to the transistor Q1 through Input Trigger 1 is shown in **Figure (19)** below.



■ **Fig (19)** Shown Second stable state when negative trigger pulse applied to the transistor Q1 through Input 1 or Positive trigger pulse applied to the transistor Q2 through Input 2.

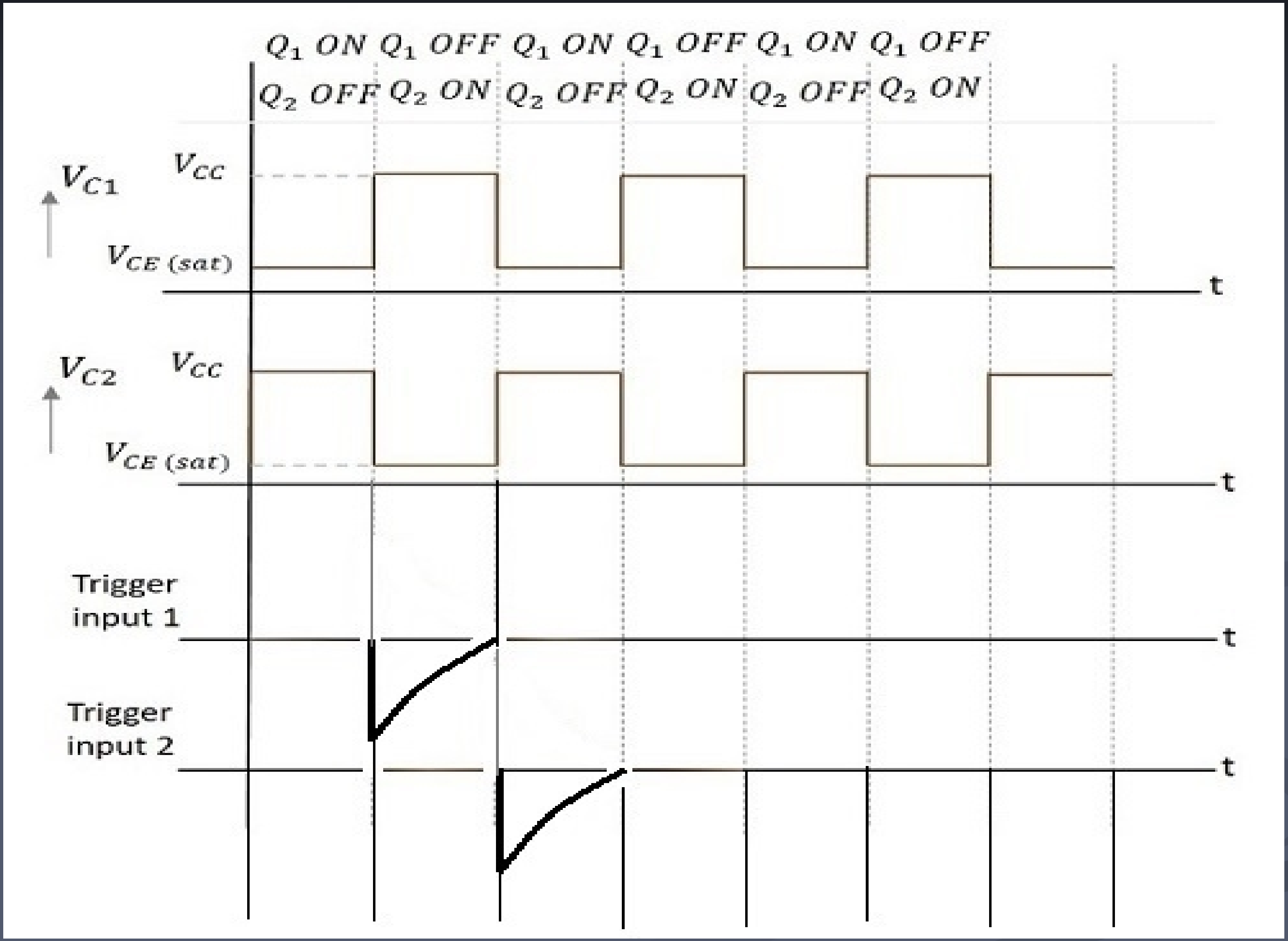
- Now, if this **second stable state** has to be **changed again, and back to Initial Stable** State **where transistor Q1 ON and Transistor Q2 Cut-off,** then a **negative trigger pulse** is applied to the **base of transistor Q2 through Input Trigger 2** or a **positive trigger pulse** is applied to the base of **transistor Q1 through Input Trigger 1. The above condition is shown in Figure (20) below.**



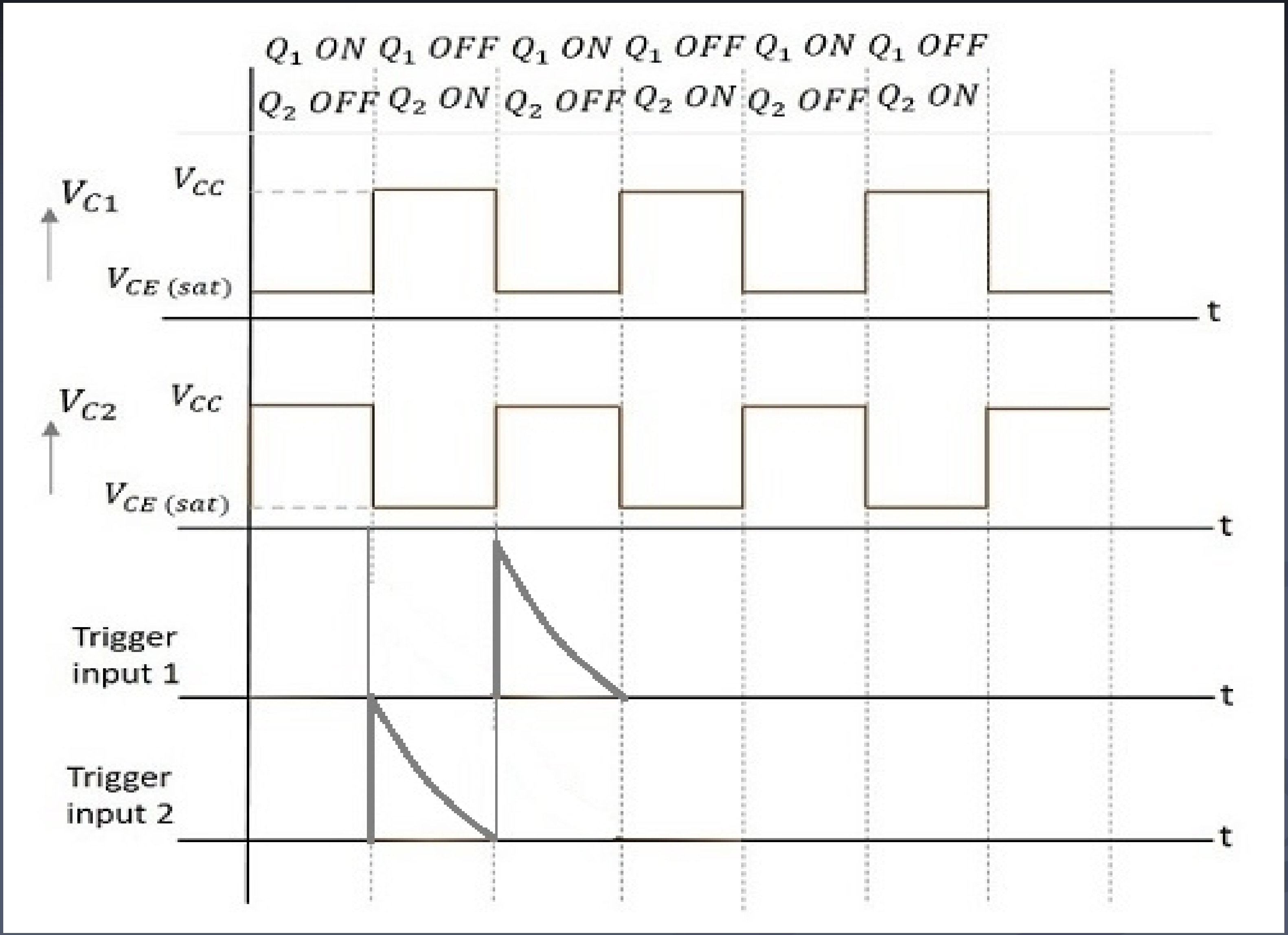
- **Fig (20)** Shown Back to initial stable state of BMV can be achieved when negative trigger pulse applied to the transistor Q2 through Input 2 or Positive trigger pulse applied to the transistor Q1 through Input 1.

BMV Output Waveforms

- The output waveforms of AMV are obtained at the collector terminal of **transistor Q1 at Point A (VC1)** or the collector terminal of **transistor Q2 at Point B (VC2)**. The **Inputs Trigger 1** given at the base terminal of **transistor Q1** through **capacitor C1** and the **Inputs Trigger 2** given at the base terminal of **transistor Q2** through **capacitor C2** are shown in the following **Figure (21)** below. **Fig (21)** Shown below BMV output waveforms with Negative Input trigger Pulses and **Fig (22)** Shown BMV output waveforms with Positive Input trigger Pulses.



- **Fig (21)** Shown BMV output waveforms with Negative Input trigger Pulses.



- **Fig (22)** Shown BMV output waveforms with Positive Input trigger Pulses.

Advantages of Bistable Multivibrator

- The advantages of a Bistable Multivibrator are as follows :-

(1) It has the ability to store previous output until no any input trigger is provided.

(2) The circuit design is not complex.

Disadvantages of Bistable Multivibrator

- The drawbacks of a Bistable Multivibrator are as follows :-

(1) Two kinds of trigger pulses are required. Every time in order to have transition from one stable state to another, triggering pulse is required.

(2) A bit costlier than other Multivibrators. It is somewhat costly than astable and monostable multivibrator.

Applications of Bistable Multivibrator

- The applications of a Bistable Multivibrator are as follows :-

(1) These are widely used in the latches circuits and counters circuits.

(2) It is used in frequency divider circuits.

(3) Bistable Multivibrators are used in pulse generation.

(4) It is used in digital operations like counting and storing of binary information.

(5) Widely used in digital computers, as a registers in Micro-processor and as a memory cells in flash memory devices.

..........Chapter End..........