STUN GUN – ELECTROMAGNETIC THEORY

Basically, Stun gun is a device used to disable an attacker by firing electric charges. The stun gun has a very high voltage and a low current. So, this process does not cause permanent injury even though this is a very painful attack. When making a stun gun, the aim is to generate high voltage from low voltage source and produce electric shock waves.

Note: Here, the circuit used is only a prototype and it is used only to demonstrate the working principle of a real stun gun.

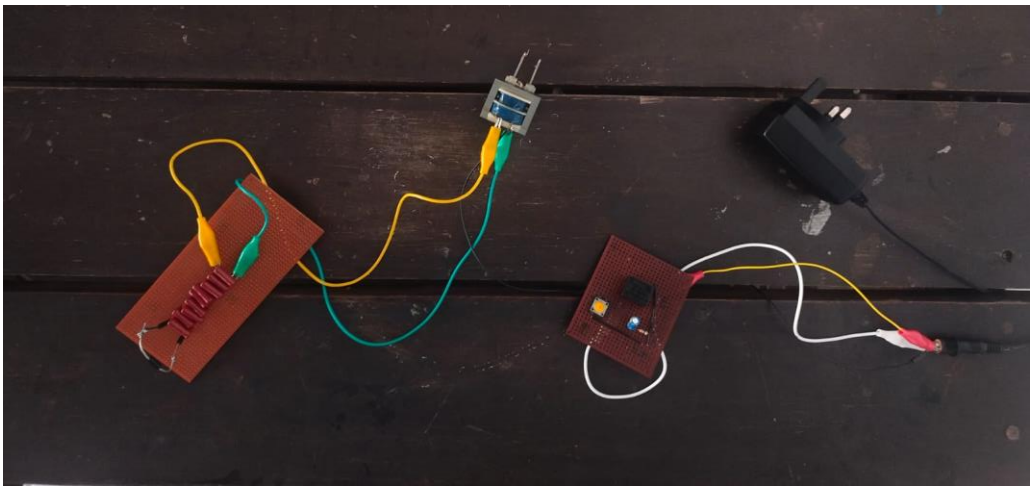

Figure 01: Prototype circuit

Here we used a step-up transformer to produce a high voltage and that is the application which use electromagnetism. Transformers are using electromagnetic induction to step up or step down the AC voltage. In the transformers when an AC passes through the primary coil, a varying magnetic flux is created due to change of current. That magnetic field resulted due electromagnetic induction, interacts with the secondary coil and it produce an AC voltage. In the step-up transformer secondary coil has more turns of wire which makes higher voltage as the output.

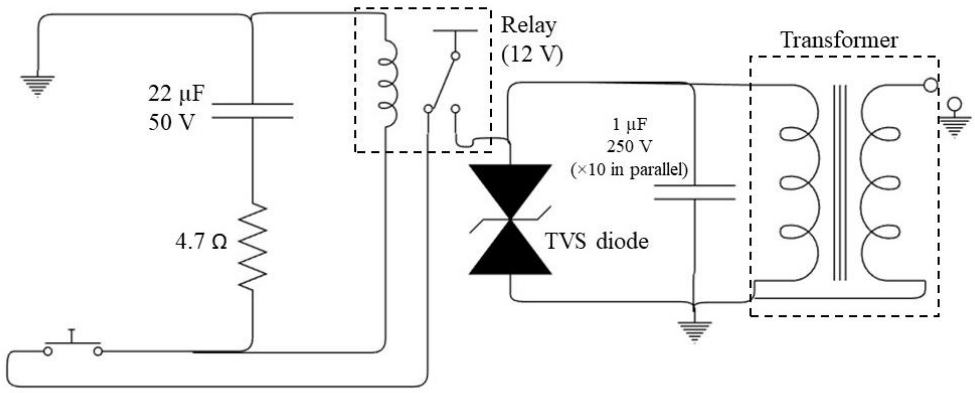

Figure 02: The circuit diagram of the prototype

CAPACITIVE SENSOR – ELECTRIC-FIELD THEORY

A capacitive sensor is a type of proximity sensor used to detect close by devices through the electric field effect formed through the sensor. To detect the targets, the sensor produces an electrical field from the sensing end of the sensor and any object that interrupts this electric field can be detected by the sensor.

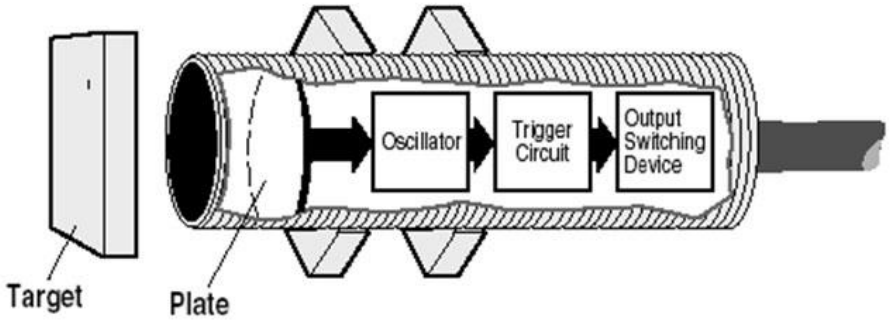

Figure 03: Principle of sensing operation

Source: Adapted from [1]

The following equation can be used to determine the capacitance.

$$C = \frac{\varepsilon A}{d}$$

Here, ε is the permittivity of the material separating the plates, A is the cross-sectional area of a plate and d is the distance between the two plates.

Using this principle, capacitive sensors can be developed to measure displacement by using the change in the area of the plates, using the angular displacement between the plates and using the change in the distance between the plates.

As depicted in the above equation, in capacitive sensors, when the area of the plate changes angularly and linearly in directions parallel to the plates, the capacitance changes. Using this capacitance change, any changes occurring to the capacitor plates can be detected and deformation measurement of brake disk is an application of this principle.

In vehicles, the brake disks are often subjected to large impact loads which result in mechanical abrasion and extreme heat generation in the brake disk. This will lead to fine cracks in the brake disks and when an impact load is reapplied, there is a high risk of fracturing the disk. Therefore, to detect such fine cracks, capacitive sensors which are capable of detecting the nanometer range deformations are used in measurement of brake disk deformation.

References

[1] J. Moermond, “What is a capacitive sensor?,” AUTOMATION INSIGHTS, https://automation-insights.blog/2017/06/07/what-is-a-capacitive-sensor/ (accessed Jul. 30, 2023).

[2] E. Technology, “Capacitive sensor and transducer and its applications,” ELECTRICAL TECHNOLOGY, https://www.electricaltechnology.org/2019/07/capacitive-sensor-applications.html (accessed Jul. 30, 2023).

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