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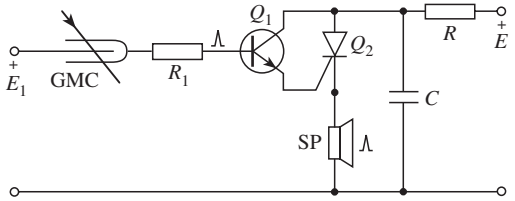
Demonstration indicator for radioactive rays

The new circuit suggested here is an indicator for radioactive rays for educational purposes. It emits loud sound pulses and is suitable for demonstrations before a large audience. Additionally, the circuit and its principle of operation have been made as simple as possible by using cheap and accessible components.

The circuit is presented in figure 1. It is based on a Geiger–Müller counter (GMC), a low-power transistor Q_1 and a low-power thyristor Q_2. In essence this is a pulse-controlled thyristor relaxation generator.

The key feature of the circuit is that the transistor is connected in parallel to the thyristor. The collector of the transistor is connected to the anode of the thyristor, while its emitter is connected to the control electrode of the thyristor. The Geiger–Müller counter is connected to the base of the transistor by means of a large resistor. Since in a nonconductive state the resistance of the GMC is very high, the base of the transistor is insulated in practice. This enhances its sensitivity. The relaxation group of the



GMC - CBM20; Q_1 - 2N5551; Q_2 - SKT10/06C; R - 10 kΩ; R_1 - 3.9 MΩ; C - 4 μF; SP - 1.5 W, 4 Ω; E - 250 V; E_1 - 450 V

Figure 1. *Basic circuit arrangement for the radioactivity indicator.*

generator consists of a capacitor C and a resistor R. The common anode resistor R and a common discharge capacitor C simplify the circuit considerably. A speaker SP is connected directly to the cathode of the thyristor in order to indicate a current pulse through the thyristor audibly.

Until a radioactive particle reaches the Geiger–Müller counter the capacitor C is charged through the resistor R to the supply voltage E of the thyristor. When a radioactive particle enters the counter, a collision ionization occurs. Due to the high value of the absorbing resistor R_1 (several megaohms), a brief current pulse flows through the counter and the base of the transistor and it is amplified. The capacitor C begins discharging through the transistor, the control electrode of the thyristor and the speaker. When the discharge current reaches the necessary value, the thyristor switches on. A short current pulse flows. As a result the speaker emits a typical powerful and sharp sound pulse. The speaker clicks each time a particle enters the detector. In this way we achieve an audible indication of the radioactive particle which has entered the counter. The sound can be heard at a great distance and by a large audience. As the capacitor discharges, its current decreases, and at a certain value the thyristor switches off. Then the capacitor is charged again until the next particle arrives. The power of the sound pulses increases with a decreasing value of the resistance R and with increasing values of the capacitance C and voltage E.

The indicator's dead time decreases if the capacitance C and the resistance R are reduced and if the voltage E is increased.

The functioning of the indicator is not critically dependent on the precise components. Their parameters can fluctuate over wide ranges in terms of set values. This also applies to the transistor Q_1 and the thyristor Q_2.

Depending on the parameters of the transistor and the thyristor and at a sufficiently high voltage E, the indicator could become a relaxation generator. In such cases the voltage E should be lowered until the generations disappear.

When quantitative measurement is necessary (precise counting of the pulses in a given period of time), an electronic counter should be connected in parallel with the speaker.

The supply voltages E and E_1 of the indicator can be equal and taken by one rectifier – 450 V dc. It is better to be able to vary E and E_1 separately, for example with two potentiometers. In this way we can choose the most appropriate working regimes for the components, regulate the volume of the sound indicator, measure the starting voltage of the GMC, register its counting curve etc.

For safety the whole circuit should be placed in a box with the direction of the radioactive rays indicated.

The indicator can be used not only for educational purposes, but also as an audible alarm system for the presence of radioactive sources.

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