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Methodological Notes

LECTURE DEMONSTRATIONS OF SHOCK WAVES IN A LIQUID

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SHOCK waves in liquids are used in industry for punching, crushing, etc... Recently, medical industry has come out with a special apparatus (URAT-1) for crushing stones in the urinary bladder by means of shock waves created in an electric discharge.

Demonstrations of electric discharges in liquids by means of electrophores and Leyden jars have been conducted earlier. In these demonstrations, the discharge energy was not great, since an additional (air) spark gap was needed and the capacitance of Leyden jars was small. Low-power shock waves were obtained.

The circuit used by us in the demonstration set-up is shown in Fig. 1. An electric discharge occurs between the central wire and the sheath at the end of a coaxial cable. The circuit operates in the following manner. The switch S is placed in position 1. The end of the coaxial cable is placed in a container of water. The capacitor C (100 μf, operating voltage 3 kV), in series with the current-limiting resistor R (220 kΩ), is charged by a low-power high-voltage rectifier (such as VS-9 or VS-23) to a voltage of 2.5–3 kV. When the switch S is placed in position 2, an "explosion" is produced by the discharge in the water.

The following can be demonstrated:

a) Crushing of stones; to do this, the end of the cable is placed in contact with a piece of brick, chalk, plaster, etc. in the water.

b) Punching; the "explosion" is produced in a thin-walled aluminum container filled with water (can of an electrolytic capacitor); the coaxial cable is inserted through a hole in a rubber stopper (Fig. 2). As a result of the "explosion," the container becomes inflated.

The described setup is mounted on an insulated plate fastened to the insulators of a capacitor of type IMZ-100 (Fig. 3). The handle of the switch must be sufficiently long and well-insulated. The plate is covered by a protective housing of organic glass to prevent any accidental contact with the conductors. The working end of the flexible coaxial cable (such as of type RK-50-7-15) is cut so that the end of the interior wire and the sheath do not protrude outside the insulation. The connecting wires from the rectifier have a high voltage insulation, and the rectifier terminals are covered with a cap of organic glass.

Despite the satefy features of the construction, only persons with special training in safety techniques should be allowed to use the apparatus.

After the conclusion of the experiments, any residual charge on the capacitor is removed by depressing the key K (see Fig. 1). This key can also be used to discharge the charged capacitor if the experiment should be interrupted for any reason. The discharge resistor R_1 (10 kΩ) and the key are mounted on the plate, and the insulated key protrudes through a hole in the protective housing (on Fig. 3 they cannot be seen, since they are located in front of switch S and the coaxial cable).

Containers made of glass and of other fragile materials should not be used in the experiments, since they would be damaged.

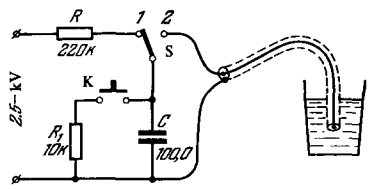

FIG. 1

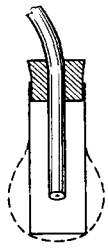

FIG. 2

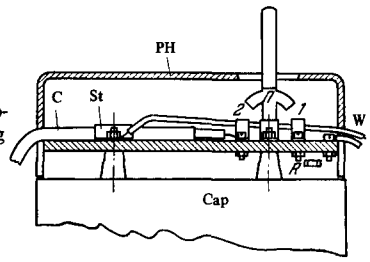

FIG. 3. S – switch, C – coaxial cable, St – cable securing staple, W – wires to rectifier, Cap – capacitor, R – resistor, PH – protective housing.

Translated by L. C. Garder