KLINGER

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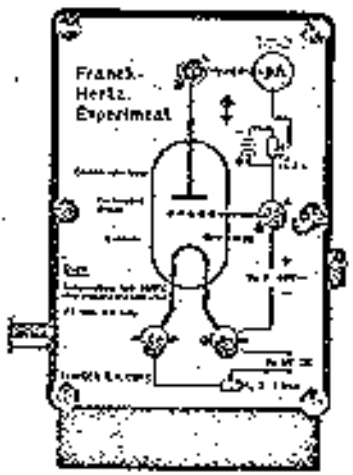
NEW IMPROVED FRANCK-HERTZ TUBE



The tube construction is similar to the original tube used by Franck and Hertz. Rigid mounting and stable position of the electrodes assures dependable results (13 maxima can be obtained). The tube is housed in a thermostatically-controlled metal oven.

Description of the tube

1. The tube has a planoparallel system of electrodes in order to avoid deformation of the electric field. The distance between the anode and the counter electrode is small in comparison to the average free path of electrons whereas the distance between the cathode and perforated anode is large in comparison to the free path of electrons to assure the highest probability of collisions.

2. A platinum ribbon with small Barium-oxide spot serves as a direct heated cathode. A diaphragm connected with the cathode limits the current and eliminates secondary and reflected electrons, making the electric field more uniform.

3. In order to avoid current leakage along the hot glass wall of the tube, a protective ceramic ring is fused in glass as a feed-through to the counter electrode.

4. The tube is highly evacuated and coated inside with getter which absorbs traces of air during the manufacturing process and acts as absorbent during the entire lifetime of the tube and prevents any changes in performance.

The Oven

The oven consists of a steel cabinet, 24 x 16 x 15 cm, containing a heating element which uniformly heats the tube and all connections leading to the tube. The heating element is mounted on the bottom of the housing; its consumption is 300 watt.

The temperature in the cabinet is kept constant by a thermostat which can be regulated from the outside. A hole in the top of the cabinet is provided for the thermometer.

Operation

After the tube has reached a constant temperature, the cathode is heated to a dark red glow and thereafter a DC voltage is applied between the anode and the cathode. A retarding regulated potential 0-3 volt is applied, between the counter-electrode and the anode (Fig. 2). As the accelerating voltage increases, all the electrons which are able to surpass the retarding potential will reach the counter electrode and will be recorded by the current indicator; as soon as the energy of electrons reaches the excitation level of the gas (in this particular case Hg), a quantum of energy is given to the atoms, and the electrons lose the velocity to the degree that it cannot surpass the retarding potential between the anode and the counter-electrode. The current decreases and is recorded on the graph as minimum.

Since the free path of electrons is small compared with the distance between the cathode and the anode, the electrons which slowed down due to inelastic collision, regain new energy in electric field, the current increases until the electrons reach the second excitation level and lose their energy the second time.

As such a transfer of energy from an electron may take place several times as the voltage on the anode increases, distinct current maxima and minima are obtained. In the voltage range from 0 to approximately 60 V, 13 such minima are observed. The difference on the abscissa between the minima corresponds to the value of the energy quantum (4.9 eV). The first peak occurs at about 7 volts because of contact potential between barium cathode and anode made of iron, approx. 2.5 volt.

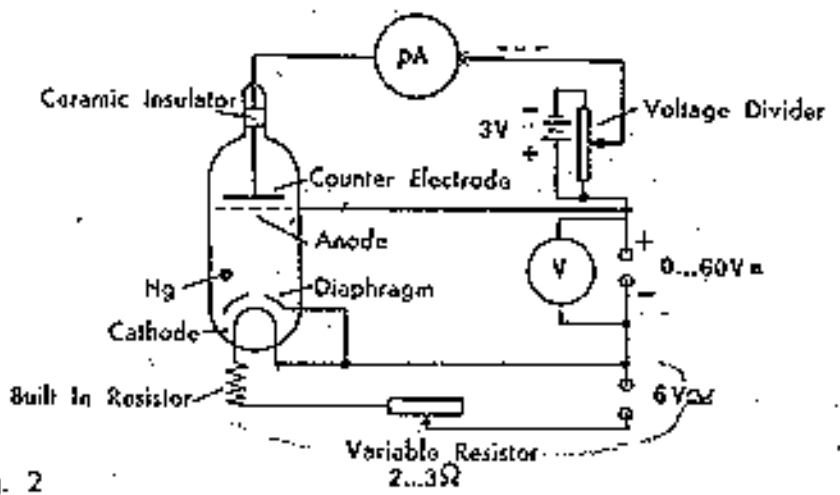


Fig. 2

The Experimental Procedure:

The diagram of connections is shown on Fig. 2. Set the position of the sliding rheostat to its maximum value. Switch on the measuring amplifier, power supply and the heater. It takes about 20 minutes to reach the proper temperature. (In that time, the measuring amplifier also reaches stabilization.) The temperature of the cabinet should be adjusted to 180° C $\pm 5^{\circ}$ C.

Set the sensitivity of the measuring amplifier at 10^{-9} A., the retarding potential at 1.5 volt and raise the acceleration potential to 50 volts. Now, move the slide of the variable rheostat to slowly increase the current in the cathode until the current indicator shows $2 \cdot 10^{-9}$A (full deflection). Immediately after, turn down the voltage on the anode to zero.

At this stage, the apparatus is ready for taking measurements:

Increase very slowly the voltage, read the currents and voltages and record it on the diagram as shown on Fig. 3.

To clearly define the maximas which occur at lower voltages, it may be necessary to increase the amplification to 10^{-10} Amp.

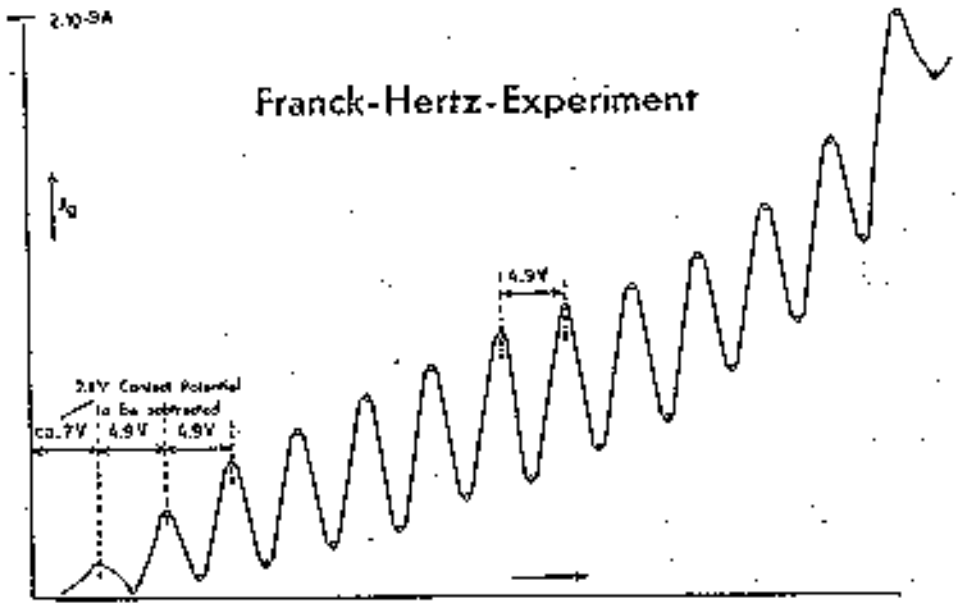


Fig. 3

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Franck-Hertz-Experiment

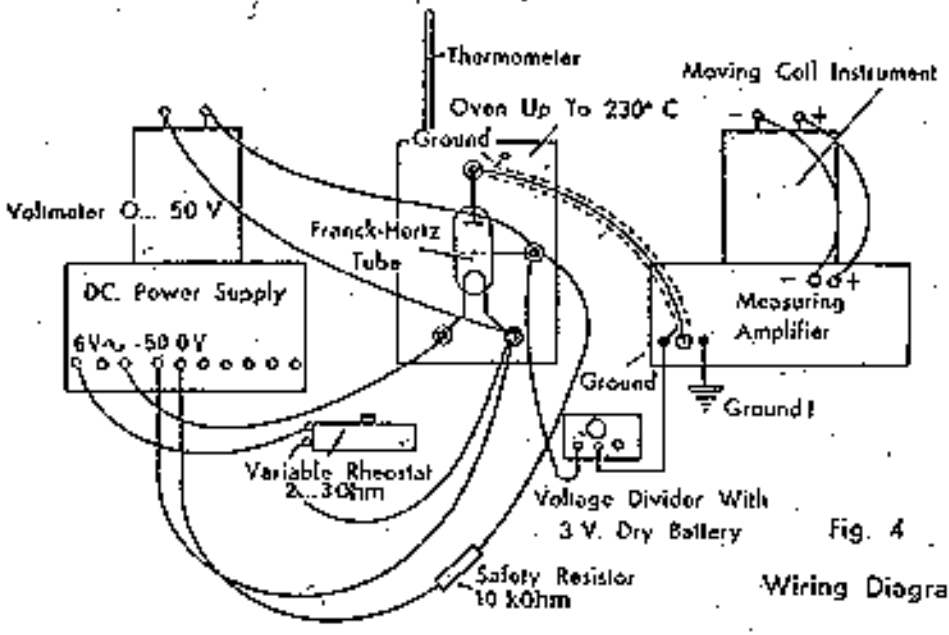

Fig. 4 Wiring Diagram

ORDERING DATA

K4307	Franck Hertz tube filled with mercury	$ 50.00
K4308	Thermostatically controlled oven	45.00
K4304	Variable rheostat 2.4 ohms, 7.5 Amps to regulate the current in the cathode	17.00
K4310	Voltage divider for the counter electrode	9.50
K4302	DC Power supply - 300 Volt with increments every 50 Volt and fine adjustment within each 50 Volt. Filament voltage 4 and 6.3 Volt, 6 Amps. For operation with 115 Volt, 60 cy.	90.00
K4314	DC Meter, Range 50 Volt	22.50
K4313	Set of leads with plugs and special coaxial cable	18.85

For measuring of small currents an amplifier with a current indicator, sensitivity 10^{-9} - 10^{-10} A, is satisfactory. For laboratory use we recommend:

K4309	Universal measuring amplifier	$ 272.00
53155	Moving coil instrument AC, DC, with ranges from 1 mA - 6 A and 0.1 Volt - 300 Volt	68.50

For demonstrations in large lecture room:

53201	Measuring amplifier	$ 385.00
53186	Demonstration multirange meter	260.00

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