Instruction Manual

for

Franck-Hertz Apparatus

Model P67103

1-800-530-1500

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1. Applications

The Franck-Hertz Apparatus (Model P67103) is designed for college students to demonstrate the existence of quantized states. The experiment can be performed in less time because the use of argon tube eliminates the heating of a tube. The data can be recorded manually, or directed to an oscilloscope or computer for display.

2. Identification

The controls on the panel of the device are shown in Fig.1.

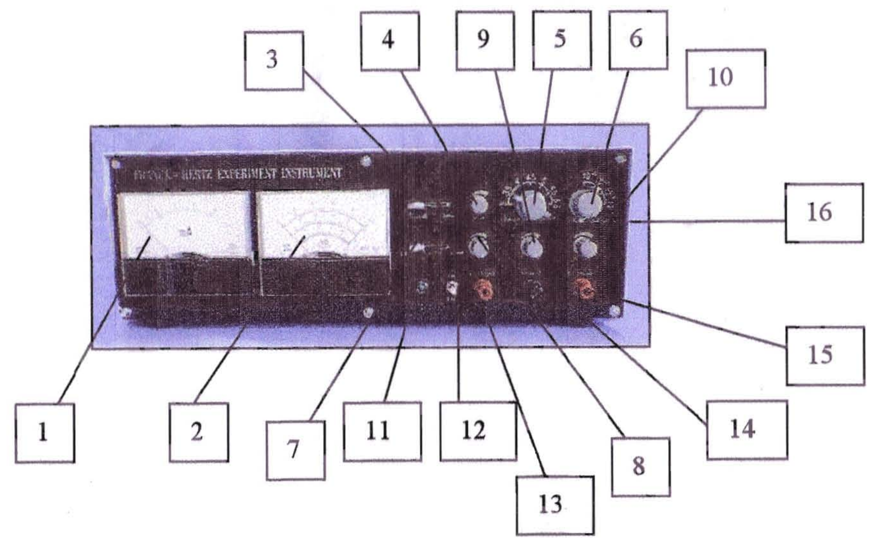

Fig.1

1 Milliameter
2 Voltmeter
3 Manual/Auto Switch
4 Scan Control
5 Filament Voltage Selector
6 Current Multiple Selector
7 Voltage Range Selector
8 1.3 –5V Adjustment
9 1.3–15V Adjustment
10 0-100V Adjustment
11 Power Indicator
12 Power Switch
13 Y-output Terminal
14 Ground
15 X-output Terminal
16 Observation Window

3. Specifications

5. Operations

1. Switch on the power. The indicator will flash.
2. Turn the "Manual-Auto" switch to "Manual", rotate the Scan knob counter-clockwise to end, turn "Filament Voltage Selector" to 3.5V, "Current Multiple" selector to 10^{-7}.
3. Turn "Voltage Stepper" to 1.3 ~ 5V, and rotate 1.3 ~ 5V adjust knob until the voltmeter reads 1.5V to set U_{G1K} =1.5V.
4. Turn "Voltage Stepper" to 1.3 ~ 5V, and rotate 1.3 ~ 5V adjust knob until the voltmeter reads 7.5V to set U_{G2A} =7.5V (rejecting voltage).
5. Turn "Voltage Stepper" to 0 ~ 100V, and rotate 0 ~ 100V adjust knob until the voltmeter reads 0V to set U_{G2k} =7.5V(accelerating voltage).

   When you have finished step 2 ~ 5, with U_H=3.5V (Filament voltage), U_{G1K} = 1.5V (the voltage between the first grid and kathode), U_{G2A} =7.5V(The voltage between the second grid and anode) you are ready to do the experiment These are suggested voltages for the experiment. You can do the experiment by parameters marked on the argon tube either.

6. Turn off the power, move the top cover of the instrument, place the Franck-Hertz tube in lamp socket, replace the top cover and turn on the power The indicator will flash. Preheat 3 minutes, before the experiment.
7. Rotate " 0 ~ 100V" adjust knob, and at mean time observe the variation of rheometer and voltmeter's readings. With the increase of U_{G2K} (accelerating voltage), the rheometer's reading appears peak and valley periodically. Record the corresponding voltage and current. Let the output current be the vertical ordinate, and U_{G2K} the horizontal ordinate. Plot the spectrum amplitude curve.
8. Turn "Manual-Auto" switch to "Auto", and connect the instrument's Y, ground, X socket to Y, ground, X of a student oscilloscope. Put the scanning range switch of oscilloscope to "external X". Switch on the power of oscilloscope, adjust the Y and X shift to make the scan baseline on the bottom of screen, aand adjust X Gain" to make scan baseline 10 grids. Rotate the scanning knob of this instrument, and observe the waveform on the oscilloscope's screen. Adjust the "Y gain" and "X gain" of the oscilloscope's attenuation to make the waveform clear and Y amplitude moderate. Rotate scanning potentiometer clockwise to end, set the maximum scan voltage to 50V, measure the horizontal distance of two consecutive crest (count the grids). Multiply the distance by 5V/grid, to obtain the value of argon atom's first excitation potential.

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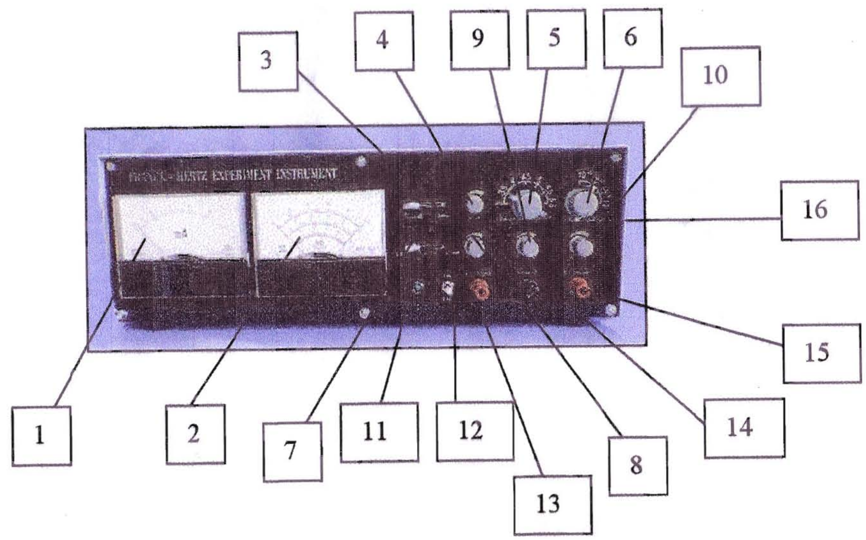

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3. Specifications

A voltage of about 1.5V is added between the first grid (G1) and the cathode (K) to dismiss the effect of space charge on cathode scattering electrons.

When the filament is heated, the electrons transmitted by the cathode oxide are accelerated in the electric field between the second grid (G2) and the cathode, obtaining more and more energy. But at the beginning, because of the low voltage between the second grid and cathode, the electron energy is low. Thus the energy exchanged is little even if the electrons collide with the atom. So the plate current I_A formed by electrons penetrating the second grid will increase with the increase of U_{G2K}. (segment OA in Figure 3)

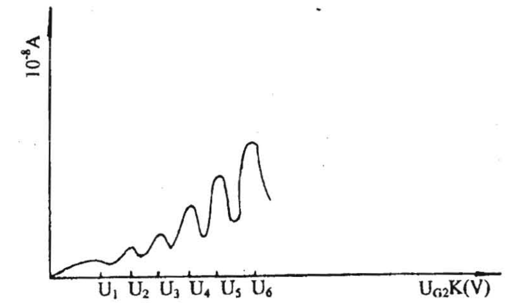

Fig. 3

When U_{G2K} reaches the first excitation potential of the argon atom, electrons collide with argon atoms near the second grid (it is a non-elastic collision), and transfer total energy obtained in the accelerating field to argon atoms, exciting them from ground state to the first excitation state. But electrons themselves, transferring all energy to argon atoms, can't overcome the reverse field. They are drawn back to the second grid even if some of them penetrated the second grid. So the plate current I_A decreased obviously. Then, with the increase of U_{G2K}, the electron energy increased too. There will be enough energy left after the collision with argon atom. Thus they can overcome the reverse field and reach plate A. And at this time current I_A begins to increase again, until U_{G2K} is 2 times the voltage of argon atom's first excitation potential, when electrons between G2 and K lost energy again because the second non-elastic collision causes the second decrease of acceleration voltage U_{G2K}

Let U_{G2K} be the horizontal ordinate and I_A the vertical axis. We can plot the spectrum amplitude curve. The voltage difference between two consecutive valley point (or peak point) is the first excitation potential of argon atom. This experiment illustrates the fact that the slow electrons in Franck-Hertz tube collide with argon atoms, excite the atoms from low level to high level. By measuring the argon's first excitation potential (13.1V, which is constant) We can verify that the energy absorbed and transmitted is discrete, not continuous.