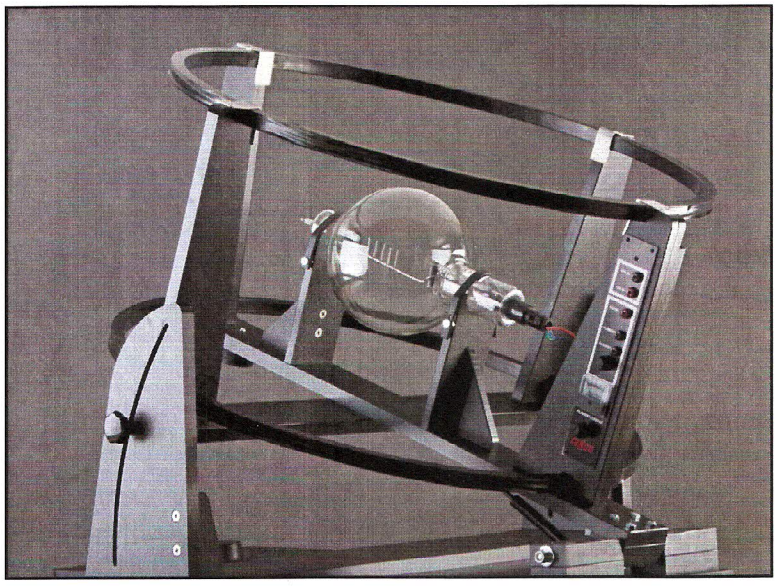
Operating Instructions:
WL0623B CENCO e/m apparatus



PRODUCT CONTENTS

Quantity	Description
1	Helmholtz coil on base
1	e/m tube

OTHER REQUIRED MATERIALS

Dual Power Supply capable of 5 A for the filament and 0 - 40 V for the accelerating voltage.
Power Supply capable of 5 A for the Helmholtz coil
Compass
Dip Needle

ASSEMBLY OF APPARATUS

1. Place the tube into the cradle with the socket end towards the connection panel. Place the rubber straps over the bulb to hold it in place.
2. Connect the female socket from the base to the male socket on the bulb. See Figure 1.

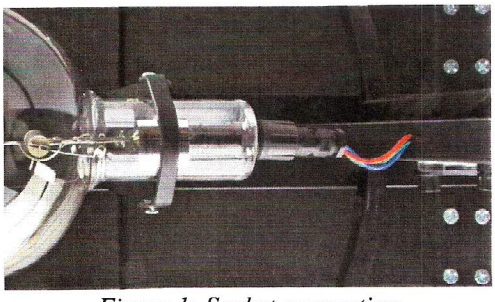


Figure 1: Socket connection

Note:
If you have the older model base then you will need the wire adaptor WLS1803-55. This will serve as a connection between the three binding post and the socket on the bulb.

3. Orient the Helmholtz Coils so that the e/m tube will have its long axis in a magnetic north-south direction, as determined by a compass.

4. Measure the magnetic inclination at this location with a good dip needle.

5. Tip the coils up until the plane of the coils makes an angle with the horizontal equal to the complement of the dip angle. The axis of the coils should now be parallel to the earth's magnetic field.

6. (Perform Step 6 only for the older base style.) Make electrical connections to the tube as shown in Figure 2. Follow the power requirements below before operating apparatus.

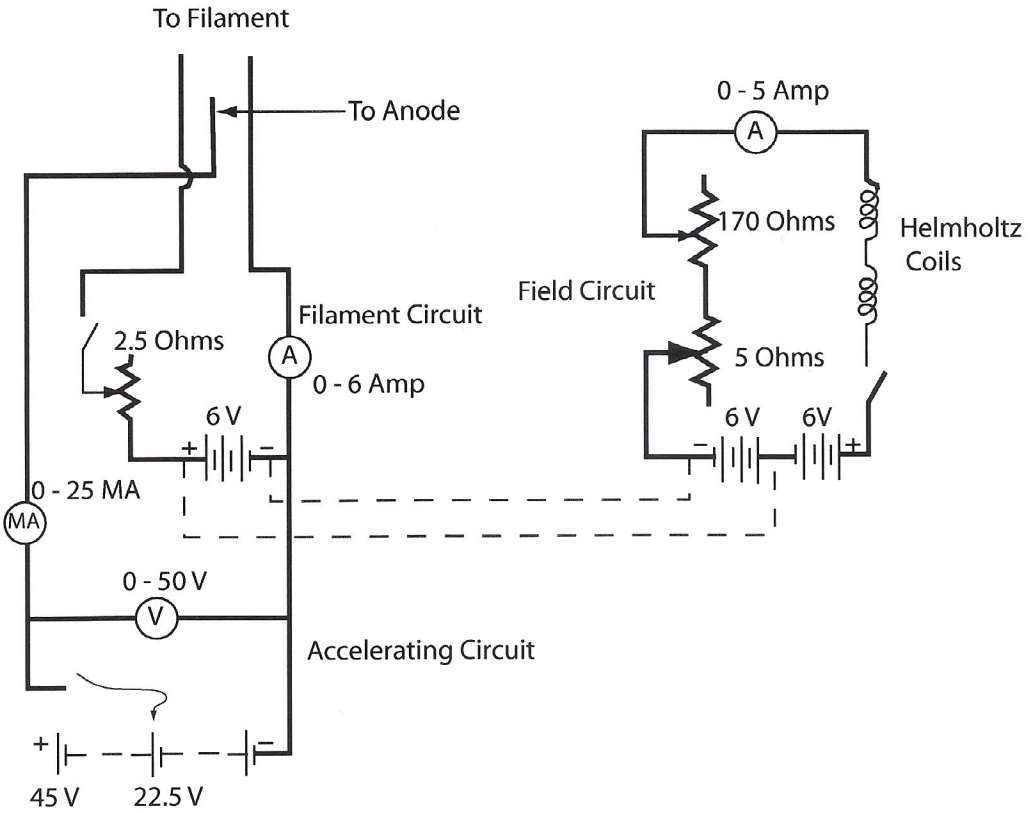


Figure 2: Circuit Diagram

7. Power Supply Requirements:

A. Filament
DC power supply capable of 5 A.
Never let the current go above 4.5 A; this will damage the filament and tube.
The built in fuse helps to protect the filament from receiving more than A than what is can safely use.

B. Accelerating Voltage
20 - 40 V DC voltage range
For more accuracy in the experiment, a DC voltmeter should be connected in parallel with the power supply.

C. Helmholtz Coils
DC power supply capable of 5 A
For greater accuracy, a DC ammeter should be connected in series with the power supply.

DESCRIPTION OF USE/ BACKGROUND INFORMATION

The Cenco e/m Apparatus (WL0623B) is designed for obtaining the value of specific charge to mass ratio (e/m) of electrons. An electron beam is accelerated through a specific voltage, so the electron velocity is known. A set of Helmholtz coils provide a constant and measurable magnetic field which can be adjust so it is perpendicular to the electron beam. The uniform magnetic field deflects the electron beam into a circular path. The axis of the coils may be inclined to the dip angle of the earth's magnetic field for quantitative measurement, and put back to a horizontal position for classroom demonstrations. By measuring the voltage of the electron beam, the current through the Helmholtz coils and the radius of the circular electron beam path the ratio of e/m can be calculated using the equation:

$$\frac{e}{m} = \frac{2V}{B^2r^2}$$

A. The Tube

The tube is filled with mercury vapor at a pressure of 10^{-2} mm Hg. The beam of electrons in the tube is produced by an electron gun composed of a straight filament surrounded by a coaxial anode containing a single axial slit. See Figures 3a and 3b for a schematic diagram of the tube. Electrons emitted from the heated filament (F) are accelerated by the potential difference applied between (F) and the anode (C). Some of the electrons come out as a narrow beam through slit (S) in the side (C). When electrons of sufficiently high kinetic energy, 10.4 electron volts or more, collide with the mercury atoms, present in the tube as mercury vapor, a fraction of the atoms will be ionized. On recombination of these ions with stray electrons from the beam, the mercury-arc spectrum is emitted with its characteristic blue color. Since recombination with emission of light occurs very near the point where ionization took place, the path of the beam of electrons is visible as the electrons travel through the mercury vapor.

Figure 3a is a sectional view of the tube and filament assembly. Figure 3b is a detailed section of the filament assembly at right angles to Figure 3a.

A. Five cross bars.

B. Typical path of beam of electrons.

C. Cylindrical anode.

D. Distance from filament to far side of each of the cross bars.

E. Lead wire and supports for anode.

F. Filament.

GG. Socket connectors and supports for filament.

LL. Insulating plugs.

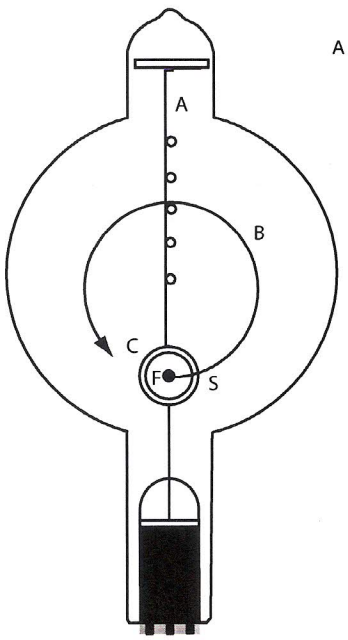


Figure 3a

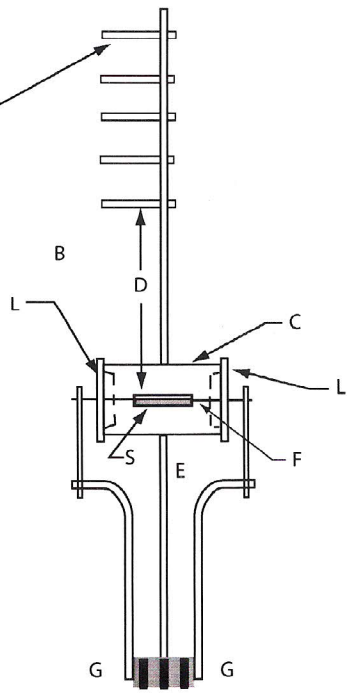
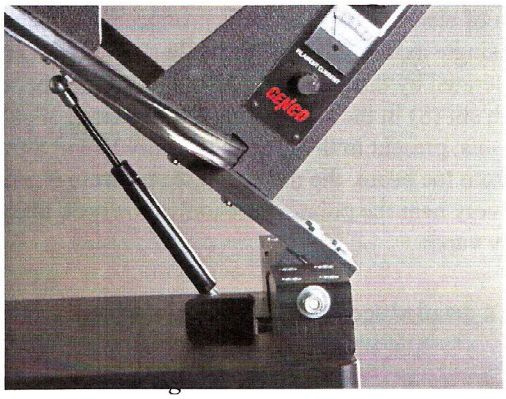


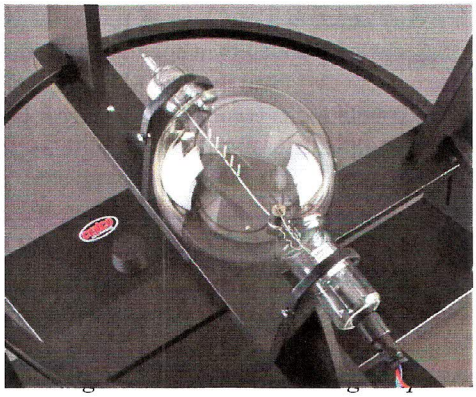
Figure 3b

B. Helmholtz Coils

The magnetic field of the Helmholtz Coils[1] causes the stream of electrons to move in a circular path, the radius of which decreases as the magnetic field increases. By proper control of the magnetic field, the sharp outer edge of the beam can be made to coincide with anyone of the five bars spaced at known distances from the filament.

Each coil of the pair of Helmholtz Coils has 90 turns of copper wire with a resistance of approximately one ohm. The approximate mean radius of the coil is 33 centimeters. The coils are supported in a frame which can be adjusted with reference to the dip angle, so that their magnetic field will be parallel to the earth's magnetic field, but oppositely directed. The two coils are connected together in series through one pair of banana plug jacks. The gas strut, Figure 4, supports the coil assembly and makes it easier to raise and lower the coils. Two plastic cradles with retaining straps, Figure 5, hold the tube in a central plane midway between the two coils.





CARE AND MAINTENANCE

For accurate experimental results and to maximize the life of the e/m apparatus, store the base on a flat study surface. Store the bulb in packing material in dry place where it will not fall.

When operating the unit do not apply more voltage or current than suggested. This will maximize the life of the bulbs. Fuses have been included in the filament circuit to prevent burnout from excessive current.

ACCESSORIES AND REPLACEMENT PARTS

Description	Catalog Number
New Replacement Bulb	WL0623D
Older Replacement Bulb	WL0623
Wire adaptor	WLS1803-55
AC/DC Digital Discharge tube Power supply (Acceleration Voltage and Filament current)	WLS1799-17
Power supply (Coil)	WLS1799-13

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[1] This arrangement of two short, parallel coils is named for German physicist Hermann von Helmholtz (1821-1894), who first used it.