Cold Cathode Rectifier

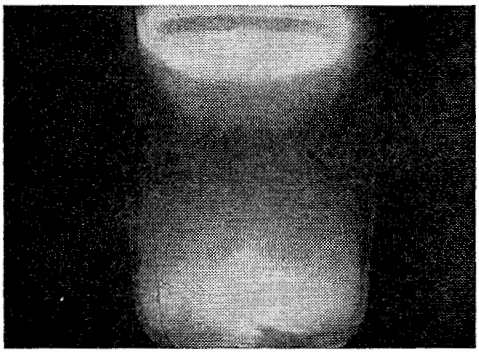

FIG. 14. The cold cathode rectifier tube produces this display when rectifying AC.

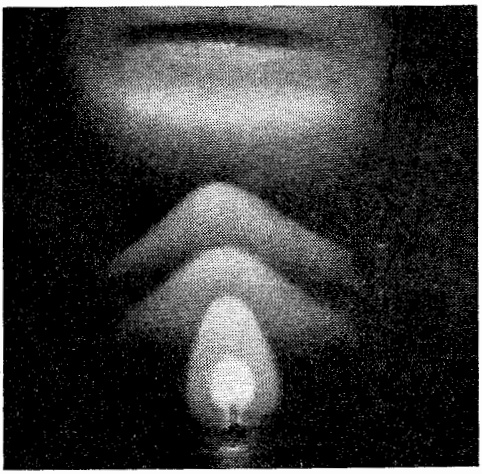

FIG. 15. When operated at low DC currents, tube produces a colorful, spectacular display.

☐ The cold cathode rectifier tube shown in Fig. 5 (left) uses the flash tube jar (Fig. 13A) and the upper ring electrode K (Fig. 8) of the De La Rive tube. Cover the bottom of the ring electrode with heavy aluminum foil to make a plane disc electrode. Insert the electrode in the jar, install the tube in the shield box, and attach the copper test clips to the tube terminals. Evacuate the tube to about .5 mm. hg. pressure.

First, the following experiment using direct current will show that the tube conducts current better in one direction than in the other. Connect the tube to the unfiltered DC output of the power supply making the disc electrode negative and using power supply jacks J3a (negative) and J3c (positive). Adjust the applied voltage by adjusting variable transformer T3 to obtain a tube current of ten milliamperes.

Then, without any readjustment of the power supply control settings, turn off the supply and reverse the cable connections at the power supply jacks to change tube polarity. Next, turn on the power supply and note that the tube current is now only 4 to 5 milliamperes. This shows that tube conduction is greater when the smaller electrode (lower) is positive.

To demonstrate rectification of the high-voltage AC available from the power supply, insert the red cable connected to the lower electrode into jack J2a and the black cable into jack J3a. This connection places DC milliammeter M1 in series with the tube and the AC voltage. Upon applying the AC voltage to the tube, the DC milliammeter will indicate the DC component of current flow through the tube. Using the previous control setting, the current will be about 6 or 7 milliamperes. The discharge in the tube appears as shown in Fig. 14 exhibiting a predominantly blue-white glow. The alternate positive and negative half cycles of AC each produces glow discharges separated in time by ½ cycle. When viewed with a properly synchronized rotating disc stroboscope, each discharge can be viewed separately.

Operation of cold cathode rectifiers depends on the large difference in surface area of the two electrodes. This large difference in area results in a high electric field strength at the small electrode and a low electric field strength at the large electrode.

When the small electrode is positive, electrons are rapidly accelerated to the electrode by the high field strength giving rise to appreciable current flow. But when the large electrode is positive, the electrons are accelerated much less in the weaker electric field at the electrode thereby resulting in a lesser flow of current. Thus, with AC applied to the tube, rectification takes place although not too efficiently in this elementary tube using air as the gas.

An interesting DC glow discharge can be viewed in this tube this way. Energize the tube with DC using power supply jacks J3a (–) and J3c (+). At about .5 mm. hg. pressure and one ma. tube current, the spec-

Electrical Discharge Tubes Cold Cathode Rectifier

tacular striated display shown in Fig. 15 appears. The cathode (upper electrode) is bathed in a soft blue glow with some red nearest the electrode. The lower portion of the tube shows several cones of light, pink in color, making up the plasma or positive column.

When operating these tubes, keep the following in mind. Heating takes place at the negative electrode when operated on DC and at both electrodes when operated on AC. Keep tabs on tube heating, particularly at the lower electrode. For most of the experiments detailed, operation may be continuous with occasional checks on tube heating. Also, as a safety precaution, never evacuate or energize a tube unless it is in shield box.

The tubes and experiments detailed above involve a number of electrical and physical phenomena. These include conduction of electricity through rarified gases, ionization of gases by electric fields, motion of electrical discharge in a magnetic field, rectification of AC current by cold cathode conduction, emission of light by ionized gases and many others. When using these tubes for Science Fair projects, decide on one particular aspect of the subject and do some additional research to provide a complete and thorough explanation of the demonstrated phenomena. ■

MATERIALS LIST—GAS TUBES

Am't Req'd	Size and Description	Use
6′	(1 x 6) wood stock	shield box
1	10 x 13 x ¼″ hardboard	back panel
1	6 x 10 x ¼″ Bakelite	tube platform
1	4 x 5 x ⅛″ Bakelite	resistor board
1	9¼ x 12¼ x ¼″ safety plate glass	shield box
1	2 x 6″ sheet iron or brass	
1	¾ x 3 x 1/16″ copper strip	copper discs
6″	¼″ copper tubing	exhaust tubes
1	⅞″ dia. x 1 1/16″ Bakelite tubing	magnet support
1 each	glass tubing; 5, 10, 15 mm. O.D. x 4¾″ long	glass tube inserts
2′	#12 bare copper wire	electrodes
2′	#6 bare copper wire	electrodes
2″	#22 bare copper wire	electrodes
2	heavy wall twist cap jars	vacuum tubes
1	pair brass hinges and hinge hasp	shield box
2	cylindrical slug magnets, ⅞″ dia. x ¾″ long*	De La Rive tube
2′	vacuum hose, 3/16″ bore, rubber**	
1	jar vacuum grease**	
2	Hoffman pinch clamps**	

* Herbach and Rademan, 1204 Arch Street, Philadelphia 7, Pa. Order TM 8650 magnets, 2 prs./$1.50, include postage.

** Morris and Lee, 294 Elm St., Buffalo 3, N. Y. (Vacuum supplies, plans for converting refrigerator compressors to vacuum pumps.)

MATERIALS LIST—ELECTRONIC PARTS

No. Req'd	Size and Description
5½′	flexible test prod wire, red, HV insul. Belden 8898 (Allied 47T811)
5′	flexible test prod wire, black, HV insul. Belden 8898 (Allied 47T801)
2	standoff insulators. Johnson 135-20-2 (Allied 73H121)
1	oil capacitor, .5 mfd., 8 Kv. WVDC, Plastic Cap. Inc. (Allied 12L840)
8	10 megohm, 2 watt carbon resistors (Allied 2MM080)
1	1 megohm, 2 watt carbon resistor (Allied 2MM080)
2	binding posts, Grayhill 29-100R (Allied 45H258)
2	test clips, copper, Mueller 45C (Allied 45H005)
2	banana jacks, red, HV insul., Johnson 108-902 (Allied 71H267)
1	banana jack, black, HV insul., Johnson 108-903 (Allied 71H268)
4	banana plugs, red, HV insul., Johnson 108-302 (Allied 71H272)
3	banana plugs, black, HV insul., Johnson 108-303 (Allied 71H273)

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. Order by Allied part number listed.

Misc.: Duro E-Pox-E cement, solder lugs, aluminum foil, rh woodscrews and other misc. fastenings

Basic Science Library

(Continued from page 13)

cal data but substantially more information pertaining to physics. The relative page counts suggest that this is a better buy for your money than Lange's book. However, both should be examined carefully to see which has the more useful data in terms of your individual needs.

EXPERIMENTAL PHYSICAL CHEMISTRY

F. Daniel, J. W. Williams, P. Bender, R. Alberty, C. Cornwell
McGraw-Hill Book Co., New York
6th Ed. 1962 640 pages $7.95

The purpose of this book is to illustrate the principles of physical chemistry, train in careful experimentation, develop familiarity with apparatus, and encourage research.

Laboratory experiments include such subjects as: dielectric and optical properties of matter; spectroscopy; diffraction, macromolecular chemistry; surface chemistry; photochemistry; radioactive isotopes and tracers. A section dealing with apparatus and methods includes material on: data handling; opticochemical measurements; thermal and electrical measurements; nuclear and radiation chemistry; purification of materials; photochemistry, spectroscopy; electronics.

THE MERCK INDEX OF CHEMICALS AND DRUGS

Merck & Co., Inc., Rahway, New Jersey
1960 1641 pages

This big encyclopedia—compiled for use by chemists, physicians and pharmacists—contains about 10,000 descriptions of chemical entities (not counting derivative materials). It boasts a cross index of about 30,000 names.

The data for each compound generally in-

(Continued on page 90)