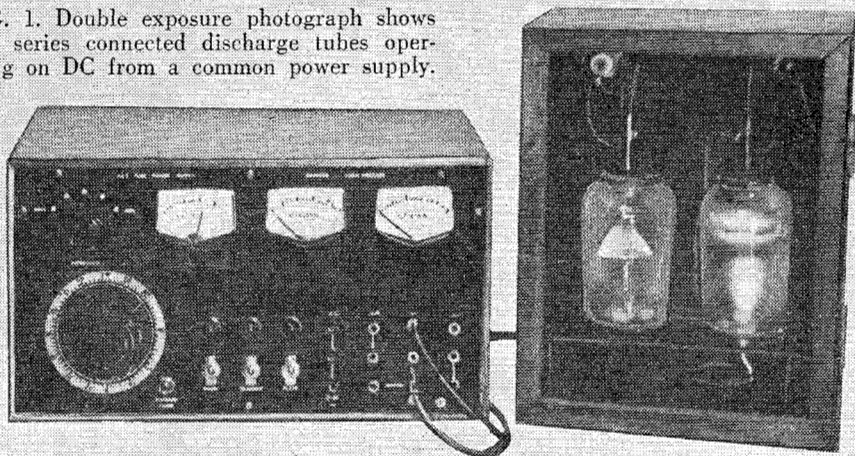


ELECTRICAL DISCHARGE TUBES

By A. A. Mangieri

FIG. 1. Double exposure photograph shows two series connected discharge tubes operating on DC from a common power supply.



A modified De La Rive tube, electronic flash tube and cold cathode rectifier tube for home experiments, demonstrations

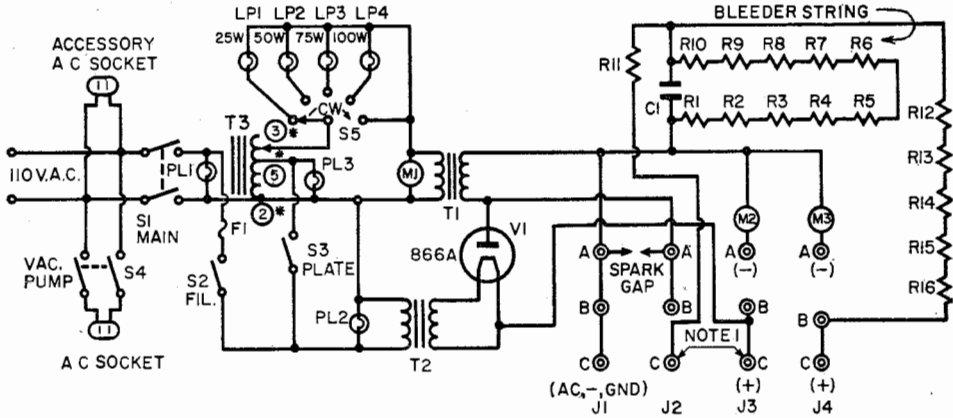
THREE special purpose electrical discharge tubes, suitable for use in Science Fair projects and for home laboratory experiments, are described. First, a modified De La Rive tube demonstrates the motion of an electrical streamer discharge in the presence of a magnetic field. Second, an electronic flash tube is detailed which produces periodic flashes of intense light. Third, a cold cathode rectifier tube, which has no heated filament, demonstrates cold cathode rectification of alternating current.

The tubes are operated from an adjustable high-voltage power supply providing AC and DC voltage up to 7 kilovolts peak and up to 20 milliamperes current with high internal impedance to stabilize and limit the tube currents. A small mechanical vacuum pump is required to evacuate the tubes to operating pressures. This equipment may be available in a well-equipped science laboratory.

Power Supply

VALUES SHOWN ARE NOMINAL

VOLTAGE	I MAX (SHORT CIRCUIT)	V MAX (OPEN CIRCUIT)	JACKS
ALTERNATING CURRENT	20 MA	7 KV PEAK	J1A, B, C AND J2A, B
UNFILTERED HALF WAVE	20 MA	7 KV PEAK	J3A(-) AND J3B, C(+)
FILTERED DC	0.8 MA	5 KV	J4A(-) AND J4B, C(+)



1- PATCH CORD. JUMPER J2C AND J3C TO OBTAIN OUTPUT AT J4

*-DESIGNATES TERMINAL NUMBERS ON OHMITE VT4 VARIABLE AUTOTRANSFORMER

FIG. 2

JACK POSITION AS VIEWED FROM PANEL

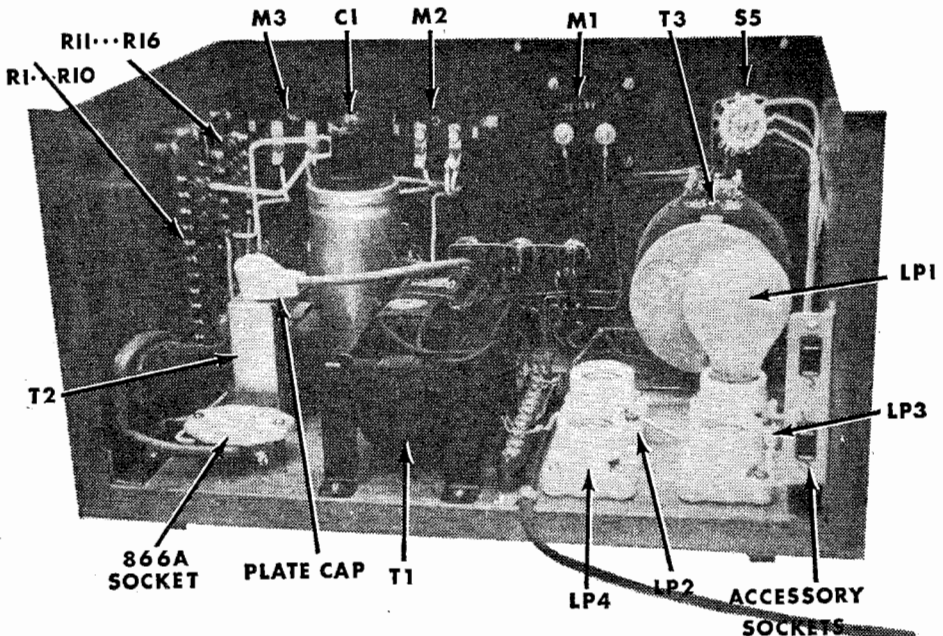


FIG. 3. Inside cabinet, parts locations are easily identified. Mount large parts first.

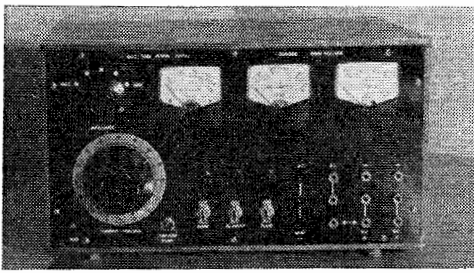


FIG. 4. All controls are mounted on front.

□ The power supply shown energizing the tubes uses the circuit of Fig. 2. The high-voltage neon sign transformer, T1, has the required current limiting feature for operation of gas tubes built into the transformer. Ordinary house lamps LP1 through LP4, selectively switched in series with T1 by means of S5, provide maximum power supply impedance at position 1 of S5 and minimum at position 5. Variable autotransformer T3 permits fine adjustment of voltages, currents.

House the components in a 9x7x10-in. deep wooden cabinet and use only a Bakelite panel. Mount the transformers T1 and T2, capacitor C1, and sockets directly on the wooden base of the cabinet breadboard style. Use only high-voltage hookup wire such as Belden 8868 for all high-voltage wiring which includes the 866A tube, the secondary windings of T1 and T2, C1, meters M2 and M3, resistors R1 through R16 and all banana jacks. Meters M2 and M3 should be totally insulated types. If the meter has a metal case or adjusting screw, install a large clear plastic guard plate in front of the meter to prevent personal contact with metal.

Mount resistors R1 through R10 on their own resistor board and secure within the cabinet. Do the same for resistors R11 through R16. Allow 1-in. clearances between all jacks, mounted in a group on the panel, and between the meters, C1, T1 and T2, and the 866A to prevent internal arc-over.

The spark gap is simply two short lengths of heavy bare copper wire, sharply pointed, and soldered to the rear of jacks J1a and J2a. Space the points, facing each other, by about $\frac{1}{16}$ in. This gap halts the destructive build-up of high-voltage transients in the transformer by arcing over when the voltage rises excessively.

The spark gap length is adjusted by bending the electrodes (with power off and S5 at position 5) so that the gap just begins to arc over as the indication on M1 indicates 130

volts by advancing T3. Make gap adjustments *only* after the power has been turned off for at least five minutes (remove line cord plug) and *only* after shorting the terminals of the capacitor with an *insulated* plastic-handled screwdriver.

Attach a HV insulated banana plug to each end of a 7-in. length of HV test prod wire for use as a jumper between jacks J2c and J3c. Use the jumper between these jacks when using jacks J4 for filtered DC output. Label all switches, controls, and jacks with decals or otherwise. Mount a well perforated panel on the rear of the cabinet. The AC sockets (optionally included) mount on the rear of the cabinet. Check the wiring.

To use the power unit, all switches must be initially off and T3 set to zero. First close S1 and S2. For the first warm-up of the 866A tube, allow ten minutes before closing S3. Thereafter, a one minute warm-up is sufficient. Depending on the setting of S5 and T3, and also on the load on the unit, the indication on M1 should be no greater than 130 volts.

If the spark gap is heard to spark over during tube operation, back off T3 slightly. Connect an earth ground to jack J1a. If a large spark takes place when grounding the unit (with T3 well advanced), reverse the leads of T1. The available voltages and their corresponding jacks are listed on the schematic. As with any other high-voltage power supply, use caution to prevent shock.

PARTS LIST—POWER SUPPLY

No. Req'd	Size and Description
1	T1—Neon sign transformer, Pri., 110 vac. Sec., 5 KV at 20 ma. Open frame type. (Hart)*
1	T2—Filament transformer, Pri., 117 vac. Sec., 2.5 volts at 5 amps. 7.5 KV insulation. Stancor P6133. (Allied 646141)**
1	T3—Powerstat. Ohmite VT4. 0-140 vac. (Allied 61G-220)**
10	R1—R10—10 meg., 2 watt carbon resistors. 10%
6	R11—R16—1 meg., 2 watt carbon resistors. 10%
1	C1—1 mfd., 8000 WVDC oil capacitor. (Allied 12L-838)**
1	M1—0-150 AC voltmeter. Triplett M. (Allied 87F838)**
1	M3—0-1 ma. DC milliammeter. Triplett M. (Allied 87F-836)**
1	S1—DPST toggle switch. (Allied 34B502)**
2	S2, S3—SPST toggle switch. (Allied 34B500)**
1	S4—DPST toggle switch. 15 amps. (Allied 34B594)**
1	F1—Fuse, 3 amps., 3AG.
1	S5—Rotary switch, single pole, 5 pos., 1.5 amps. (Allied 36B063)**
3	PL1, PL2, PL3—panel lamps, 110 vac.
1	LP1—25 watt, 115 volt incandescent lamp.
1	LP2—50 watt, 115 volt incandescent lamp.
1	LP3—75 watt, 115 volt incandescent lamp.
1	LP4—100 watt, 115 volt incandescent lamp.
1	V1—866A rectifier tube.
12	J1a thru J1c—HV insul. banana jacks, Johnson 108-902. (Allied 71H267)**
Misc.	866A tube socket & plate cap, HV test prod and hook-up wire, four Edison lamp sockets, fuse post, resistor board, Bakelite panel, misc. fastenings etc.
	* Hart Electrical & Sign Supply Co., 91-93 West Broadway, South Boston, Mass. \$13.45 ppd.
	** Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.