

External Grid Vacuum Valve Construction

A Unique and Simple Means of Making Experimental Amplifiers

By R. U. CLARK, 3rd

SINCE the introduction of the first real practical hot filament detector into the radio field, it has been the one great ambition of every wireless amateur to construct experimental vacuum valve detectors for personal use. Sad to relate but very few workers in the

in with the line of work being undertaken at the time of enlightenment, the incident will be forgotten or prove of little use. The author—and probably many others—had often thought of using the "High-low" type of electric light bulb for constructing valve detectors, but had always given the

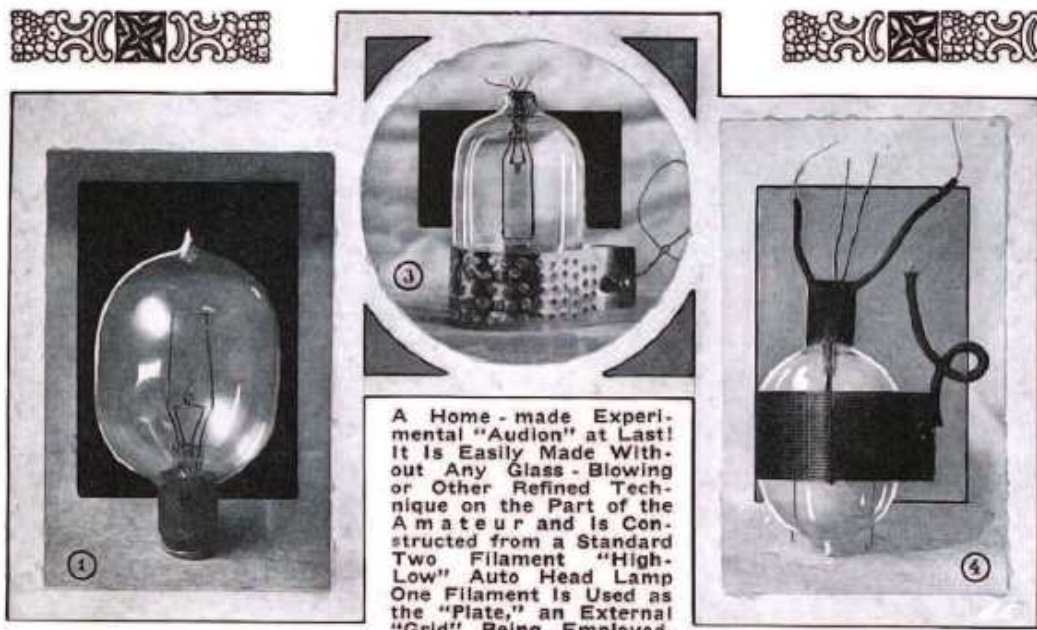
from the makers, and specified in this case "without bases," it will be necessary to carefully remove the brass ferrules and sealing compound, which together form the lamp base, after first cutting the connecting wires away at the contacts to which they are soldered. This work is best done with a small file and a pair of nail scissors, or pinners, and much caution should be observed to prevent accidental breakage.

It will be taken for granted that the experimenter intends to prepare more than one bulb for the initial try-out. Altho there may be a slight difference noticeable in the behavior of different lamps of the same make, the variation will be found in most cases to be very slight. The first bulb tried out, however, might be defective; hence the advisability of using more than one lamp in testing out the idea involved.

A word at this point in regard to the operation of the valves under consideration may save much trouble later on in the game. A good deal has been said against the hot filament detector which is manifestly undeserved. It has been repeatedly stated that, unless exhausted of air to a very exact degree, devices of this nature will prove worthless as detectors. Quite naturally, this is true to a certain extent, but it is often possible to obtain almost equally good results from valves which may vary in this particular, provided the operator is willing to work to find the optimum point of filament luminescence and high voltage adjustment, as required for the utmost sensitiveness under varying conditions of vacuum within the bulb at hand.

Another point worth mentioning is that of the strange and oftentimes erratic action of this class of detectors after they have seen considerable use, which calls for the same solution as above stated. The fact is that probably no one thoroly understands these bulbs as yet.

Before fitting up the lamps as detectors, the wires which lead to the inside should be tested for a possible short-circuit which must, of course, be avoided, except as explained elsewhere. In order to gain a clear conception of the new bulb circuits, which are to be obtained by rearranging the filament leads, the reader is asked to refer to the diagrams in Fig. 2. In this drawing the view *A* represents the original connections as made by the manufacturers. At the point *1* in this view the wires should be disconnected. At *B* and *C*, same figure, the cor-



A Home-made Experimental "Audion" at Last! It is Easily Made Without Any Glass-Blowing or Other Refined Technique on the Part of the Amateur and is Constructed from a Standard Two Filament "High-Low" Auto Head Lamp One Filament is Used as the "Plate," an External "Grid" Being Employed.

past have had the means necessary to perform much research work in this branch of the art, owing chiefly to the expensive apparatus required for the actual construction of the bulbs.

It is regrettable that the above should be the case—especially in view of the fact that the particular instrument under consideration may still be considered in the embryonic state, and quite capable of being vastly improved.

The present high cost of all good detectors of the valve-amplifier type precludes the possibility of their being used, in furtherance of new ideas, except by those with money to spare, and in most cases places them beyond the reach of many earnest workers.

After a considerable expenditure of time and money, the writer has evolved a very simple and inexpensive method of making experimental vacuum valve detectors, of the external grid type, which will be explained at length in this article. It is the hope of the author that the idea involved, which has been thoroly proven, will be of great interest to a large class of readers. Certainly no one field offers more opportunities of interest to experimenters than the one in mind.

Considerable incentive and encouragement may perhaps be found by others in the fact that, altho the direct outcome of no little work, the actual discovery of the double filament bulb, that plays the all-important part in making our experimental detectors, was the result of chance. During a few minutes' respite, spent in looking thru a motor magazine, the writer became aware that the solution of the problem of making valves was staring him in the face in the guise of an auto head-light bulb with two filaments.

It often happens that such discoveries are the result of chance, but the fact remains that unless the particular finding fits

idea up as impractical. It remained for the urge of real necessity to demand that every possible means be given a thoroly trial.

As may have been already surmised, the real workable valves which are illustrated in the views accompanying this exposition, are not only of the external grid type, but also have two filaments, and thus giving double life to the instrument. It will be at once apparent that, since the bulbs contain two separate filaments and circuits within them, that one is to be heated by the low voltage battery, and the other is intended to constitute the plate, and when used as such its two wire leads will be short-circuited. When one filament has burned out in use it will be reconnected to form the plate, while the other filament, formerly acting as a plate, will furnish the heat necessary to throw out the stream of desirable electrons, on which the whole action of the device depends.

In the first illustration there is shown a view of the "High-low" auto head-light bulb which does the trick. This lamp should be purchased in accordance with the following specifications, and if not obtainable at any of the big auto supply houses in the reader's home town, they can be had from the makers or others as listed elsewhere in this issue.* The bulb which the author, after many tests, has found best suited to the peculiar requirements of the valve detector is rated as follows:

Maker's
Number Volts C.P.
T 14 6-8 4 & 12, also 12 & 18 C.P. semi-tubular in shape,

with double-contact bayonet base. Usual retail price 80c, with 35% off on lots of 5, making the price 55c each.

*Unless these lamps are specially ordered

Send stamped self-address envelope to the editor and names of concerns supplying these lamps will be sent gratis.

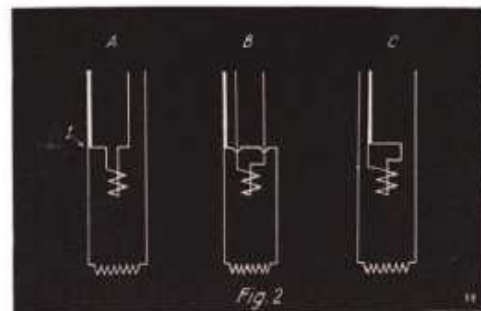


Diagram Showing How Two Filaments in the "High-Low" Auto Head Lamp Bulb are Connected to Give Two Different Forms of "Plate" Element.

rect wiring plan for using the upper and lower filaments respectively, at incandescence, is shown.

(Continued on page 58)

The Breakers

on the
ocean front



Atlantic City's Newest Fire-Proof Hotel

offers unusual attractions during Autumn and Winter Seasons. Luxurious lobbies, spacious verandas, restful sun parlors and superb music. A palatial residence for those seeking rest and recreation.

American and European Plans

Illustrated literature and terms mailed
Garage with accommodations for chauffeurs.

High Frequency Bargains

In taking our inventory we found over 200 Violet-Ray machines of all makes. We selected 100 of the best machines, which we thoroughly overhauled in our factory making them better than new. Many of these machines cost over \$40.00.

We have placed all these instruments in two groups and are disposing of them for the ridiculously low price of **\$9.75** and **\$12.50**.



How to secure one of these machines

Send only 50 cents to pay express charges and we shall send you one of these instruments by express for your examination. This amount will be deducted from total cost of machine. You need not accept if not satisfactory.

Send at once for we shall send the best machines out first and the quicker you send in your order, the better machine you will get.

We shall also send our beautiful booklet "Violetto" describing the many uses for the high-frequency current. Write us before purchasing any kind of Violet-Ray Machine.

BLEADON-DUN CO., 11-17 S. DESPLAINES ST.
Dept. 2A CHICAGO

two electrodes EE, and the poles of an electromagnet MM, were situated at right angles to each other so that the rays could be deflected in opposite directions by either a magnetic or electric field. The procedure was then to first deflect the rays by an electric field of known strength to any point B on the luminous screen; then to increase the magnetic field in the opposite direction until the rays were just brought back to their original position again.

By knowing the strengths of both the magnetic and electric fields it is easy to calculate the velocity of the rays, for it is a well-known fact that the force of an electric field on an ion *does not* depend on the velocity of the ion, while the force of a magnetic field on an ion *does* depend on the velocity of the ion, or in other words upon the number of lines of force it cuts per second. These facts may be expressed by simple formulas well known to students of physics, as follows:

$$\text{Magnetic force} = H e v \text{ and} \\ \text{Electric force} = V e \text{ where}$$

H and V are the strengths of the electric and magnetic fields respectively, "e" is the charge on the ion and "v" is the velocity of the ion. In the experiment the rays were brought back to zero so that it is evident both fields are equal, therefore:

$$H e v = V e, \\ \text{or } v = \frac{V}{H} \text{ whereby the velocity is deter-}$$

mined from V and H which are known, or can be measured.

From such determinations it has been found that the positive ions in a tube like the one shown may travel as slow as 600 miles per second, and from their speed they are identified as helium atoms. Others traveling at approximately 2,000 miles per second appear to be hydrogen atoms, which are the smallest positive ions so far known. The negative ions travel in such a tube at about 100,000 miles per second or even as high as the velocity of light, and are without doubt free electrons. Under other conditions much slower moving ions are found than any mentioned and they probably correspond to the groups or clusters noted earlier. Much work is now being done to determine the nature of ions under different conditions, and this bears directly on the problem of the nature of Electricity itself.

EXTERNAL GRID VACUUM VALVE DETECTOR CONSTRUCTION.

(Continued from page 28)

A glimpse of a semi-finished detector is presented in Fig. 3, in which the outside grid has been lowered to give a clear view of the interior of the bulb. In this picture the base wires are shown separated, but not connected to the necessary leads which are shown elsewhere.

Some idea of the finished appearance of our detector can be gained from a survey of Fig. 4. The grid on these valves is made of perforated aluminum or nicked brass. The holes can be punched by hand or the material bought in the finished state.

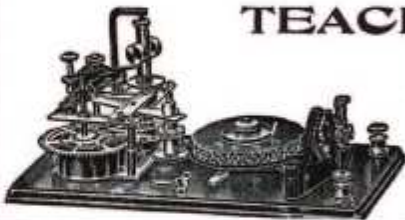
It may be that some who glance at this article will form the opinion that the detectors illustrated will not give good results on account of the small area and positions of the internal parts. This, however, has not proved the case, as the author's experiments with the bulb actually pictured here have proved them quite sensitive under the right conditions.

The matter of current regulation with this valve is a rather important one. In

"THERE'S MONEY IN IT"

AT HOME LEARN TELEGRAPHY AT HOME
MORSE AND WIRELESS

TEACH YOURSELF



in half the usual time, at trifling cost, with the wonderful Automatic Transmitter, THE OMNIGRAPH. Sends unlimited Morse or Continental messages, at any speed, just as an expert operator would.

Adopted by U. S. Gov't. 4 styles. Catalogue free.

OMNIGRAPH MFG. CO.
39L Cortlandt St. New York

SAVE 25% to 60%
on slightly used

GRAFLEX-KODAKS

Cameras and lenses of every description. Equal to new. Save money. Write now for Free Bargain Book and Catalog. Selling hundreds of money-saving bargains in slightly used and new cameras and supplies. All goods sold on 10 days' Free Trial. Money back if not satisfied. You take no chances dealing with us. We have been in the photographic business over 15 years. Write Now

CENTRAL CAMERA CO., Dept. 175, 124 So. Wabash Ave., Chicago

Convert Your Bicycle Into a Motor-Cycle



We sell you the motor complete or furnish you with the finished parts from which you can build the motor yourself with few tools. We send you the printed instructions with blue prints of the drawings for \$25 or full particulars for 3-cent stamp.

STEFFEY MFG. CO., 5025 Brown St., Phila., Pa.

order to operate the valve efficiently the filament must burn brightly and should be fed at about 20% above the specified voltage, the exact amount varying with changing conditions. An accurate low voltage rheostat is essential for the proper handling of any hot filament rectifier, and especially so in the case of our instrument. The regulation of the high voltage battery, however, presents the greatest variation from common practise, and therefore affords much opportunity for research work.

A 'phone circuit battery of about 60 volts is generally considered quite sufficient for the majority of present-day valve detectors, but in the case of the bulbs under consideration it is best to command a high potential of up to 70 volts, altho very good results can be obtained with as little as 50 volts. The current from the cells which form this battery must be controlled by a potentiometer of very high resistance or, better still, several pairs of high resistance 'phones can be substituted therefor. The author has found during his tests that a potential of about 75 volts, subjected to the retarding effect encountered by using the skin of the hand or fingers as a rheostat, gave unusually good results.

The idea of using part of one's body as a current regulator is, of course, impractical, but the resultant effect is so striking that it leads the author to believe that a new instrument may be developed to take the place of the present potentiometer, which is known to be a very wasteful instrument. An adjustable bank of receivers of different resistance but similar pitch, connected with a common sound chamber or horn, should entirely eliminate the need of a potentiometer. There is also a chance of employing a variable condenser in this connection to approximate the capacity effect obtained in using the body as a resistance.

During the war it will naturally be impossible to test out any form of wireless instruments, except in the laboratory, where some type of non-radiating circuits must be utilized, and even there a buzzer practise set would constitute the limit of sending power available now. No aerial or ground connections are permitted under the recent Radio Act.

For the real electrical experimenter and research worker there still remains a wide field in which to work with any type of valve-amplifier that is not too highly valued to experiment with. Two of the many possible uses to which electronic relays can be put outside the radio field are considered separately in the following paragraphs.

Hot filament valves are slowly coming into use as rectifiers of electric current in commercial stations, but are still considered in the chrysalis, or unfinished state. The great draw-back in using bulbs for this purpose lies in the excessive waste of filament which takes place, making the rectifier very short lived. It would be folly to use an expensive instrument for experiments along this line, but one of our lamps, which cost only about 60c to replace, may be used without one's being considered extravagant. By using the filaments interchangeably at intervals of a few hours each it may be possible, under the right conditions, to greatly increase the active life of these bulbs when used as model rectifiers.

The most wonderful property of the vacuum valve, and the one which holds the most in store for the inventor, is doubtless its ability to act as an amplifier. For increasing, indirectly, electrical energy and mechanical motion the electronic valve presents a very desirable medium. Many systems of automatic sound control are being developed with the aid of the amplifier valve. There is no limit to the possi-

bilities of experimentation in this direction. Loud-speaking megaphones, phonographs, telephones, horns, ad infinitum, all await development. Submarine destroying devices, aerial torpedoes, locating apparatus of all kinds, can be invented which will prove to be the undoing of things out of sight, but not out of the hearing of the delicate ear of the microphone, augmented and sensitized by the addition of an amplifier bulb.

It is the author's hope that the foregoing ideas may prove of real interest to a very large class of readers.

Important Notice to Subscribers

Due to the congestion existing at the present time in all railroad movements, also on account of the fact that many train clerks have gone to war, there is a congestion of mails all over the United States. It may happen that your magazine will be slow in reaching you, and this delay may be from a few days up to several weeks.

Kindly bear this in mind before sending in a complaint, as the magazine will surely reach you in due time. Only after not having received a certain copy for a period of three weeks should a complaint be sent in.

You will confer a favor upon the publishers not to write until this time has elapsed, thereby saving them a vast amount of clerical labor.

THEORY OF TUNING, WAVE LENGTHS AND HARMONICS.

(Continued from page 33)

terminals of the parts of a circuit can be more than that which is applied to the whole circuit.

The relation of the different pressures may perhaps best be represented by such a diagram as shown in figure 3, in which the two pressures of 2,915 volts are shown at such an angle with each other as to form a resultant pressure equal to 110 volts. The two large pressures are very greatly out of phase with each other, so that their geometric resultant on this composite mutual effect is really only 110 volts.

The next step in the development of our discussion should be to consider what will happen in the circuit, and the numerical effect on the equations given, if the frequency of the applied pressure is doubled; that is, f is to become 120 cycles. In this case $2\pi fC = 754$, very nearly. Supposing the condenser is the same as used when the frequency was 60 cycles; the value of

$$2\pi fC = 754 \times \frac{1}{100,000} = .00754 \text{ and } L = \frac{1}{.00754 \times 754} = 0.17 \text{ henry.}$$

It is thus evident that with a given condenser having an unchanging capacity, if the frequency is doubled, the value of the inductance must be decreased four times in order to produce a condition of complete resonance in the series circuit.

The current in the circuit under the new condition of doubled frequency will be the same as with the original frequency of 60 cycles, provided the ohmic resistance has not been changed, and likewise the pressures between the terminals of the condenser and of the coil will be 2,915 volts as before. In order to decrease the inductance four times, the number of turns in the coil, or included in the circuit by the contact P will need to be only one-half as many as were originally included. If the number of turns were decreased three-fold the inductance would be reduced nine-fold.

(Continued on page 62)

\$2.50 a Month
The masterpiece of watch manufacture—adjusted to the second, positions, temperature and isochronism. Encased at factory into your choice of the exquisite new watch cases.

21 Jewel Burlington

All stars for both men and women

The great Burlington Watch sent on simple request. Pay at rate of \$2.50 a month. You get the watch at the same price even the wholesale jeweler must pay.

Write Today for Free Watch Book

See handsome color illustrations of all the newest designs in watches that you have to choose from. Your name and address on a postcard is enough. Get this offer while it lasts. Write today.

Burlington Watch Co. Inc. 7445 19th & Marshall Bld. Chicago

414 PAGES
145 ILLUSTRATIONS

I.C.S. ELECTRICAL ENGINEER'S HANDBOOK

50c

ELECTRICITY!

HERE'S just the book on Electricity that you need to answer your many questions—to solve your knotty problems, to teach you new kinks, to be your memory for tables, rules, formulas and other Electrical and Mechanical facts that some people try to carry in their heads—and fail.

With this "Little Giant" I. C. S. Electrical Engineer's Handbook in your pocket, tool chest, on your work bench, drawing table or desk, an hour or a day need not be lost "dirging up" some forgotten rule, some unfamiliar fact; you'll just turn to the very complete index and get it "in a jiffy." Just a few of the subjects treated are:

- Electricity and Magnetism; Electrical Symbols; Batteries; Circuits; Magnets; Direct and Alternating Currents; Dynamos and Motors; Belts; Shafting; Electroplating; Electrical Measurements; Meters; Arc and Incandescent Lamps; Mercury Arc Rectifiers; Transformers; Insulation; Electric Cars; Single and Multiple-Unit Control; Transmission; Rail Welding; Tables of Wires—Sizes, Capacities, etc.—Mathematical Rules, Formulas, Symbols; Tables of Constants, Equivalents, Roots, Powers, Reciprocals, Areas, Weights and Measures; Chemistry; Properties of Metals; Principles of Mechanics; First Aid, etc.

The Electrical Engineer's Handbook is one of 22 I. C. S. Handbooks covering 22 Technical, Scientific and Commercial subjects, all crowded with value. They have the contents of a full-sized book condensed into pocket-size ready to go with you anywhere and be at your instant command. They are substantially bound in cloth, red edges, goldleaf stamping, printed from new, clear, readable type on good quality book paper. There is an illustration at every point where a picture will help. Hundreds of thousands have been sold on a money-back guarantee of satisfaction.

The former price of these Handbooks was \$1.25, but **THIS MONTH you can buy 50c each, the ones you want for only 50c postpaid** (For 10c extra we will send a cloth-covered protecting case.)

You Run No Risk! Money Back if Desired!

International Correspondence Schools
Box 5382, Scranton, Pa.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 5382, SCRANTON, PA.

I enclose \$_____ for which send me postpaid the Handbooks marked X, at 50c each. I may return any or all and get my money back within ten days from receipt:

- | | |
|--|---|
| <input type="checkbox"/> Electrical Engineer's | <input type="checkbox"/> Advertiser's |
| <input type="checkbox"/> Telegraph and Teleg. Engineer's | <input type="checkbox"/> Business Man's ★ |
| <input type="checkbox"/> Mechanic's | <input type="checkbox"/> Bookkeeper's |
| <input type="checkbox"/> Steam Engineer's | <input type="checkbox"/> Sign and Correspondent's |
| <input type="checkbox"/> Westinghouse Air Brake | <input type="checkbox"/> Salesman's |
| <input type="checkbox"/> Civil Engineer's | <input type="checkbox"/> Window Trimmer's |
| <input type="checkbox"/> Coal Miner's | <input type="checkbox"/> Cotton Textile Worker's |
| <input type="checkbox"/> Concrete Engineer's | <input type="checkbox"/> Farmer's |
| <input type="checkbox"/> Building Trades | <input type="checkbox"/> Poultryman's |
| <input type="checkbox"/> Plumber's and Fitter's | <input type="checkbox"/> Mariner's |
| <input type="checkbox"/> Chemist's | <input type="checkbox"/> Automobiles |

Name _____
Street and No. _____
City _____ State _____