electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

Radio City—"Cathedral of Electronics"

Relays for electron-tube circuits

Thyratron controlled rectifiers

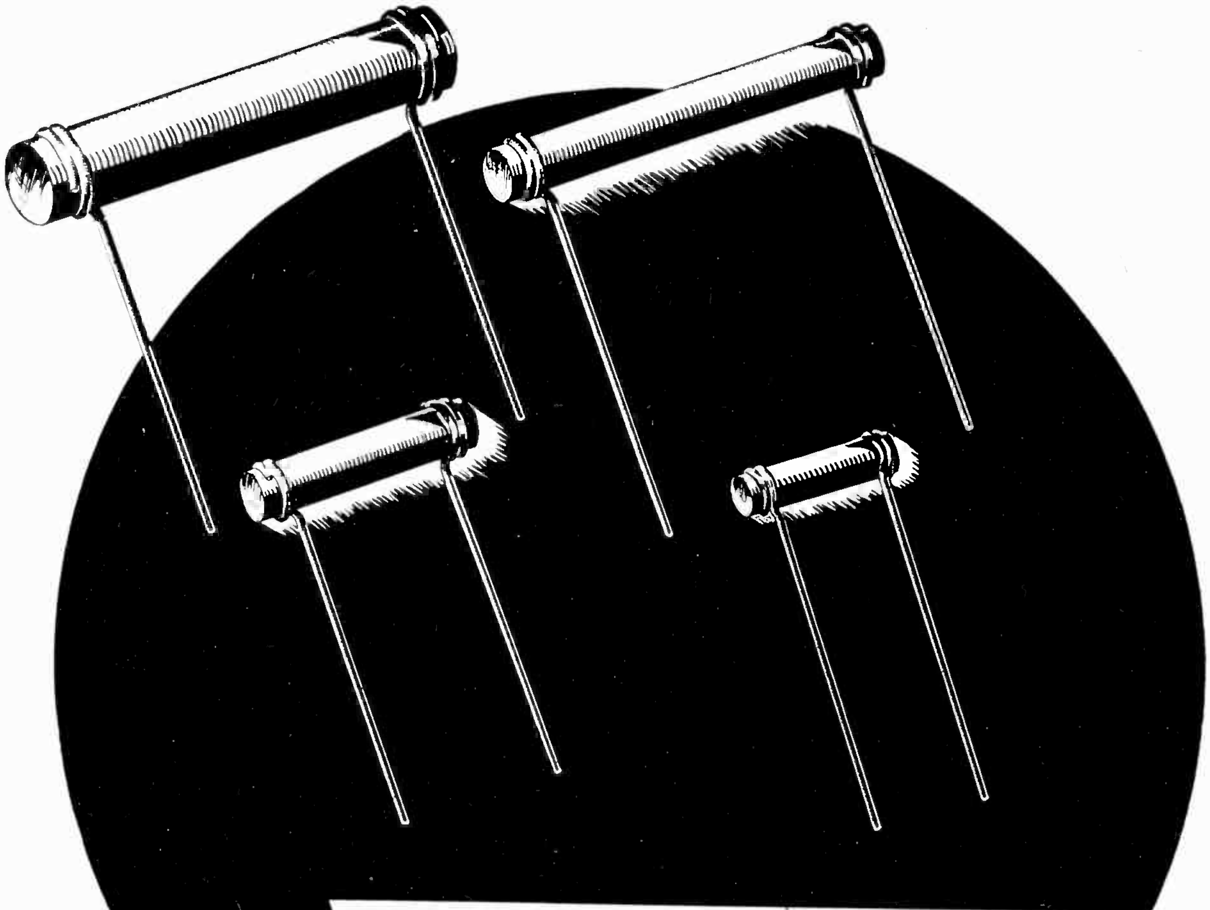
Data on the new radio tubes

A combined tuning indicator and "noise gate"

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

FEBRUARY, 1933



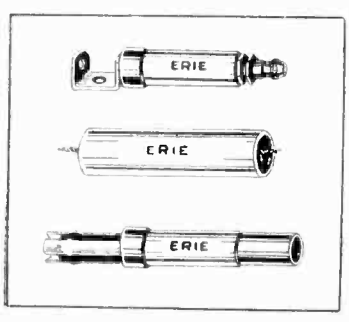
The change of resistance with voltage is very small in ERIE RESISTORS. In the majority of cases it is less than 2%. This means that regardless of what voltage the resistors are used at, the resistance value is constant.

ERIE RESISTORS are conservatively rated. 2,000 hours or more at loads 50% over the continuous rating have shown no failures, in repeated tests.

When you specify ERIE RESISTORS you are getting the very best moulded type resistor of fixed resistance value that the market affords.

Charts showing the small voltage effect and conservative rating of ERIE RESISTORS give the complete story and show the appreciable savings which set manufacturers may make by using them.

We will gladly send you our book of data sheets showing these and other charts which fully explain the technical data on Erie Resistor Corporation High Resistance Products.



ERIE SUPPRESSOR RESISTORS are made in plug, screw and distributor types. They will not change more than 10% in resistance value in 50,000 miles use provided one suppressor resistor is used in each high tension lead.

Samples and additional information gladly given on request.

ERIE RESISTORS

ERIE RESISTOR CORPORATION, ERIE, PA.
Factories in Erie, Pa., Toronto Can., and London, Eng.

Electronics, February, 1933. Vol. 6, No. 2. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, February, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

▼

Your stake in the coming

BROADCAST RE-ALLOCATION

SHORTLY after the new Administration takes hold and the personnel of the Radio Commission is completed, a re-allocation of North American broadcasting stations may be looked for. Pressure from Canada and Mexico for more wavelengths (however unjustified by proportional population figures) will undoubtedly be met by conceding more channels to our northern and southern neighbors. In this re-arrangement, the doom of the U. S. "clear channels," which bring good radio broadcasting to millions in small towns and rural communities, now seems sealed.

WHEN this massacre of the clear channels begins, and the airways on which important broadcasters operate become howling bedlams outside of the immediate neighborhood of the transmitters, the radio industry will have only itself to blame for past apathy. Little or no interest has been displayed by radio engineers or industry organizations. Radio reception in the vast stretches of America, has been taken for granted, like the sunshine. Meanwhile selfish interests and political trading are ever forcing unimportant stations into more advantageous position locally, to the destruction of nationwide good service. At Washington the pressure of those who would ruin outlying reception is continuous; yet never a word comes in rebuttal from radio men who know the inevitable result.

SOON, those who avow to discredit the radio engineer and his "fool theories", will ride high in the political chariots of officialdom. Ignorant, political tampering with the present fairly smooth-running radio machine, will deprive millions in rural communities of good radio. And it will destroy future markets for radio sales.

Gentlemen of the radio industry, wake up!

ELECTRON TUBES IN

Vast amusement undertaking is veritable "cathedral of electronics"

The Radio City Music Hall, the largest theater in the world, 6100 seats, contains 3000 kw. of lighting controlled by 314 tube-reactor circuits

IT was the electronic tube that made Radio City possible. And Radio City's two great theaters just completed, present the last word in applications of thousands of tubes, for sound, light control and miscellaneous uses.

In the electronic installations alone, nearly half a million dollars have gone into tube and associated equipment. Here is the roll call for tube applications now in regular operation.

Thyratron control of stage and auditorium lighting.
Sound-picture reproduction.
Public-address or "re-inforcing" system.
Rehearsal system connecting all operating stations.
Paging throughout dressing rooms and back-stage.
Bechstein-piano amplification.
Radio programs in lobbies.
Outlets for headphones for deaf patrons.
High-frequency air-conditioning.
Dial-controlled radio-phonograph system.
Complete private broadcast studio for Roxy's gang.

Some 3,000 kw. of lighting is controlled over 314 tube-reactor circuits manipulated by the lighting director in the pit box, permitting any change of color or intensity, as well as the presetting of a number of different combinations in advance. Lamp groups in both auditorium and house are divided into four colors, red, amber, green and blue, besides a special daylight color for the stage cyclorama screen. Employing the nearly 2,000 knobs in the control pit, the lighting director and his assistant can preset four to ten scenes in advance, permitting at least ten lighting changes without resetting.

Control of the light intensity in each of the 314 16-kilovolt-ampere circuits is accomplished by passing the voltage supply through one winding of a saturable core reactor functioning as a choke coil. The other winding of this reactor is fed by direct current from a Thyratron and a Phanotron tube. The variation in the direct current by saturating the core, affects the impedance or choking effect on the first or current-supply circuit. In turn the amount of rectified current fed to the second coil will depend on the electrical relationship between the elements of each tube. Changes can be made absolutely gradually, without any individual steps, from "black-out" to full brilliancy. The tube racks are located under the stage, in the basement, and flank the reactors, which are mounted on rubber-insulation supports in a sound-proofed room. Failure of a tube from any cause, results only in the corresponding circuit lamps being extinguished.

The 314 tube-reactor circuits in the 6,100-seat Radio City Music Hall make this by far the most elaborate theater lighting-control scheme ever attempted, with more than twice the number of circuits in the Chicago Civic Opera installation.

RADIO CITY THEATERS

Lighting-control, sound, and air-conditioning applications of tubes

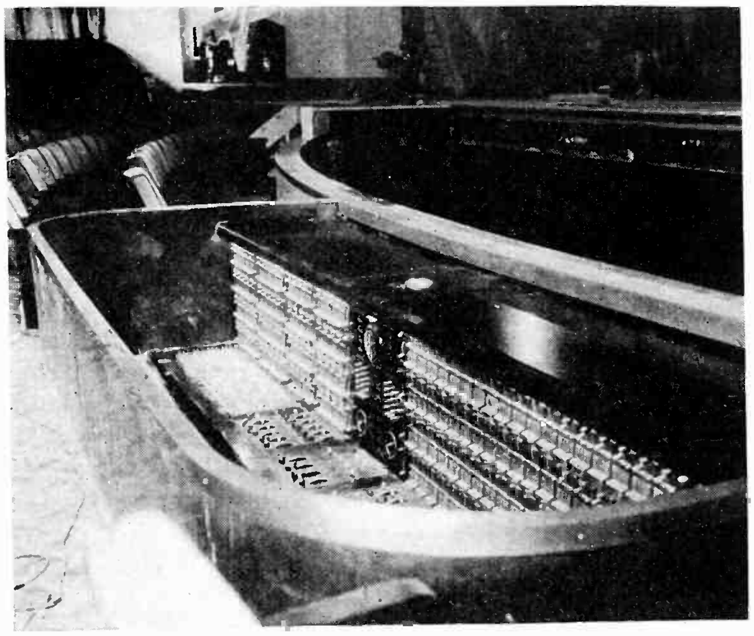
Selsyn operation of the color screens on the 150 spotlights located throughout the auditorium is another innovation in this theater. Small motors drive the selsyn-motors at any of five speeds, and the individual color screens move in exact synchronism through their various changes.

The light control installation in the large Music Hall employs Thyratrons and was made by the General Electric Company. The control equipment in the smaller 3,500-seat Roxy Theater employs a similar tube-reactor system, and was installed by the Hub Electric Company, Chicago. The smaller house employs 190 control circuits, centering in a control board 12 ft. long and 6 ft. high.

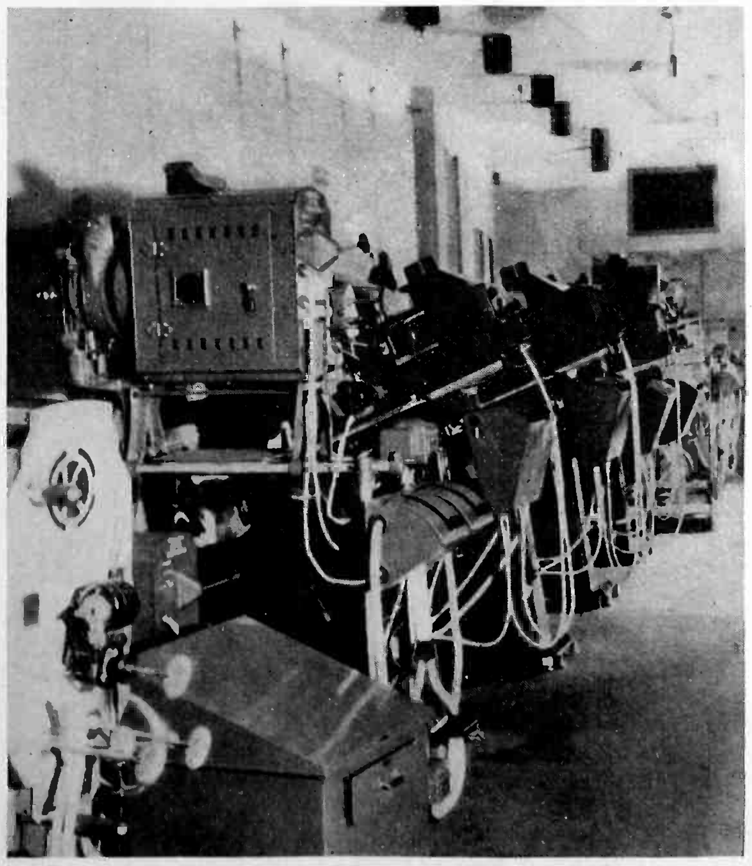
Sound systems in Music Hall

In addition to the four-motion picture projectors which have their own channels, and speakers behinds the screen capable of delivering 10 acoustic watts the elaborate system of sound reproducing equipment installed in Radio City Music Hall by the RCA Victor Company is divided into eight units and covers the widest range of sound apparatus ever used anywhere.

First in importance is the sound reinforcing system which reinforces the stage presentations and orchestra music to suitable levels so that the desired volume and clarity of dialogue and music may be obtained at all points in the auditorium. Fifty plug-in positions for velocity ribbon microphones located at various points near the stage are used in this system. Eleven of these microphones are spotted along the footlights, and are switched in to pick up voices, as the actors move back and forth on the stage. The velocity microphone used it is declared has two and one-half times more sensitivity than a microphone of any other type, and imparts a naturalness of tone and a distinctness of speech hitherto unattainable, according to Ernest Braun, engineer.



The lighting-control box in the pit of the large theater, with its 2000 control knobs

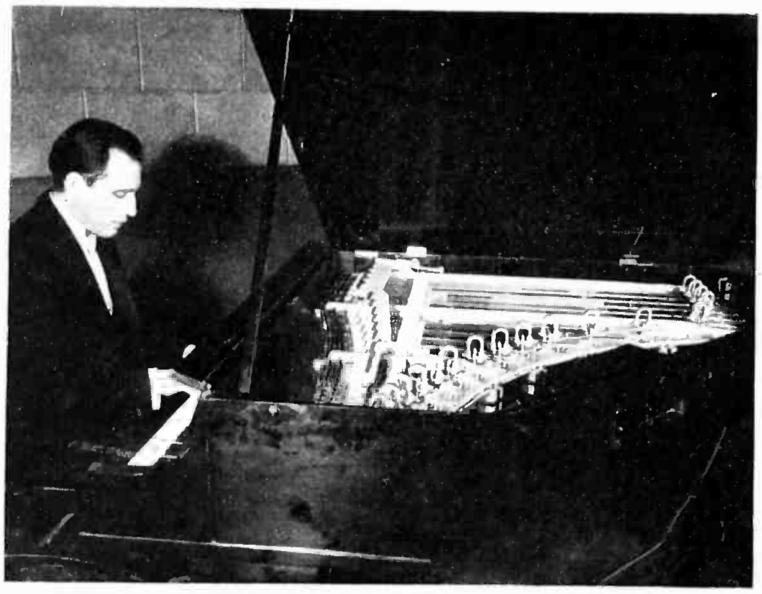


Four sound-picture projectors, with a throw of 180 ft., onto the largest screen ever used

Fifty microphone amplifiers located on a specially constructed rack beneath the stage and operated by a control console apply the desired sound to the loud speakers. All amplifier units are complete in themselves in that they contain their own a.c. operated power apparatus. The sound-control booth is located in the topmost projection gallery, and provides mixing channels for all sound circuits.

Second in the eight-unit system of sound reproducing apparatus is the rehearsal address system. This consists of microphones located at 38 designated points in the auditorium and loudspeakers above the stage. This system was installed for use in connection with the direction and execution of rehearsals and orchestra presentations. Seated at a microphone plugged into one of the outlets in the auditorium the director can convey his instructions to the stage projection room, spotlight rooms, fly gallery or any other part of the theater without raising his voice.

The third unit of sound reproducing apparatus is the stage manager's call system which penetrates practically every part of the theater. Sitting at his desk, the stage



One of the nine Bechstein electronic pianos, with tube amplifiers, imported from Germany

manager can place himself in immediate touch with one or all dressing rooms, stage employes' quarters, the front of the house or the executive offices. Fifty-six loudspeakers are employed in this system.

Another unit of unusual interest is the group of 52 acousticon seat phones for the hard-of-hearing patrons located in the orchestra. Jacks are provided at the seats, and instruments are leased from the checkrooms.

A rear-stage sound projection system is available for the projection of sound-motion pictures from the rear of the stage to be used as background and other effects in conjunction with the stage presentations. It consists essentially of two soundhead attachments, a voltage amplifier unit, a film phonograph with associated amplifier and monitor loudspeaker, all located in the rear stage projection room. When in operation, it is used in conjunction with the main sound projection system.

Two preview rooms, located on the studio floor, are equipped with sound projection systems. These systems are similar in general design to those furnished with the main sound projection system, except that they have a smaller power output. They are of the same high fidelity characteristic as those supplied for the theater auditorium.

A radio and monitoring system furnishes to the private studios on the studio floor, radio pick-up of a predetermined number of radio stations and permit the monitoring of the various sound systems in the theater and other outside lines terminating within the theater. The equipment is completely controlled by a remote-dial system.

For the Roxy Theater, the sound equipment is similar, although less extensive and comprising fewer units in view of the smaller number of seats to be served.

Air-conditioning by ionization

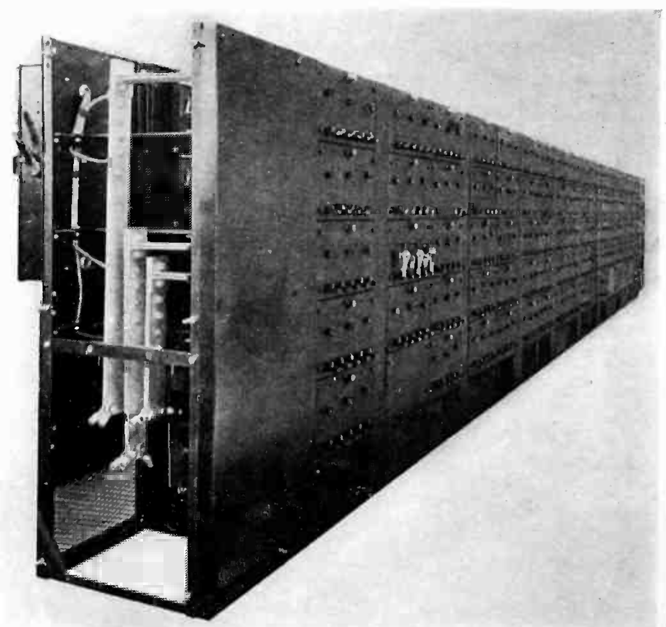
The ventilating system of the Roxy Theater in Radio City is distinguished by an innovation consisting of six ionization machines which provide the equivalent of mountain air in purity and vitality.

This mechanism is the result of approximately twenty years of experimentation seeking a physical and controllable reproduction of nature's methods of air purification. This ionization machine, it is believed is successful in reproducing the natural climatic elements as they exist in open country under ideal weather conditions. A period of two hours in this atmosphere has an essentially invigorating effect, it is declared.

The machine consists of a series of special discharge tubes made of transparent vitreous material, containing an inner and outer electrode. These tubes are energized with a high potential electric current, supplied from a step-up transformer. Within these tubes a luminous discharge, rich in ultra-violet, is set up, while outside of the tube an intense electric field is produced and a non-luminous electric discharge takes place in the air surrounding the tube. Solarization, with ultra-violet light, of somewhat shorter wave length than is normally present in sunlight at the earth's surface, is accomplished by both the discharges within and without the tube.

Nine of the popular Bechstein-Hammond electric pianos were purchased in Germany last summer by Mr. Rothafel, director of Radio City, and several are now installed in the music halls. These pianos are bereft of sounding boards, but have a series of microphones, each of which picks up the vibrations of half-a-dozen piano strings, the output of these microphones then being amplified and heard through loudspeakers. American-built speakers and tubes have been incorporated in these original all-European instruments, with consequent improvement in quality.

The elevators in the office buildings of Radio City are being equipped with photocell safety rays, employing photoelectric units to insure that the elevator doors are clear, before being closed. A projector sends a beam of light across the doorway, shining onto a photocell. If the body of a passenger intercepts this light beam, eclipsing the photocell, relays are operated and the door is prevented from closing, which in turn prevents the elevator from moving. Altogether 58 elevators in Radio City will be so equipped.



One of the long panels for Thyratron control circuits in Music Hall. Reactors are directly behind tubes

The National Broadcasting Company will occupy elaborate studios in Radio City, in the 70-story RCA building. These studios are now under construction. Delays have occurred in the production schedule, and it is now believed that the new Radio City NBC studios will not be ready for originating network programs until sometime in September of this year.

New amplifiers—detectors and rectifiers

NEARLY a score of new tubes was formally introduced to the industry during the first few weeks of the new year. Many of these tubes offered distinct possibilities to receiver engineers with imagination, others pushed forward the frontier (at present somewhat restricted) of high quality reception, and still others seem merely to complicate an already complex picture.

There are new amplifiers, new detectors, new oscillators, new rectifiers. There are new hybrids, combinations of triodes, or diodes, and pentodes in the same envelope. There are complete class B amplifiers under one glass top; there are high-vacuum rectifiers with gaseous rectifier characteristics; tubes for auto radio, for high quality receivers, and tubes for universal a-c, d-c sets, at present all the rage.

Rumors in the industry indicate that interests formerly opposed to unlimited introduction of new tube types have retreated from this conservative stand and are now ready to get in on the fun. All of this will require tube manufacturers to change their plant layout to accommodate a vast number of tube types, and in the process to be willing to take their losses inevitable with changing machines from one type to another.

Among the tubes designed primarily for amplification the 2A3 is most interesting. This is a triode designed purely and simply for those few receivers, now in the laboratory, which will be purchased by people desiring the acme of fidelity of reception. This tube is a power amplifier; it has a very high value of transconductance (5,500 micromhos), and a very low value of resistance (less than 1,000 ohms). The tube has a multifilamentary cathode, many strands of emitter in series and parallel. A single tube will put out 3.5 watts, push-pull tubes will deliver 15 watts.

For those manufacturers who want to use a pentode with the 59-type characteristics, without paying for the versatility of this tube there will be the 2A5, a heater-type power pentode. This tube will probably supercede the 47 because of its low hum output.

The 53, a complete class B tube in one envelope, resembles the 79 except that it has a 2.5-volt cathode and will probably deliver more power output by virtue of its higher plate voltage and greater emission. It is aimed at the low price, small space (and poor bass) receiver.

Among the hybrid tubes there are diode-pentodes and the possibility of a pentode-triode. These are for first and second detectors which frequently have additional functions such as oscillator, or QAVC or first a.f. The 90 and 92 are two-grid detectors, the 2B7 and the 6B7 are duplex diode-pentodes primarily for the second detector although they can be used as first detector or even as the final i-f tube. In the second detector position the pentode may provide audio amplification or noise suppression control.

To go with the new power output triode there is a high-vacuum heavy-duty full-wave rectifier delivering 250 ma. For automobile receivers the 84 is of interest as having a very low internal voltage drop despite the fact that it is a high-vacuum tube. The voltage drop is approximately 20 volts obtained by close spacing, and

[Please turn to page 55]

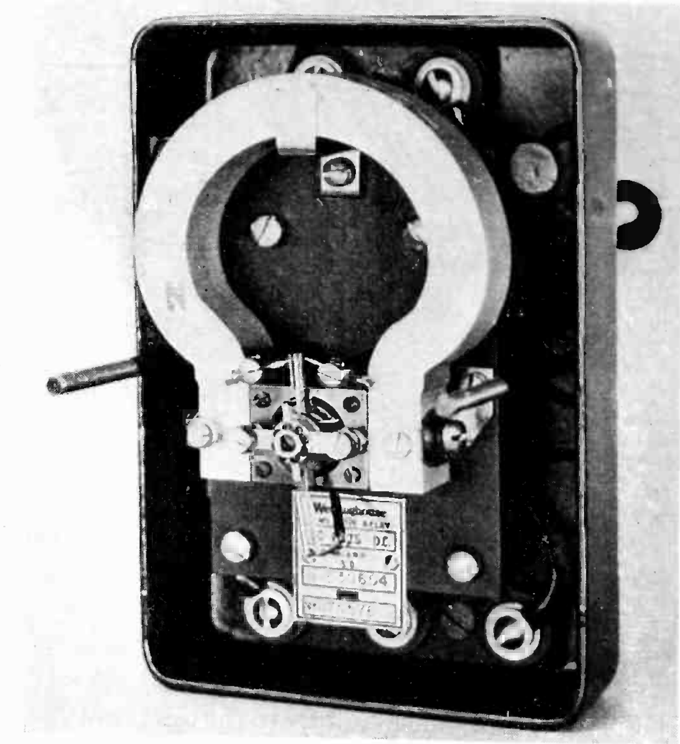
Type	Use	Bulb	Type	Cathode Voltage	Cathode Current	Plate Voltage	Plate Current	Screen voltage	Grid bias	Plate resistance	Mutual conductance	Amp. factor	Power output watts	Load resistance
53	Class B amp.	ST-14	Heater	2.5	2.0	300	12–70	...	0	......	....	....	10	10,000
75	85 with high-mu triode	......	Heater	6.3	0.3	180	.....	...	1.5	......	1,000	80	...	......
77	RF pentode	ST-12	Heater	6.3	0.3	250	2.25	100	3	1.5 meg.	1,250	1,500	...	......
78	6.3-volt 58	ST-12	Heater	6.3	0.3	250	10.0	125	3	0.65 meg.	1,650	....	...	......
79	Class B amp.	S-12	Heater	6.3	0.6	180	7.5	...	0	......	....	....	5.0	10,000
90	2-grid detector	S-12	Heater	2.5	1.0	250	3.5	...	0	10,000	1,400	14	...	100,000
92	2-grid detector	S-12	Heater	6.3	0.4	250	3.5	...	0	10,000	1,400	14	...	100,000
2A3	Power output triode	ST-16	Filament	2.5	2.5	250	60	...	42	765	5,500	4.2	3.5	2,500
2A5	Power output pentode	ST-14	Heater	2.5	1.75	250	34	250	16.5	100,000	2,200	220	3.0	7,000
2A7	Electron coupled detector-oscillator	ST-12	Heater	2.5	0.8	250	3.0	E_1 = Self-biased $E_2 = 250$, $I_2 = 10$ $E_3 = +100$ $E_4 = 3$ to -50 E_6 = tied to No. 3 grid						
2B7	Diode-pentode	ST-12	Heater	2.5	0.8	250	5.5	100	3	Pentode section				
6A7	Electron coupled detector-oscillator	ST-12	Heater	6.3	0.3	250	3.0	E_1 = Self-biased $E_2 = 250$, $I_2 = 10$ $E_3 = +100$ $E_4 = 3$ to -42.5 E_6 = tied to No. 3 grid						
6B7	Diode-pentode	ST-12	Heater	6.3	0.3	250	5.5	100	3	Pentode section				

Note: Values given in this table are subject to considerable change as several tubes were still in the development stage at the time the table was compiled.

Relays for electronic devices

IN THE wide acclaim for electronic devices, particularly those operating from light-sensitive units, a fundamental and important part of the circuit is frequently forgotten.

This is the relay; the connecting link between the stream of electrons and the work to be accomplished. Many light-sensitive surfaces coming into use today are really very old and the literature contains many references to combinations discovered anew each year. But the sensitive, rugged and comparatively inexpensive relays so important to the art are relatively recent in development. In this survey, the types of relays requiring less than 0.5 ma. will be called supersensitive, those requiring one or more milliamperes are of the telephone type, and the heavy-duty relays with contacts which can carry up to several amperes will be called auxiliary relays. Voltage, current, and resistance will be the d.-c. values, unless marked a.-c.



Relay of supersensitive type

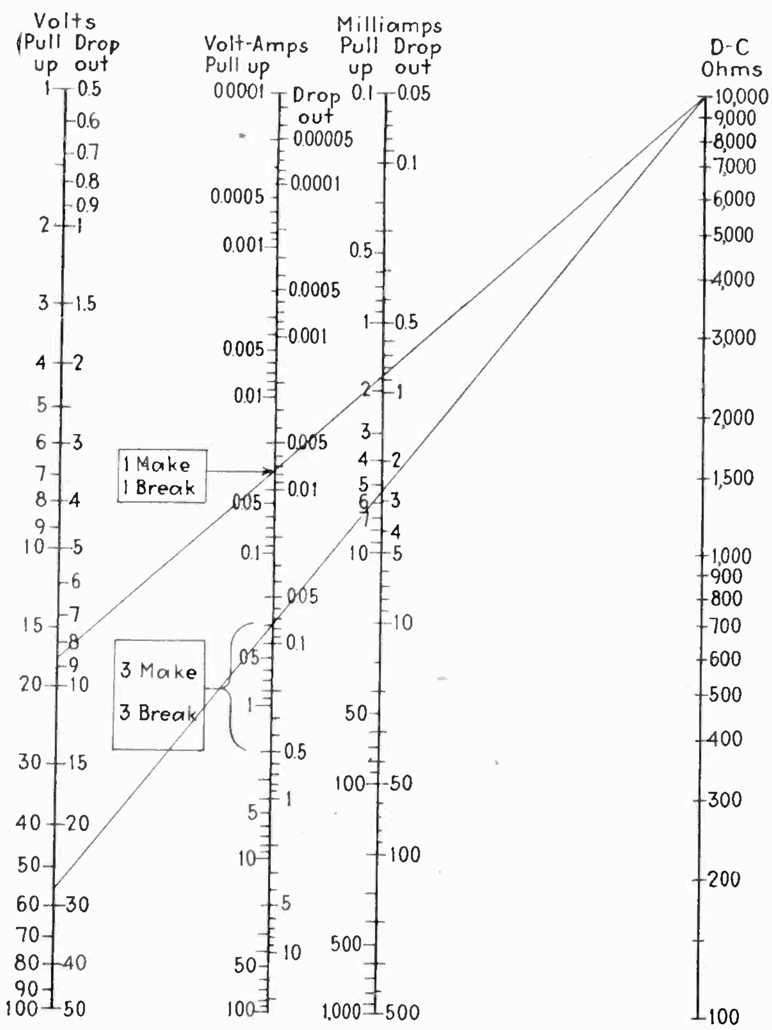


Fig. 1—Nomogram giving essential data on d.c. relays of telephone type. The most sensitive one-make, one-break relay is marked at 0.03; the average sensitivity of more complicated relays is noted. This chart is made on the assumption that the drop-out current or voltage is one half the pick-up, and one-quarter the volt-amperes

Supersensitive relays

Supersensitive relays are made to operate on currents as small as 15μa, have a resistance of 1,000 ohms, and can be made to close circuits from the output of a light-sensitive metallic disc, a vacuum tube or a selenium cell.

The supersensitive relays can be used in three ways:

1. Galvanometer (zero center) relays: with no current flowing, the contact arm rests midway between the contacts. When current flows, the contact arm moves either to the left or right contact, depending on the polarity.
2. Constant current relays: with a definite value of current flowing, the contact arm rests midway between the contacts. When the value of current decreases a predetermined amount, the left (low) contact is closed and when the value of current increases a predetermined amount, the right (high) contact is closed.
3. Low and high current relays: This is an extension of the preceding case. With all values above a predetermined high value, the contact arm rests against the "high" contact. With all values below a predetermined low value, the contact arm rests against the "low" contact. For any value between the low and high values neither contact is closed.

For quick action, such as a light-beam counting instrument, the contact points are set close together, so that the contact arm moves only a short distance. These supersensitive relays are generally used as a single-pole, single- (or double-) throw switch, and are used to control other relays having a heavier current-carrying capacity, or to actuate signal devices. Table *A* shows some stock ratings and current capacities of these relays. By comparing the current capacity of the relays of Table *A*, with the coil requirements of Table *B, C* or *D*, arrangements of auxiliary or telephone relays can be made.

Among the relays originally made for telephone work there are now several types especially suited for use in the plate circuits of amplifier tubes. The most sensitive telephone-type relays, operating on one or two milli-amperes d.-c., are provided with one make contact, or one break contact, or both, in order to require the minimum of electrical energy for operation. Such relays have as much as 10,000 ohms d.-c. resistance.

Telephone relays of the same general form and size usually pick up with the same speed. The drop-out time can be lengthened by using certain devices to prevent rapid decrease of magnetic flux. For instance, the medium relay speeds are attained by a copper sleeve on the core piece, and the slow relays by a heavy copper slug on the end of the core.

The sensitive relays are of the fast type, and can be made to operate in 0.02 to 0.05 seconds, and drop out in the same time. The less sensitive, lower resistance relays can be made in fast, medium and slow operating speeds. These times are given in Table B.

To operate from plate circuits, it is generally advisable for the relay to have as high a drop-out value as possible. For example, suppose a relay to pull up (close a make contact, or open a break contact) on 2.0 milli-amperes d.-c. This means that the relay will pull up when the grid of the tube is supplied with a voltage which allows a plate current of 2.0 ma. to pass. For sensitive operation, the minimum plate current change, with a corresponding small grid voltage change (high transconductance) is needed. Any relay will drop out if the current through it is decreased to zero—but this requires a negative grid voltage sufficient to bias the tube to the cut-off point of plate current. If, however, the above-mentioned relay drops out at 1.0 ma., then the grid swing can be less negative, and a more sensitive circuit is the result. Most of the sensitive telephone-type relays are designed to drop out for values of current of the order of one-half their pull-up currents.

The currents needed to pull up a relay have been mentioned; but this is not the only useful factor. It is necessary to know at least one other item, usually the resistance. Knowing the pull-up and drop-out currents, and the resistance, a good working idea of the sensitivity of the relay can be obtained from calculation, or from Fig. 1 which is a nomogram of the useful quantities concerning the relay coil. The most sensitive relay is one which will pull up with the least volt-amperes (watts), and by suitably matching the resistance to the circuit to be used, maximum sensitivity is attained.

With a given set of relay constants, frame, contacts, and springs, some interesting coil characteristics are given in Fig. 1. Usually the sensitive telephone relays operate on 0.03 to 0.05 volt-amperes. Now if exactly similar relays are desired, with different coil resistances, the volt-amperes will be approximately the same, and the desired currents, voltages, and resistance can be found directly on the chart.

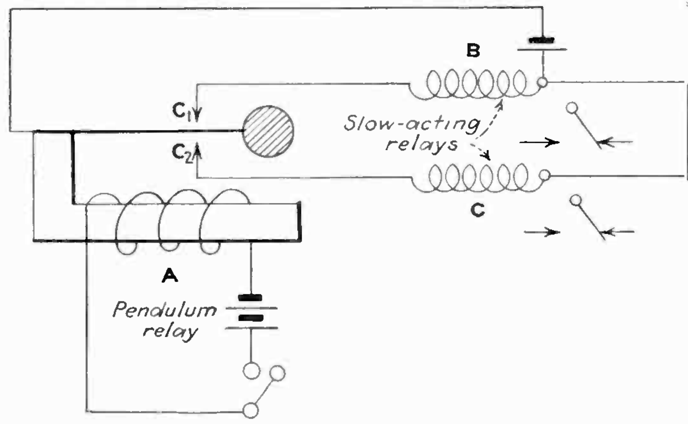


Fig. 2—Pendulum or vibrating reed relay

The values as found on Fig. 1, for different coils, with the same frame, springs, etc., will be approximate for any of the relays given in Table B. They are quite accurate when used for finding coil characteristics of low resistance relays, from similar high-resistance sensitive relay coils. The reason for this is that a high-resistance coil is wound with very fine copper wire, and the wire covering and other insulation is a fairly high percentage of the active cross-section of the wire. Lower resistance coils have a lesser percentage of insulation. This means that the ampere-turns of the lower resistance coil can be increased with the same available winding space. As an example, a 10,000-ohm coil for a sensitive relay requiring 0.05 volt-amperes, can be replaced by a 1,000-ohm coil requiring 0.05 volt-amperes, or slightly less. Using the volt-amperes for the sensitive relay, a lower resistance coil can usually be safely expected to work on the same (or lower) volt-amperes.

Fairly sensitive telephone-type relays can be made with three make and three break circuits[2,3], the equivalent of a 3-pole double-throw switch. More contacts than these can be provided if needed for special purposes. Extra contacts require additional coil energy for operation. Practically all of the relays in Table B can be supplied with the 3 P D T arrangement.

A recent development is the use of high carrying capacity switches, having a mercury[3] or vacuum contact[3,7], actuated by a telephone relay mechanism. This

TABLE A — SUPERSENSITIVE RELAY

Operating Current Microamperes	Resistance Ohms	Contact Rating	Price
15[1]	1,100	Under 0.2 amps. at 6 volts;	$37.75
20[1]	500	or loads which do not pro-	37.75
250[1]	300	duce a visible spark of arc	34.00 (Approx.)
10 to 15[8]	1,100	0.2 amp at 6 v.	40.00
30[8]	1,100	....	25.00

TABLE B — TELEPHONE-TYPE AND SENSITIVE RELAYS

Pick-up current amperes	Release current amperes	Resistance ohms	Volts	Contact	Speed	Designation
0.003[3]	0.0003	3,800	....	SPDT 50 watts non-inductive	0.01 to 0.02 sec. make and 0.01 break	FQA
0.046[3] a.c.	......	130	110 v. 60 cycle	SPDT		FQA
0.004[3]	0.002	3,200	....	SPDT		AQA
0.0005[4]	0.0004	14,000	....	SPDT		TQA micrometer adjusting
Prices vary from $2.50 to $5.00 except for TQA						
0.001[4]	......	10,000	....	SPDT 2 amp. 110 a.c. 2 amp. 12 d.c.	......	CAX-51 Price $5
0.0019[9]*	0.001	9,000	....	SPDT	Release 0.02 sec.	3,700 fast coil, short armature
0.003[9]*	0.0008	8,000	....	SPDT	Release 0.1 sec.	3,000 medium coil, short armature
0.0035[9]*	0.001	5,000	....	SPDT	Release 0.2 sec.	2,600 slow coil, short armature

*Make in 0.005 to 0.015 sec. and can be furnished with double point bronze contacts for light duty. Double point gold contacts will carry 0.1 amp., 50 volts on intermittent service. Single or double platinum contacts for severe service. 1/4 in. silver contacts, 1 amp. 120 volts intermittent, and for low inductive loads. 3/16 in. platinum contacts for inductive loads, and continuous service.

Prices range from $3.70 (bronze contacts) to $5.30 for 3/16 in. platinum contacts.

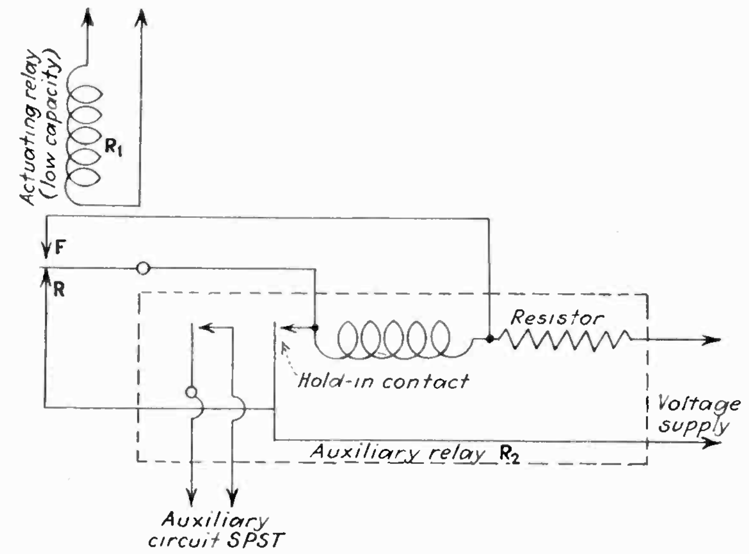


Fig. 3—Auxiliary relay circuit with lock-in feature

makes the control of heavy currents possible by a single plate-circuit relay.

A fairly new group of relays is of the general shape of the telephone relay, but it is designed to use alternating current[3]. These relays are also useful for plate circuits having self-rectification. A shading coil holds in the relay armature during the no-voltage part of the cycle.

Mechanical delay relays are of several types. The vibrating reed[2,3] is used to hold in one or two slow-action relays during the time of vibration, which can be adjusted. Figure 2 shows a typical circuit. By adjusting the contacts, B and C can be kept closed for time delays from 1 to 10 seconds.

An oil-dashpot relay[3] is also used for time delays; this type of relay does not require a special circuit. The sunflower, or step-by-step relay, is similar to that used in telephone circuits, and can be used to select one of several possible operations. Each pulse of electrical energy moves an arm one position.

Mechanical latch relays are sometimes useful; the relay pulls up and stays up until a release is secured either manually, or by energizing a second operating coil. Polarized relays either make or break a circuit according to the polarity of the impulse supplied. Counters for recording the number of impulses given, are of use in many applications.

It is assumed that the general use of the auxiliary relay is to control fairly heavy currents, from one to ten amperes, from a smaller capacity relay. These relays will, therefore, be operated on commercial voltages and frequencies, usually 115 volts 60 cycles. In some cases, operation from a 6-volt storage battery or a 115-volt d.-c. line is desirable; these are in Table D.

Other contact ratings, and number of poles may be secured through correspondence with the manufacturers. Table D shows only single-pole, single-throw auxiliary relays; both front and back operated, i.e., a make contact when the coil is energized or de-energized respectively.

Circuits which operate slowly, often cause severe burning of the low capacity relay contacts, when operating an auxiliary relay. A recent auxiliary relay[8] has been developed having an arrangement which prevents arcing or burning of the telephone-type relay contacts. The circuit is shown in Fig. 3. When R_1 armature touches the F contact, the coil of relay R_2 (in series with resistor) pulls up, and the hold-in contact keeps R_2 closed. Relay R_1 can now vibrate or make intermittent contact, but no sparking takes place because of the closed auxiliary contact.

When the R_1 armature moves back to the rear contact R, the R_2 coil is shorted, full voltage being momentarily put on the resistor until the hold-in contact opens.

This relay also prevents destruction of telephone-type relay contacts under severe conditions of chattering, vibration, etc., as the auxiliary relay coil circuit remains closed, once it has been actuated, until the smaller relay definitely opens, and touches its other contact.

TABLE C — SPECIAL PURPOSE RELAYS

Description	Operating time	Volts Amps.	Resistance ohms	Approx. list price
Pendulum relays[2], [3] type 2000[2]	1 to 10 sec.	6 v.	7.5	$5.00
		45 v.	250	.....
		120 v.	2,000	.....
Vacuum contact[3], [7]	....	115 v., 60 cycle	5,200	.....
Magnetic counter[5] 5 figures, with reset. Type US, Type UD for d.c.	0.1 sec. per impulse (0.05 sec. on 0.05 sec. off min.)	115 v., 60 cycle 0.5 amp.	....	25.00
		115 v. d. c.	....	25.00
Magnetic counter[3] 4 figures, no reset	....	115v. a.c. 60 cycle 0.1 amp.		
Operation indicator[8] Type C to show circuit operation, manual reset — use in series with relay.	0.1 amp.* 0.15 amp†		6.0 ohm*	$1.50
	1.0 amp.* 1.5 amp.†		0.06 ohm*	$1.50

* D.C.. † A.C

TABLE D — AUXILIARY RELAYS

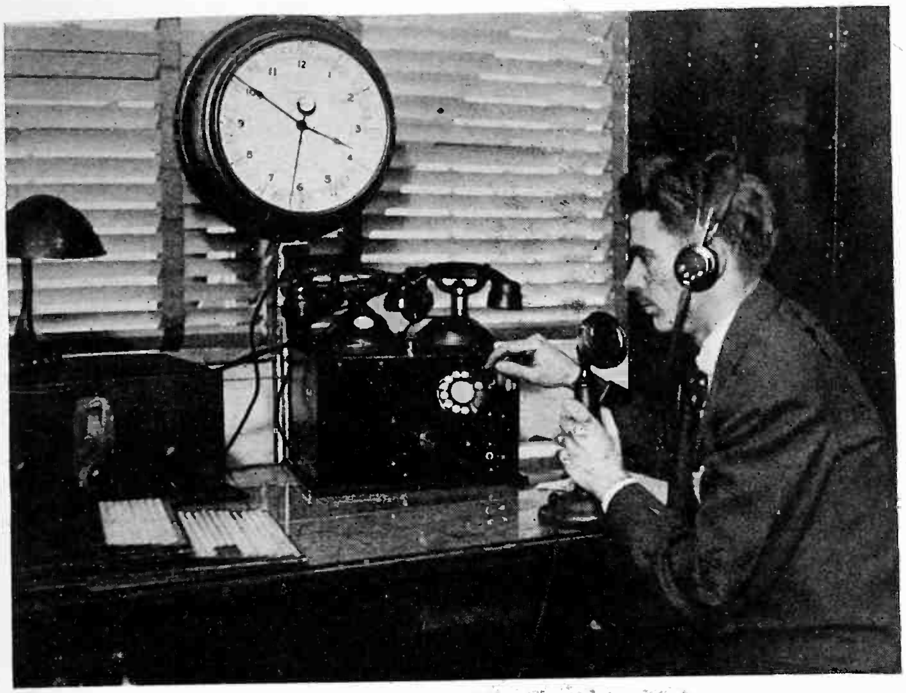
Front or back contact, and designation	Contact Capacity Volts	Amps.	Coil	List price
Front L[6]	110 a.c.	5	110 a.c. 60 cycle	$28.00
	115 d.c.	4		
P[6]	110 a.c.	10	110 a.c. 60 cycle	29.00
	115 d.c.	6	110 a.c. 60 cycle	
R[6]	110 a.c.	15	110 a.c. 60 cycle	30.00
	115 d.c.	10		
E[6]	110 a.c.	20	110 a.c. 60 cycle	31.00
	115 d.c.	10		
Back L[6]	110 a.c.	5	110 a.c. 60 cycle	26.00
	115 d.c.	3		
R[6]	110 a.c.	15	110 a.c. 60 cycle	28.00
	115 d.c.	6		
	Non-inductive			
Back B[4]	110 a.c.	10	Coil 7 watts	6.00
	110 d.c.	2	110 a.c. 60 cycle	
	220 a.c.	8	0.165 amp.	
	Non-inductive			
Front A[4]	110 a.c.	30	Coil 7 watts	6.00
	110 d.c.	6	110 a.c. 60 cycle	
	220 a.c.	3	0.165 amp.	
	Inductive and d.c.			
Front A[4]	230 a.c.	30	Coil 7 watts	8.00
Blow-out coils for 5, 10, 15, 20, 25 or 30 amp.	230 d.c.	30	110 a.c. 60 cycle 0.165 amp.	
	Non-inductive			
Front[8] (double break)	120 a.c.	30	115 a.c. 60 cycle	6.00
	120 d.c.	30	0.15 amp.	
	Non-inductive			
Front[8] single break with auxiliary (hold-in) contact	120 a.c.	15	115 v. a.c. 60 cycle	7.50
	120 d.c.	15	0.25 amp.	

MANUFACTURERS

1 Weston Electric Instrument Company, Newark, N. J.
2 North Electric Company, Galion, Ohio.
3 Automatic Electric Company, 1033 W. Van Buren St., Chicago, Ill.
4 Struthers-Dunn Company, 139 N. Juniper St., Phila., Pa.
5 Veeder-Root Company, Hartford, Conn.
6 Signal Engineering & Manufacturing Company, 154 W. 14th St., New York City
7 C. F. Burgess Laboratories, 202 E. 42nd St., New York City
8 Westinghouse Electric & Manufacturing Company, 95 Orange St., Newark, N. J.

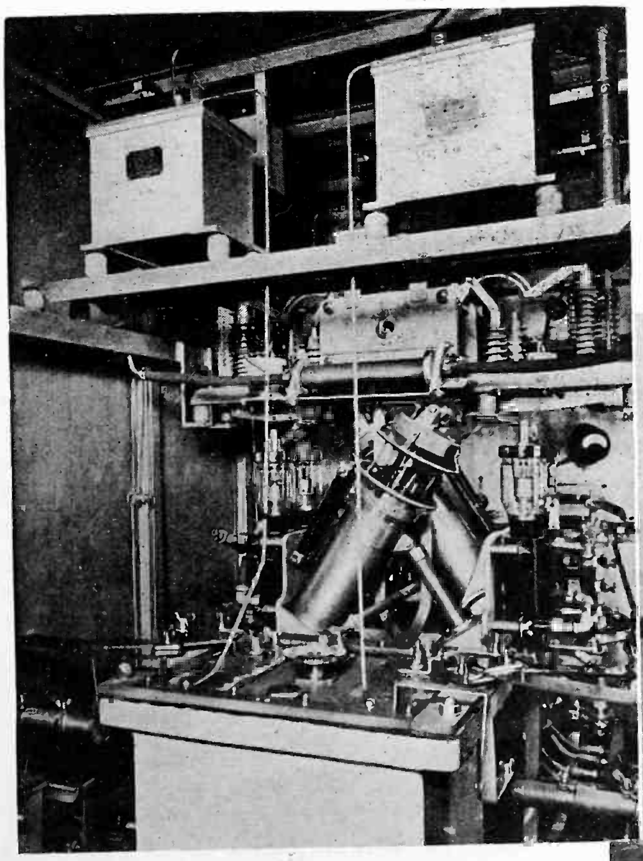
Note: This is, of course, not a complete list of relay manufacturers, nor is it even a comprehensive list of relays. Hundreds of relays and combinations are for sale by the above manufacturers as well as by Western Electric, Stromberg Carlson, General Electric, Ward Leonard, American Instrument Co. and others.

ELECTRONS IN NEW ROLES



An "automatic dial" selects the wavelength wanted, in this new short-wave set used by the United Air Lines, Chicago. Any one of five or six planes can be reached by dialing its number

In Berlin, Germany, Alfred Mintus has produced this walking-stick radio set. The cane forms its own ground and antenna



The new British Empire Broadcasting station at Daventry, England, is designed to send out short-wave programs to the entire world. It started into operation last month

A visitor to the vault of the East River Savings Bank, Amsterdam Ave., New York City, has his approach announced by an electric-eye, which receives its beam from a mirror opposite

Gaseous discharge tubes for radio receiver use

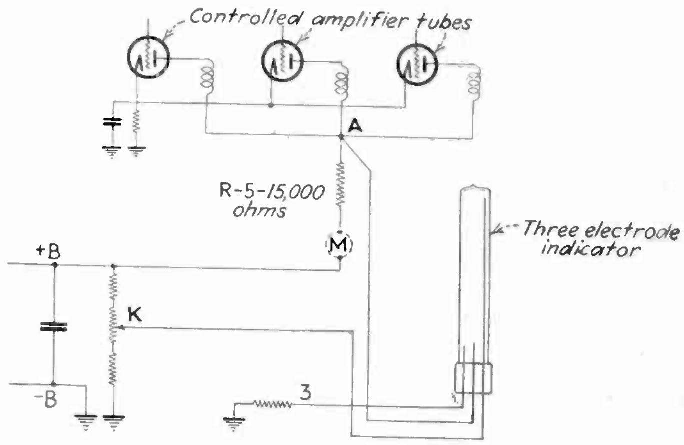


Fig. 2—Essential circuit elements of gaseous discharge tuning indicator

By JOHN F. DREYER, Jr.

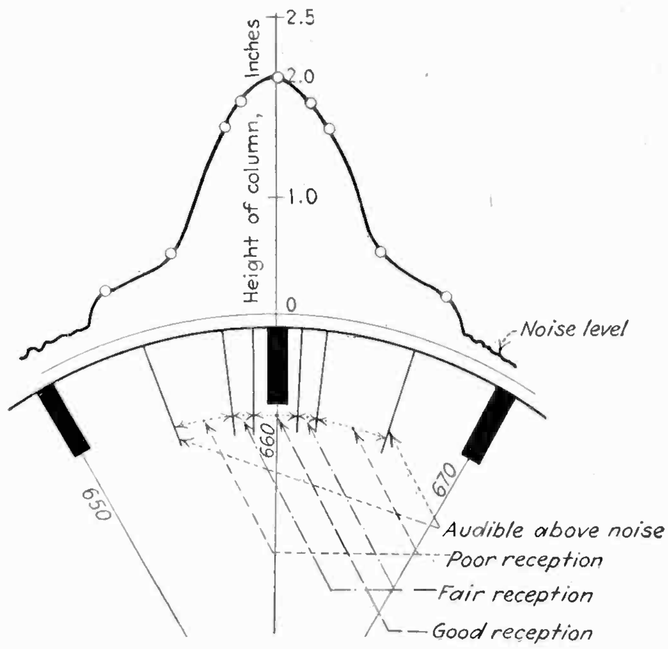


Fig. 3—Action of tuning-indicator on local signal

MODERN radio receivers, generally of the super-heterodyne type, have extremely sharp resonance curves. In general, also, they are equipped with automatic volume control. Receivers of this type, although yielding very satisfactory reception when adjusted exactly to the carrier-frequency of the desired station, prove difficult for the user to adjust.

To illustrate this point an average, moderately priced nine-tube super-heterodyne receiver was examined. The location was uptown New York City and a good but not extreme antenna was used. First, WEAF, 660 kc. was observed. In turning the station selector from 650 kc. to 670 kc. it was observed that over a considerable portion of this range, the station was received with considerable volume and extremely poor quality. Also at times a very objectionable hiss was heard accompanying the signal. Over a very small portion of the range, corresponding to the proper frequency, the station was received with proper tone quality and free from disturbing noises. Also, at 650 and 670 kc., where no receivable signal existed, the receiver brought in at a maximum, all the disturbing noises generated by sparking electrical apparatus in the vicinity.

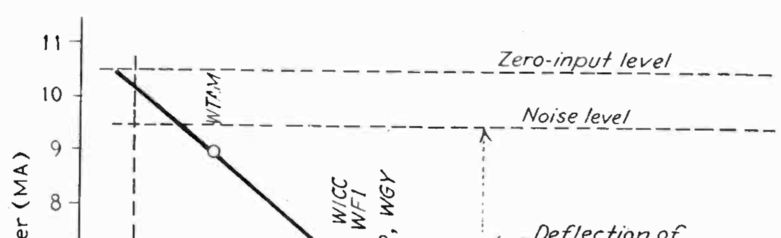


Fig. 1—Plate current variation in nine-tube super-heterodyne. Daytime signals in New York City

These undesirable characteristics are typical and occur when adjusting to any other signal. Radio manufacturers, appreciating these things, have modified their circuits to minimize them. The distortions which occur are: High amplification of inter-carrier noises; over-emphasis of higher side-band frequencies when off tune, due to shape of reasonance curve, and due to excess amplification caused by the AVC system. That is, the proper amplification for desired signal is only obtained when the carrier frequency registers with the maximum resonance response. These effects are minimized by the addition of a visual tuning indicator and a silencing device. The silencing device may be manual or automatic. When automatic, the arrangement is sometimes referred to as a "noise gate."

In this receiver, the AVC feature operates to adjust the grid bias of the r.f. amplifier tubes. The gain is made sufficient to amplify the input signal to an approximately constant voltage at the second detector. This results in a low grid bias when the receiver is tuned to a point in the broadcast spectrum where the input is weak. On the other hand, when the input signal at a particular frequency is strong, the grid bias is increased. This results in the plate current of the amplifier tubes varying in a definite manner with signal strength. Figure 1 illustrates this variation of plate current with signal input for the particular receiver mentioned. It will be noted that the plate current is recorded for various signals from approximately 10 μv. to 30,000 μv. The curve is a straight line through most of its length, when the scale of signal inputs is plotted exponentially. With antenna and ground shorted (no signal input of any kind) the plate current was approximately 10.5 ma.; with antenna connected and receiver tuned between stations, the plate current was depressed to an average value of 9.5 ma. This was due to a general noise level.

The gaseous discharge tube provided with a long cathode, a short anode and an auxiliary electrode was devised by Professor A. Senauke of New York University, to be applied to AVC receivers to serve as a visual tuning indicator. Figure 2 illustrates the essential portions of the circuit of an AVC receiver for providing visual tuning with the gaseous discharge or neon tube. The meter *M*, measures the current of the controlled r-f tubes. If a resistor *R* is inserted, as the plate current of the tubes decreases, the voltage between points *A* and *K* increases. This causes the gaseous discharge to increase in area and hence travel up the long cathode. The motion of the glowing gas discharge replaces the moving pointer of the meter. The height of the discharge is proportional to the increase in voltage between *A* and *K* above the voltage required to just start the climb. In the tubes as manufactured (under various trade names such as Tunalite, Flashograph, Tonebeam, etc.), the height of the column is also directly proportional to the current flowing between cathode and anode which is approximately two ma. at full column. The third electrode was provided to create an initial ionization which gives a much more dependable action than if but two electrodes were used. This third electrode is generally connected to a point about 40 volts more negative

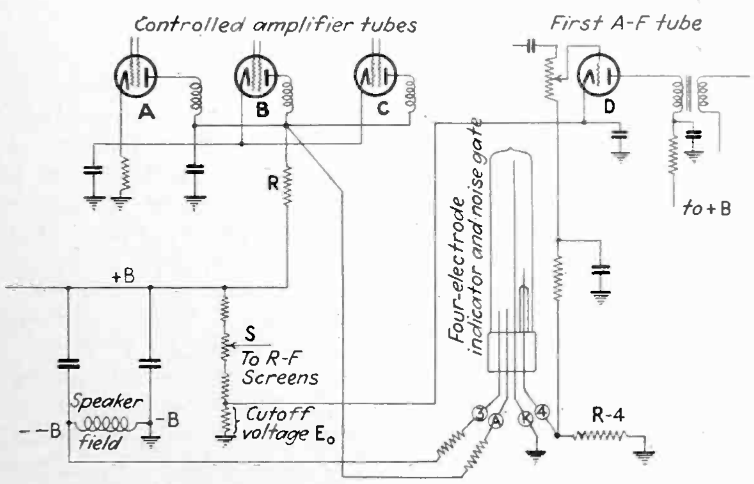


Fig. 4—Circuit of four electrode gaseous tube as tuning indicator and noise gate

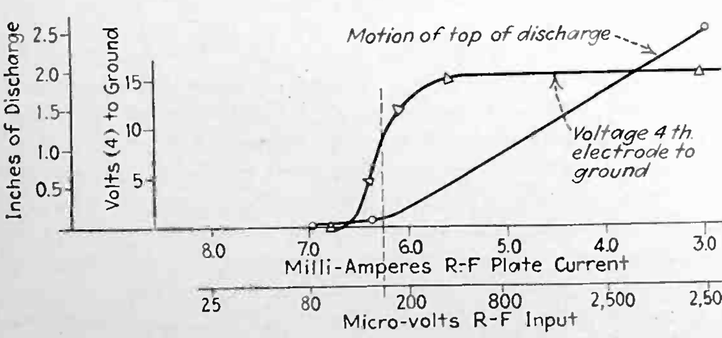


Fig. 5—Characteristics of indicator tube when adjusted to exclude signals below 200 microvolts

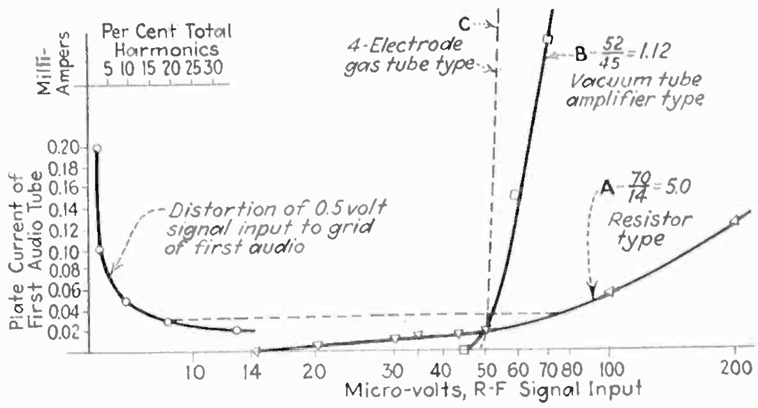


Fig. 6—Characteristics of three noise-gate systems

than *K* through a current limiting resistor of one-tenth to one-quarter megohm.

Figure 3 illustrates a magnified portion of the station selector dial in the vicinity of the 660 kc. signal. The curve directly above the calibrations illustrates the height of the gaseous discharge as the receiver is adjusted through the signal.

In turning the station selector from 650 kc. toward the desired signal at 660, the action is as follows: first, noise up to 654 kc. gradually increasing signal accompanied by bad hiss up to 658 kc., fair reception of signal up to 659 kc. Good reception is then enjoyed for the small space of 2 kc. and the action is then repeated in the reverse order on the other side.

Referring again to Fig. 2, adjustment of the potential of point *K* is desirable to take care of variations in (1) line voltage, (2) normal plate-current of r-f tubes and (3) variations in the indicator itself. The first two of these variations are present even though a conventional meter is used. The third has been greatly minimized so that the adjustment *K* is no longer essential.

Several prominent manufacturers have used the gaseous discharge tube as a tuning indicator for over a year and have found it satisfactory. Recently, experiments have been under way by Professor Senauke and the writer, to utilize this type of tuning indicator for a noise gate as well. The addition of a fourth electrode and certain circuit changes give promise of doing this, even better than the present methods employing vacuum tubes.

In Fig. 4, the essential elements of circuit employing the four-electrode tube are illustrated. Tubes A, B, and C are the ones controlled and the action of the electrodes (3), (A), and (K) is the same as previously described for the tuning indicator action in Fig. 2. In this illustration, the fourth electrode (4), is insulated with a glass stem to a point about one-half inch above the lower ends of the other electrodes. This electrode is connected through a resistance (one-quarter to one-half megohm) to ground. It is also connected through a low-pass filter to the grid return of the first a-f tube. The cathode of this tube is initially biased positively by a voltage (E_o) sufficient to completely cut off its current. The adjustment for both the noise gate and tuning indicator is effected by varying the maximum plate current of the controlled tubes. This is done by means of a potentiometer connection to the screens. Other methods of adjustment are feasible.

To explain the action, a characteristic of a typical four-electrode tube is submitted in Fig. 5. In this figure a curve of the voltage developed in resistor R_4 against plate current of controlled tubes is shown. It will be noted that approximately 10 volts are developed for a very small increment of input voltage. At the same time this action is occurring at the fourth electrode, the visible discharge from the long cathode is climbing as indicated in the second curve. In Fig. 5 the circuit is in adjustment to exclude signals weaker than approximately 150 μv. As the current through resistor R is decreased, the first thing to occur is the motion of the "long cathode" discharge. When this discharge reaches the vicinity of the fourth electrode an additional discharge develops at that point. The discharge there, causes the sudden appearance of a voltage on the resistor R_4, which reduces the bias of the a-f tube and allows the signal to be further amplified and reproduced in the loud speaker. Any signal or undesirable noise which is too feeble to cause the discharge to rise to the electrode will not be heard in the receiver. This threshold value of sensitivity may be controlled by the adjustment S, (Fig. 4). It should be further noted that as stations of greater signal strength are encountered, the voltage does not greatly increase over the value initially released. This is valuable in preventing the working bias on the audio tube from becoming too low.

In all circuits which provide "noise-gate action" to an AVC receiver, a feature of great importance is the rapidity (with respect to signal strength) with which the audio tube is put in operating condition. If the action is slow, stations which have signal strengths in the region corresponding to the release of the over-bias, will be distorted. It is obviously desirable to maintain this region as small as possible.

In Fig. 6, the release of the first audio tube, by means of three different noise gate systems is illustrated. The receiver used was the one already mentioned, in which the audio tube was a triode (56) which required a rather high grid bias to produce cut-off. Curve *A* is for the receiver with no additional tube, but with resistors arranged in such a way that the variations of the plate current of the controlled r-f tubes cause the cut-off and release of the audio amplifier. On the left, another curve is drawn to the same scale of ordinates, but with percentage distortion as the abscissa scale. If 20 per cent is taken as the upper limit of distortion compatible with tolerable reception, it is to be noted that all stations within a region having approximately 5 to 1 signal strength ratio will be distorted.

Curve *B* represents the action when the receiver is equipped with a silencing tube of the screen-grid, d-c amplifier type. The action is very sharp and represents about the best that can be done by conventional methods. The region of distortion has an input signal strength ratio of 1.12 to 1.

Four-element gaseous discharge tubes provide actions all the way from curve *B* to curve *C*, which it will be noted is extremely abrupt. The increment of input voltage between zero current in the first audio tube and a value to give good reception is too small to be measured on a standard signal generator.

It is felt that this new gaseous discharge tube should prove interesting to the set designer because it combines tuning indicator and noise gate. The addition of the noise gate can be effected with practically no additional expense over that required for the tuning indicator alone.

✦ ✦ ✦

A NEW BOOK ON AN ELECTRONIC SUBJECT

Radio Engineering

By Frederick Emmons Terman, Associate Professor of Electrical Engineering, Stanford University. Published by McGraw-Hill Book Company, 1932. 688 pages; 418 figures. Price $5.

THERE IS NO DOUBT THAT an up-to-date complete text on radio engineering was overdue so that the most radio engineers will buy Professor Terman's book without looking at it. It gains when examined in some detail. First in what we might call the routine matter of radio engineering, such as circuits, general properties, an agreeable surprise is in store: the mathematical developments have been cut down to a little over 250 lines (not pages) apart from a certain number of foot-notes. Strangely enough the cut in mathematical equipment has been made possible by giving more space to important demonstrations likely to be of use over and over again. The discussion of the resonance curve is a noteworthy example; it is more detailed than in most other radio books, and the author adds to the proposed universal resonance curves one of his own which has much to recommend itself. It is followed by a chapter on coupled circuits in which, to mention only one detail, ten full resonance curves, all relating to the broadcast band, are reproduced. The treatment of vacuum tubes is brief, but sufficient, as we may look forward to Chaffee's book on this subject. This leaves room for a thorough discussion of the audio and the radio amplifier. By reducing the resistance-, impedance- and transformer-coupled audio amplifier circuits to their equivalent, the ideas are clarified and the mathematical steps cut down. A welcome feature is the theory of the transformer-coupled audio stage; a similar discussion had only been available in scattered German publications. Class B and C amplifiers are also described. In the field of vacuum tube oscillators which quite logically follows the chapters on amplifiers, it is pleasing to see the section on practical circuits having high frequency stability and the corresponding page of diagrams. As might be expected the chapter on detection is well handled.

With the exception of 50 pages devoted to radio receivers (as they are, not were) the second half of the book is devoted to more professional problems, such as modulation, sources of energy, radio transmitters, antennas, radio waves and radio measurements.

Some difference of opinion might arise with respect to the footnote references, in which the attempt is made to cite a limited number of comprehensive articles, about 75 in the first half and about 170 in the second half of the book. While noted in a uniform system the number of the first and last page of the article might well have been indicated as is now the almost universal habit, and the method followed in the radio abstracts in the *Proc. I. R. E.*, the *Engineering Abstracts*, the *Wireless Engineer*, etc. It would also have been useful to cite more books (Jolley, Vigoureux, O. B. Wood, R. T. Beatty, etc.) on subjects which could not be fully explained. On the other hand, it is very difficult to see why Professor Pedersen's book is mentioned four times whereas Professor Appleton who has carried out so many experimental investigations has to be content with a 1928 reference.

The index is more complete than might be thought at first sight, but one looks in vain, for instance, under damping, transient, grid current, etc. These are all minor matters and by insisting upon concrete examples rather than formulas, facts rather than theories, Professor Terman has created a text of the greatest interest to the engineer as well as to the amateur who is not satisfied with superficial knowledge.

There is one reduction in mathematics not to be overlooked: the price is unusually low for a book of this kind.

Thyratron controlled voltage rectifiers

By H. W. HARTMAN
Vacuum Tube Engineering Dept.
General Electric Company

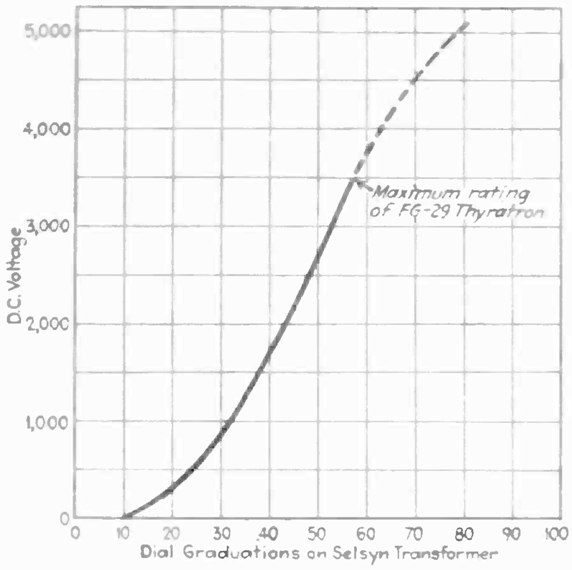


Fig. 3—Curve showing control of rectifier

ONE of the most recent developments in Thyratron-controlled rectifiers for laboratory use makes possible obtaining uniform voltage control throughout the entire voltage range from zero to the maximum voltage of the rectifier.

The control of this rectifier, three-phase, full-wave, is obtained by changing the phase relation between the grid and plate voltages of the Thyratron tubes by the use of a three-phase Selsyn transformer. The secondary winding is connected Y and mounted on a rotor with a leg of the Y connected to each grid of the three Thyratron tubes (FG-29), and by turning this rotor from 60 degrees to 90 degrees full 100 per cent uniform regulation can be obtained in the direct-current rectified voltage, or from zero to maximum voltage.

Figure 1 illustrates the relation of the d.-c. grid voltage of the Thyratron (E_c), a.-c. plate voltage of the Thyratron (E_p), a.-c. voltage impressed upon the grid by the Selsyn transformer (E_s) and the tube characteristic (E_d) for one phase of the rectifier, the other two phases simply follow in sequence.

At the point (O) where the Selsyn voltage meets the tube characteristic curve (E_d), the tube breaks down and carries current for the length of time shown by (T).

The Selsyn voltage curve (E_s) can be shifted to cause the tube to carry current for a longer or shorter period of time as desired.

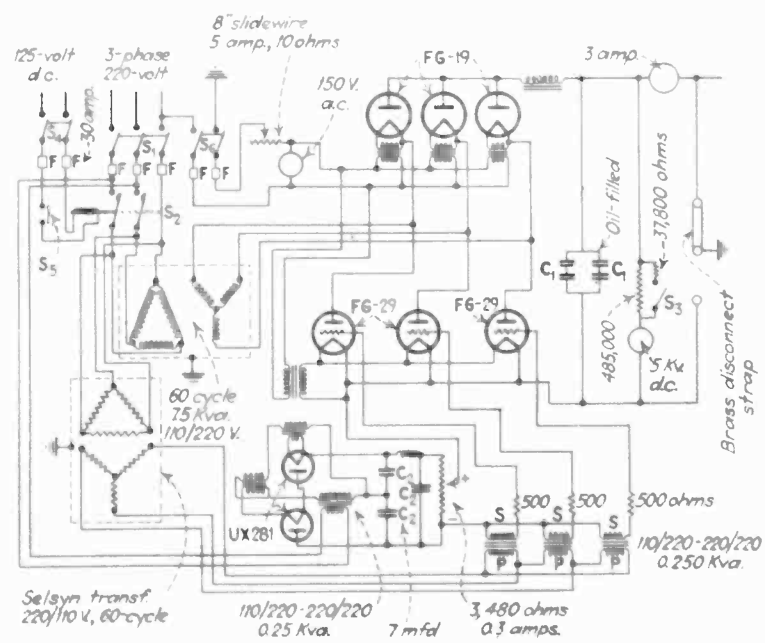


Fig. 4—Diagram of 7.5 kva., 5000-volt rectifier

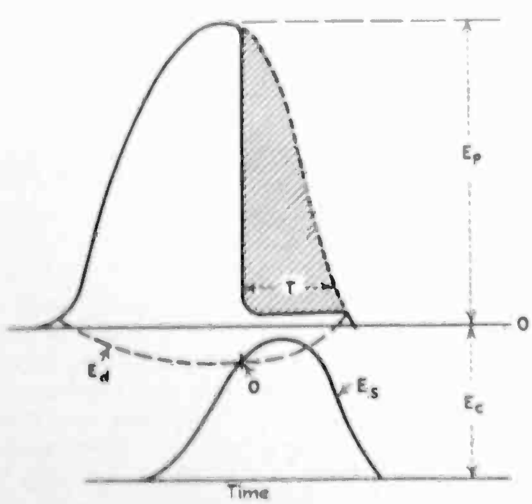


Fig. 1—Relations in the controlled cycle

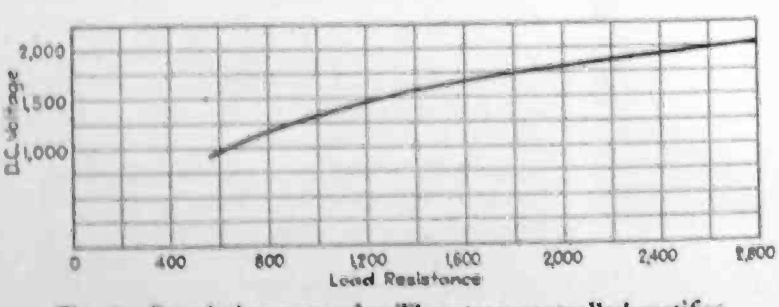


Fig. 2—Regulation curve for Thyratron-controlled rectifier

This type of rectifier is suitable for applications above about 2,000 volts direct current as in such cases the cost of d.-c. generators rises rapidly. By proper choice of tube types d.-c. voltages up to 10,000 are obtainable.

Figure 4 is a wiring diagram of the 7.5-kva., 5,000-volt rectifier now in use.

The advantages of this type rectifier are:

(a) Uniform control over full range.
(b) Eliminates the induction voltage regulator.
(c) Reliable. Easy to operate.
(d) Can be used for remote control without any great additional cost.
(e) The voltage regulation can be compounded by adding another circuit to the grid of the Thyratron.
(f) The space used could be much less than the space required for an induction voltage regulator or motor generator set.

HIGH LIGHTS ON ELECTRONIC

Opposed photronic cells responsive, independent of general illumination

An ingenious plan for making photocells of the Weston photronic type unresponsive to general changes in daylight illumination, while still responsive to local spotlight changes, is reported by Horace H. Raymond, consulting engineer, Berlin, Conn. He accomplishes this by using two photronic cells, connected with opposite polarities together. The two cells thus "buck" each other for all general changes of illumination and so fail to operate the relay connected in parallel with them. But if either one of the cells is lighted separately, enough current is generated to unbalance the circuit and work the relay. Mr. Raymond has found this arrangement to work well on a garage-door control, the set-up being unresponsive to daylight, yet instantly operable by a headlight beam directed on one of the cells.

The cells are mounted on a wooden board about 12 in. long and connected together so that the positive terminal of one is connected to the minus terminal of the other. Two leads are then brought from the terminal of one of the cells to the terminal of a sensitive relay. The board containing the photronic cells is then placed inside the garage in line with one of the glass windows in the top of the door. The cells may be placed on the side wall or on the ceiling and may be exposed to strong daylight, the only precaution being to place them so that the sun does not strike them.

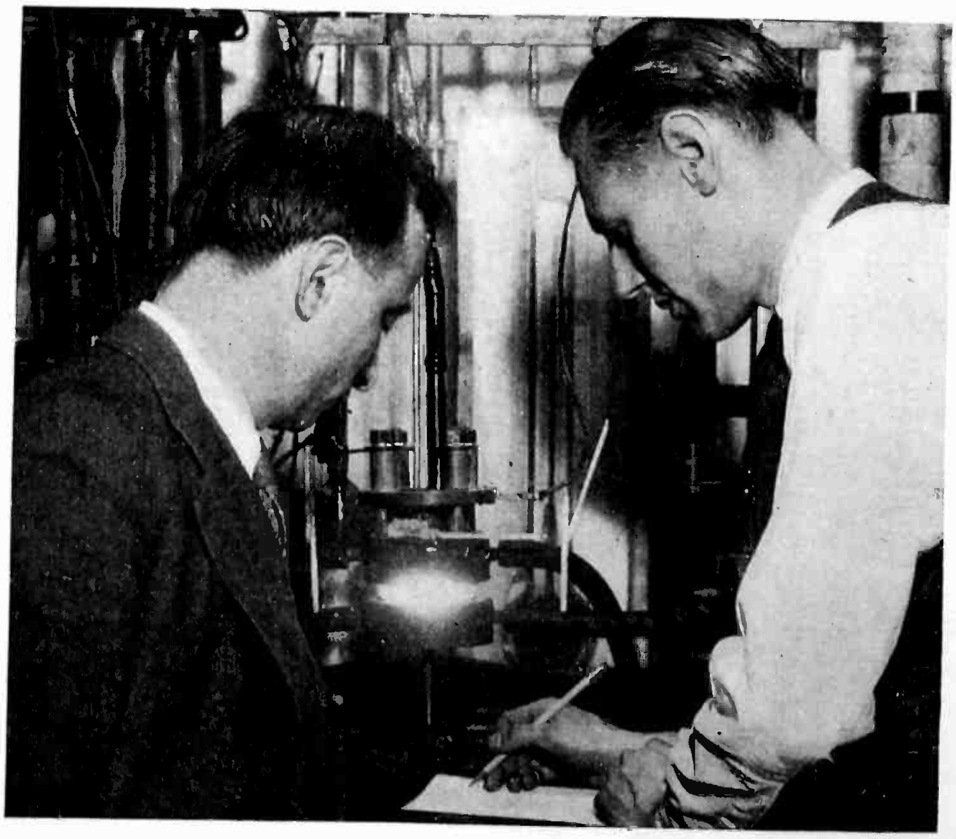
As long as both cells are equally illuminated by daylight, no current flows through the sensitive relay. If, however, one of the cells is illuminated, the current output of that cell is greater than the current output of the other, so that we get a flow through the sensitive relay which can be used to control the door operating mechanism. Since it is likewise true that darkening one of the cells or the other will produce the same effect, it is necessary to place the cells high up where the shadow of passing persons will not affect them.

"This arrangement is very stable and has been in use on my garage for a number of weeks without adjustment, the current being left on night and day," writes Mr. Raymond.

"This same principle can be used for interrupted beam application out of doors or in well lighted buildings without the necessity of providing a hood. In this case the light source is trained on one of the photoelectric cells only. If two light sources are used, one for each cell, directional counting may be performed."

✦ ✦ ✦

CARBORUNDUM CONTROLS MERCURY-ARC



The new Slepian-Ludwig method of controlling a mercury arc by means of a high-resistance rod partly immersed in the mercury pool, was exhibited at the January convention, A. I. E. E.

✦

Rotations of frictionless meter counted

The Builders Iron Foundry, Providence, R. I., has developed a special line of turbine meters for measuring the passage of steam, gas, etc. The gas or fluid flows through a restricted area and spins a freely-running propellor blade which rotates proportionately to the quantity of fluid passing.

In such a meter, however, it is essential that the turbine blades be not loaded sufficiently to slow them down and give incorrect readings. For this reason the development of such turbine meters has been restricted, since it is not possible to extend the shaft of such a turbine runner through packing-glands to operate an external counter.

The problem of counting the rotations of the free-running turbine blades is now accomplished readily enough by means of a photo-cell which responds to the light impulses coming through the glass window in the valve housing, as the vanes rotate. In this way an accurate count of the rotor revolutions is kept, without imposing the faintest load on the rotor itself.

✦

Amplifier music for patients during operations

Members of the New York Society of Anesthetists recently demonstrated the power of music to assuage discomfort during surgical operations, by delivering appropriate musical selections directly to the patient, without interfering with the conversation of the surgeons and nurses. In co-operation with Erpi experts, Dr. A. F. Erdmann, noted surgeon, has been experimenting with sound therapy for several years.

"The new electromagnetic pickup," Dr. Erdmann said, "transmits the music from the phonograph record to an individual patient, without inconvienc-ing or distracting the attention of others who may be in the room. It serves to divert his attention from the operation—keeps his mind off what is going on about him, and shuts out the conversation of those performing the operation, which sometimes has an unfavorable effect."

DEVICES IN INDUSTRY + +

Industrial X-rays for examining metals

An X-ray machine built especially for the industrial field for the radiographic examination of thick sections of metal, is rated at 10 ma. and 300 kv. peak for continuous operation and employs the so-called doubling circuit using two kenotron tubes as rectifiers. Condensers are placed in series with the tubes and the high-tension transformer. The condensers serve to boost or double the voltage supplied to the X-ray tube by the high-tension transformer on the useful half cycle.

This increase to 300,000 volts for continuous operation of X-ray tubes permits the rapid X-ray examination of steel sections up to 3½ in. in thickness and by longer exposures satisfactory examination of steel up to at least 4½ in. in thickness. Consistent operation of the apparatus and the stability of the X-ray tube developed for this high-voltage has made it possible to examine welds of heavy steel plates as a routine procedure.

✦

A "rogue's gallery" of talking films

The use of sound pictures as a means for the identification of criminal suspects would in itself be invaluable, according to a writer in *The American Journal of Police Science*. The ordinary "rogues' gallery," as it exists today, furnishes us with very little—a still-life full-face view, a profile, and a verbatim description. This is at best a clumsy and inaccurate means of identification, used for general leads rather than positive proof. The growth of a mustache or beard is enough to render such photographs practically useless. In many states the use of fingerprints is limited by legal entanglements. The substitution of a collection of living "speaking" representations will be a distinct advance in the technique for establishing the identity of criminals, furnishing what Professor Moley calls "a fourth dimension" of identification which leaves no aspect of the prisoner unrecorded. It will be an incalculable aid to any police organization or prosecuting office and may aid in abolishing some of the questionable tactics of these officials which they now feel to be indispensable in establishing their cases and preserving semblances of efficiency.

There is now a concerted attempt under way to establish a central bureau of information and records, to be supplemented with sub-branches in the larger cities, which in turn serve as collection centers for the smaller districts. At the same time, however, the flow of information can be directed outward, from the center. Pre-supposing a complete movietone library in existence at the central criminal bureau, it is easy to imagine the possibilities for the use of films in a nation-wide hunt for any particular man. Small, indeed, is the town which has no moving picture apparatus. Through the distribution of the films as needed would be molded an extremely strong organization for the discovery and apprehension of criminals, carrying to the smaller cities and towns the advantages and resources of the better equipped and more efficient police.

Aside from its value to the witness and the police, the movietone could serve as a broadcasting agency for arousing the interest of the general public. Few people take particular notice of a post-office bulletin describing a "man wanted." How many read carefully a newspaper description of a suspect? But few would fail to be interested in a living advertisement of "I am wanted."

What man planning to commit a crime would not think seriously of his chances of detection and escape when he may appear, walking and talking, before the eyes of thousands scattered throughout the country?

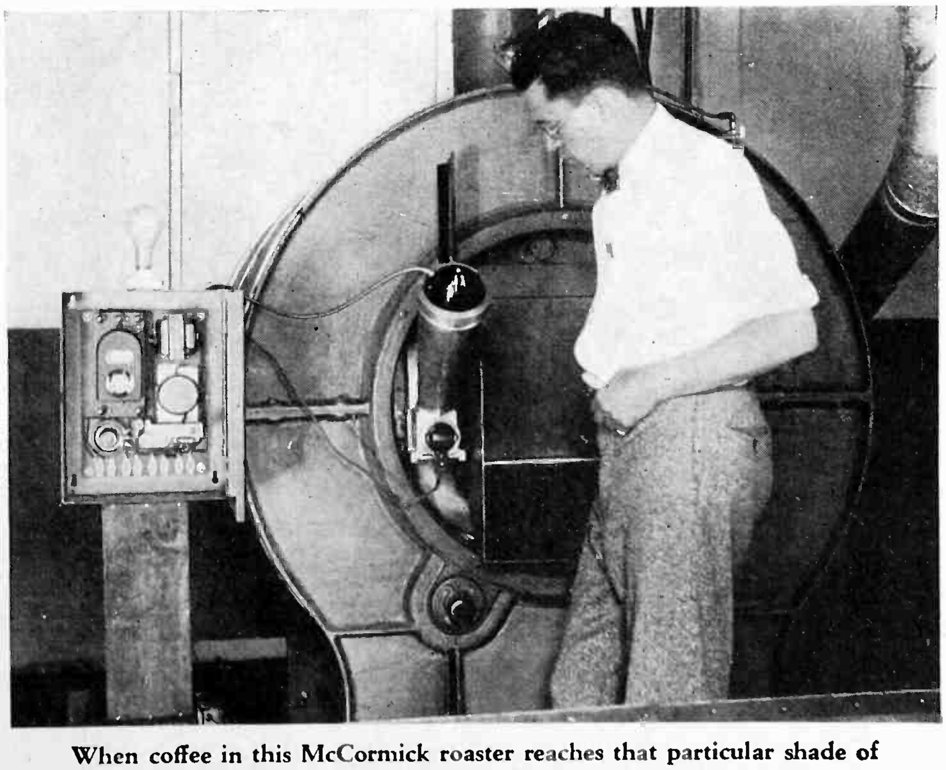
Photoelectric photometer tests air purity

Harvard Observatory has a valuable new research instrument in a photoelectric photometer designed by W. A. Calder to study the luminous intensity of faint and brighter stars and tested recently in the more mundane field of air purity investigation at the Harvard School of Public Health.

While the apparatus is primarily for astronomical use it may be employed for highly precise measurements, particularly of faint light as in basic analyses bearing on air conditioning, notably in evaluating the concentration of dust particles in segregated volumes. It occupies only about one cubic foot of space and utilizes a Kunz photoelectric cell and Lindemann electrometer in translating light intensities into scale readings. A Telechron clock motor is provided to drive the sectors requisite to equalize the light of the star under investigation with that of the comparison star. Amplification of light values along the line practiced by Professor Joel Stebbins with vacuum tubes is under consideration in connection with this photometer. The illustration shows the device attached to a telescope with a 3-in. lens for the study of colar corona luminosity during the recent solar eclipse.

✦ ✦ ✦

PHOTO-CELL SIGNALS WHEN COFFEE IS ROASTED



When coffee in this McCormick roaster reaches that particular shade of golden brown which indicates that the ideal roasting has been secured a Weston photoelectric cell notifies the supervisor to recharge the roaster

An electronic phase-failure relay

By C. STANSBURY and
G. C. BROWN

Research Engineers,
Cutler-Hammer, Inc.

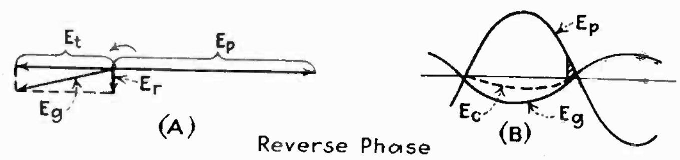


Fig. 2—Normal phase relations in circuit

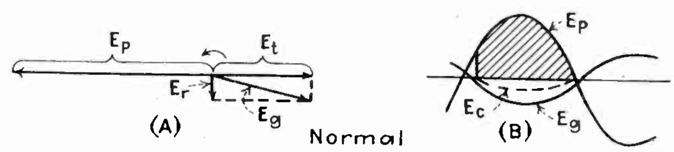


Fig. 3—Effects of a phase reversal

THE applications of electronic devices in industrial control apparatus fall in two general classes: Those in which the electronic apparatus performs functions which cannot be performed by other known apparatus, and those in which it has to compete with other means having the prestige of years of successful service. The application described in this article falls in the latter class, as electro-magnetic devices for performing functions similar to those described have been in use for years and it is only due to their superior characteristics and performance that the electronic arrangements described are coming into use.

Where a polyphase (generally three-phase) a.c. motor is used for driving an elevator or hoist, it is necessary to so arrange the controller as to prevent operation of the motor unless the supply voltage conditions are correct. For instance, if the phase rotation of the supply voltage is in the wrong direction (which may possibly be the case, due to switching or maintenance operations on the power distribution system) the motor will run in the "up" direction when the controller handle is put in the "down" position, and vice versa. This is obviously a dangerous condition, and is ordinarily combated by including in the controller a relay which distinguishes between correct and incorrect phase rotation, opening its contact and making the controller inoperative in case the latter occurs. Similarly, dangerous conditions result from the failure of one of the supply lines, resulting in single phase instead of polyphase supply and from other abnormal voltage conditions. The protective relay should be so designed as only to close its contact when no such dangerous conditions exist; that is, only when the supply voltage conditions are perfectly normal and satisfactory.

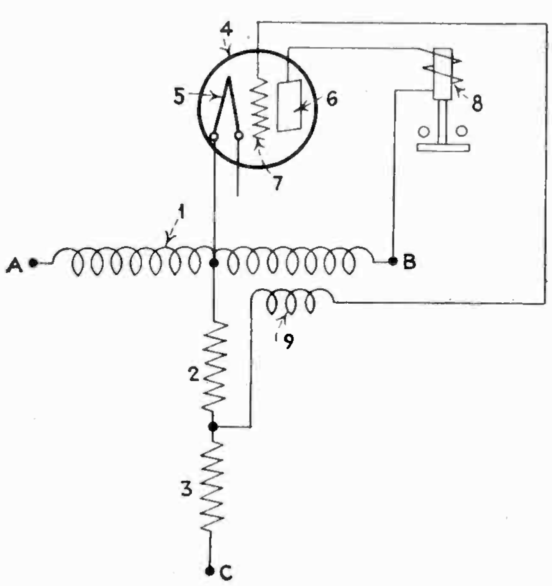


Fig. 1—Elementary diagram of the phase-failure relay

There are three general types:

1. Relays using the rotating magnetic field-induction principle, in which a movable member responds to the direction of rotation of a field induced by the supply current or to its failure to rotate due to single phase condition.

2. Multi-coil relays depending on the change in phase relation of the currents in the various coils under normal and abnormal conditions.

3. Voltage-sensitive relays connected in a network of resistors, reactors, etc., in such a way that abnormal phase conditions produce low voltage, causing the relay to respond. This method has the weakness that it is very difficult to devise a network in which such voltage changes resulting from abnormal conditions are materially greater than the range of the normal operating voltage which must be provided for.

Advantages of electronic apparatus

There are a number of desirable objectives in setting out to design an electronic substitute for the above. Some of the advantages which prove to be obtainable are:

1. Greater simplicity and cheapness. The electronic and auxiliary apparatus used is of standard type, suitable for a large number of other uses.

2. Functioning can be made inherent in the circuit and need not be dependent on the proper functioning of delicate moving parts, light contacts, etc., all such parts being eliminated.

3. A.C. elevator and other motors are often controlled by contactors and relays which use d.c. in their coil circuits. Electronic phase protection apparatus offers the opportunity to provide such protection with the same tubes which also furnish the rectified current for these coils, the only additional apparatus required being simple and cheap. On the other hand, there is the disadvantage of the cost and inconvenience of occasional tube replacement. This factor diminishes with the improvement and cheapening of the tubes which is inevitable.

The relay described below is of what may be termed the shunt type, as it responds to the voltage conditions of the lines feeding the load; as contrasted with the series type of protection which responds to phase relations of the currents passing to the load. The former type is suitable for applications like elevators where the motor is stopped frequently. If the line voltage of one phase fails while the motor is running, the counter-voltage generated in the motor will hold up the voltage of the respective line, and prevent the relay from functioning until the motor approaches rest. This is desirable in an elevator so that a landing can be reached before the equipment is shut down by the relay. A method of electronic protection of the series type, not covered by this article, but operating on the same principle, has been developed for protection of motors which run more or less continuously.

The electron tube circuit

Figure 1 is an elementary diagram of the system. The tube is of the grid-controlled gas rectifier type. The method of control makes use of the well-known principle of shifting the phase of the grid voltage with reference to the anode voltage. But, instead of using such phase shift control in the way most commonly described, as a means of taking any portion of the half wave desired and thereby adjusting the r.m.s. current, advantage is here taken of the fact that there is one critical phase position of the grid voltage from which a slight shift in

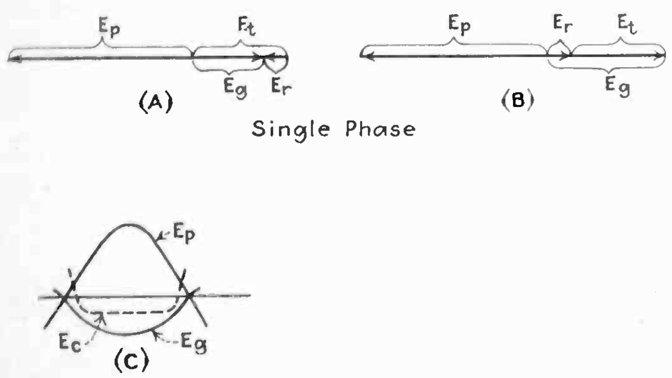


Fig. 4—Single phase circuit conditions preventing flow of current

phase in one direction makes the tube conduct during practically the entire positive half-cycle, while a slight shift in the other direction prevents current flow for more than a negligible part of the half-cycle. This is best explained by reference to the other figures in which E_p is the voltage applied to the anode, E_g that applied to the grid, and E_c is the critical potential below which the grid must be kept to prevent the starting of an arc. The network of Fig. 1 has the property that under normal phase conditions the relation of E_g to E_p is as shown in Fig. 2, which permits conduction during practically the entire positive half-cycle; while reverse or single-phase conditions produce the relations of Fig. 3 or Fig. 4 respectively, which substantially prevent any current flow through the tube.

The voltage E_r in Fig. 2 is due to the IR drop in the resistor 2 of Fig. 1. The voltage E_t is that of the transformer winding 9. These voltages combine vectorially to give E_g, which is shown in Fig. 2B as permitting current to start through the tube near the beginning of the positive half-cycle of the anode voltage. Figure 3 shows the voltage conditions resulting from reverse phase rotation. It is evident that the phase of E_g has advanced relative to E_p enough to block conduction through the tube except possibly for a negligible period toward the

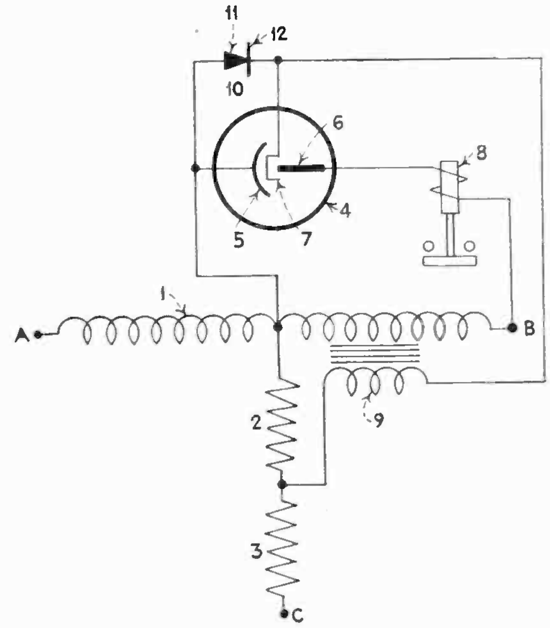


Fig. 5—Use of an auxiliary rectifier in phase-failure relay using cold-cathode tube

end of the cycle. There are a number of possible single phase conditions, depending on which of the three lines fails, and on the type of apparatus connected between the various lines, but when analyzed all such conditions may be reduced to either Fig. 4A or Fig. 4B. The difference lies in whether E_r is in phase with or in opposition to E_p. E_t is always in direct opposition to E_p.

It is only necessary to make E_t large enough to give grid voltage which is sufficiently negative to prevent starting of the tube even for the case where E_t is opposed by E_r as in Fig. 4A.

It will be clear that although reference has been made to abnormal conditions such as reverse phase rotation or phase failure, the normal condition shown in Fig. 2 is a critical one and adjustment can be made so that this condition will be disturbed for any desired departure of voltage balance from normal.

When an attempt was made to apply Fig. 1 to a tube of the so-called grid-glow type, difficulty was experienced because the anode current will start in the tube when the grid voltage exceeds either a definite positive or a definite negative critical value, such critical values being of the same order of magnitude, somewhere between 200 and 400 volts, depending on circumstances. The requirement was that under normal conditions the grid voltage should in every cycle exceed one of these critical values and so cause the tube to conduct, but must not exceed either critical value when abnormal conditions exist. It was not found possible to meet this requirement by phase shift means alone, but the problem was solved by introducing the auxiliary rectifier (preferably of copper-oxide type) shown as 11 in Fig. 5. This rectifier permits making the grid potential sufficiently positive to reach the *positive* critical potential, but at the same time prevents the grid from reaching the *negative* critical grid potential. With this addition the functioning is substantially the same as that described for Fig. 1.

A number of elevator controllers using the arrangement described herein are in successful service—two of them having been in service for over two years.

The application should be of particular interest to advocates of electronic methods because of its success in direct competition with old and well-tried electromagnetic methods.

Magnetic control of mercury vapor rectifier tubes

By Herbert J. Reich*

Since the development several years ago of the hot-cathode thyratron, quite a number of articles have been published concerning the various methods by which the grid may be used to control the anode current. It does not appear to be generally known, however, that equally satisfactory results may be obtained by using a magnetic field instead of the grid as the controlling element.

A magnetic field in the region between anode and cathode, preferably close to the anode, and at right angles to the path of the anode current, will increase the anode voltage necessary to cause the tube to break down. The critical anode voltage increases with field strength, so that the magnetic field produces an effect similar to negative grid voltage.

If a permanent magnet or other form of unidirectional field is used in conjunction with a tube supplied from an a.c. source, increase of field strength may be made to decrease the average anode current continuously from its maximum value to a value approximately half as great. Beyond this point further increase of field strength will reduce the current suddenly to zero. By means of an electromagnet energized from the same a.c. source as the anode, the current may be varied either continuously or suddenly from maximum value to zero. This may be done by varying the phase of the magnetic field with respect to the anode voltage, by maintaining a constant phase displacement between the magnetic field and anode voltage and varying the strength of the field, or by a combination of these methods. The explanation of the action of the tube for these various methods of control is similar to that when a grid is used as the controlling element[1]. The secondary of a model T Ford spark coil has been found to make an excellent electro-magnet for this purpose, both with and without a core. By proper design of the core the exciting current may be as small as ten or fifteen milliamperes, which compares favorably with the grid current required by thyratrons. Many simple circuits may readily be designed for varying the phase of the exciting current with respect to the anode voltage.

The anode current may also be controlled in many mercury vapor rectifier tubes by means of a high frequency electromagnetic field, even when a small oscillator is at a distance of several yards from the tube circuit.

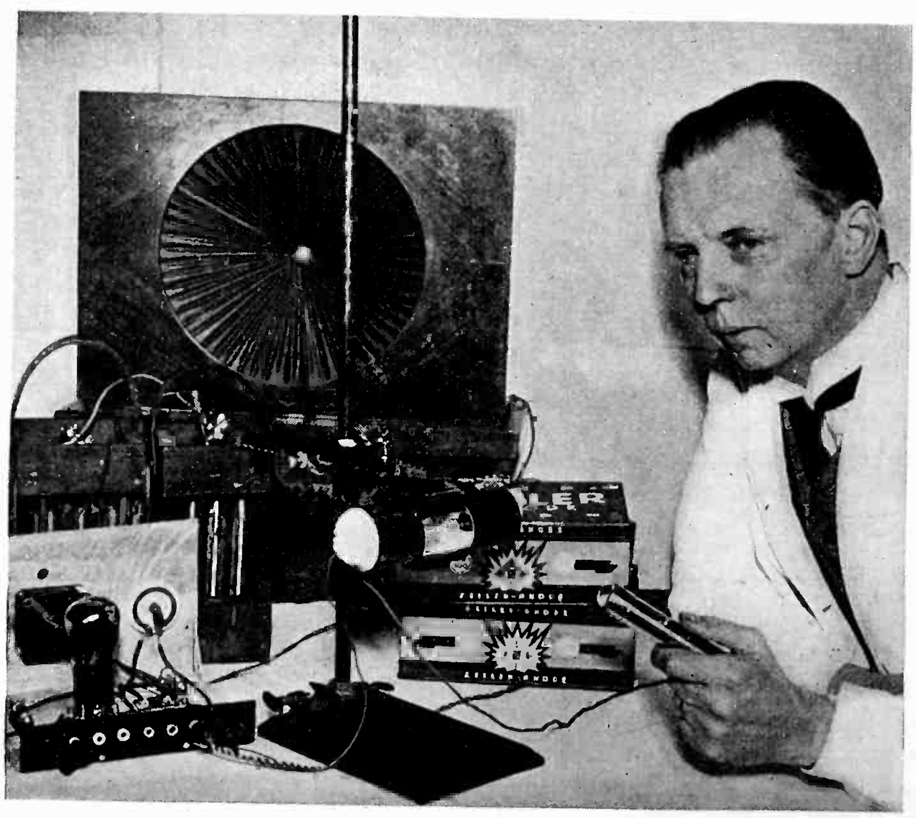
It is apparent that the use of a magnetic field in place of a grid in controlling the current passed by hot-cathode mercury vapor rectifiers may be of considerable advantage, since a simple two-element rectifier tube is usually much less expensive than a grid-controlled tube. It should be pointed out, however, that magnetic control is not effective with the type of recifier tube in which the anode completely surrounds the cathode.

*Dept. of Electrical Engineering, University of Illinois.

[1]A. W. Hull: "Hot Cathode Thyratrons", G. E. Rev., Vol. 32, No. 7, July, 1929, 390-399.

✦ ✦ ✦

MUSIC WITH A FLASHLIGHT



Joachim Winckelmann, Berlin, sends a continuous current through a selenium cell; when light falls on the cell a tone emitted by an oscillator varies in frequency with the intensity of illumination

✦

High frequency ceramic material

A new ceramic body having characteristics of interest to workers at high frequencies has been developed in Germany and will soon be available in this country. It is reputed to be useful where accuracy of dimension and high dielectric and mechanical strength are desired. The data below were taken in accordance with the standards established by the German Ceramic Society.

PHYSICAL AND ELECTRICAL CHARACTERISTICS

Specific weight	2.6–2.7
Dielectric strength, kv/mm	35–45
Dielectric loss	See below
Dielectric constant	6.5–7.1
Compressive strength, lb./sq.in.	96,000–118,000
Transverse strength, lb./sq.in.	14,700–19,000
Impact strength, cm kg/cm²	4.0–4.5
Tensile strength, lb./sq.in.	3,700–9,000
Linear coefficient of expansion	7.8

The dielectric loss varies with frequency as follows:

Frequency in kilocycles	Dielectric loss in per cent
100	0.21
1,000	0.16
3,000	0.15
4,300	0.14
8,600	0.11
12,000	0.10

✦

Permeability of iron at ultra-radio frequencies

J. Barton Hoag and Haydn Jones, of the University of Chicago, report in the *Physical Review,* November, 1932, that the magnetic permeability of iron falls gradually from the value 30 at 469.8 megacycles (63.8 cm.) to 22 at 589.8 mc., 18.7 at 829.8 mc. and 9.65 at 1,350 mc. (22.21 cm. waves). These are the first measurements made with undamped waves; they suggest that as the frequency increases the magnetic premeability of iron tends toward unity, the value for empty space.

FROM THE LABORATORY + + +

Electronic microscope—studies of electronic emission

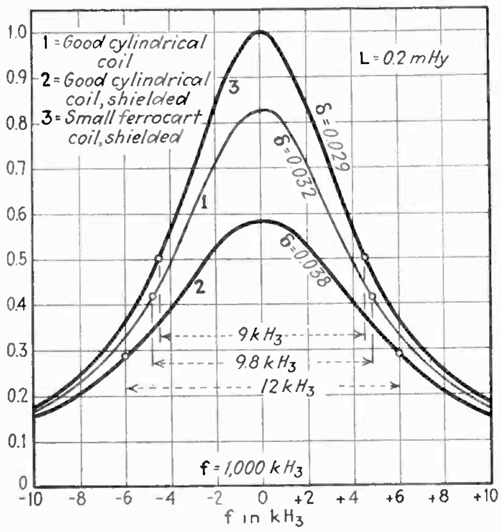
IN AN INTERESTING SERIES OF experiments M. Knoll, F. G. Houtermans and W. Schulze, of the Berlin Institute of Technology, use was made of the magnetic field produced by two short coils for focussing electrons issuing from an incandescent oxide-coated cathode. An enlarged image of the emitting surface was obtained upon a screen of zinc sulfide for visual observation, a zinc sulfide silver phosphorescent layer for photography. The electronic microscope shows that the emission of an oxide-coated cathode is much less uniform than might be thought from the appearance of the surface. Photographs made by the microscope may be found on page 377, December *Eectronics.* On heating the cathode when the plate potential is zero, the emission becomes uniform for a moment, but in a fraction of a second active specks or channels are formed; the negative space charge which builds up near these zones tends to make the image hazy. Oxide-coated cathodes with uniformly emitting surface show distinct saturation; no saturation is obtained up to 2,000 volts when active zones are present, no doubt merely on account of the uneven distribution of the space charge. This work was described in the *Zeitschrift für Physik,* October 1932, and a photograph of the electronic microscope will be found in January, 1933, *Electronics,* page 23.

✦

Tuning coils wound on magnetic cores

CONSIDERABLE INTEREST ABROAD has been aroused by a new magnetic core developed by Hans Vogt, Berlin, on which inductances for tuning circuits may be wound. The material is called "Ferrocart" and makes possible the construction of compact inductors with small external fields and with low losses. In these respects the material seems to resemble the Polyiron cores developed in this country and discussed widely a year ago.

"Ferrocart" consists of minute particles of a high-grade magnetic material. These individual particles are themselves quite free from losses, and are arranged by means of a special insulating process so that the formation of eddy currents and the losses resulting therefrom are reduced to a minimum. The magnetic losses in the case of wave lengths of 200 to 600 meters, are reported to be less than the high frequency



losses occurring in copper. However the new material possesses a considerably greater magnetic conductivty than air so that the amount of copper employed can be decreased and therefore the copper losses avoided.

The material itself is made in the form of plates or rolls of different dimensions, from which the individual cores for the coils are worked in the necessary dimensions. The material is easy to work, can be stamped out and sawed. Individual parts can be pressed together by employing pressure and heat.

✦

Photometry of stars by means of a photo cell and a low grid-current tube

GREATLY IMPROVED RESULTS in the photoelectric photometry of stars are obtained according to A. E. Whitford, of the Washburn Observatory, Madison, Wis., when instead of measuring the photoelectric effect produced in the cell (sensitivity 220 μa per lumen) by means of an electrometer, it is amplified with aid of a low grid-current tube (FP 54). The photoelectric cell (sensitized sodium) and the vacuum tube are placed inside a metal container which can be fastened to the ocular tube of the telescope and evacuated to 1/100 mm. of mercury. The high resistances required (14,000 and 74,000 megohms) have been secured from the S. S. White Dental Manufacturing Company. The single stage amplifies over two million times, and when the device is placed near the focus of the 15-inch refractor, the current produced by stars of 14th magnitude can be measured by a sensitive galvanometer. (This corresponds to the light from a standard candle "seen" from a distance of about 250 miles). The report of this work will be found in the *Astrophysical Journal,* November, 1932.

The cesium-oxygen silver photo cell

THIRTEEN COMMERCIAL cesium-oxide photoelectric cells representing three different types of vacuum and three gas-filled tubes, were exposed by J. C. Peters and E. B. Woolford, Leeds and Northrup Company, to the light from a 6-volt, 18-ampere projection lamp run at 10 amps. (1,545 deg. C.) At the end of 820 hours the light was shut off for 200 hours; after 1,300 hours the e.m.f. (45 volts for vacuum and 90 for gas-filled cells) was removed for 200 hours, the current being measured once daily during all this time in a separate test set. According to the report published in *Physics,* October, 1932, the PJ-14 cell has the most constant results. Gas-filled cells may decrease or increase in sensitivity over 100 per cent after a few hundred hours. Changes following the deposition of minute amounts of cesium are described by Prescott and Kelly, *Bell System Technical Journal,* July, 1932. See also *Electronics* Digests, February, 1932.

✦

World's largest medical magnet

WHAT IS BELIEVED TO BE the largest magnet constructed for medical purposes has been installed in the St. Louis University School of Medicine. This magnet weighing 3,000 pounds represents an investment of $20,000 and is a memorial to Colonel E. L. Bingham former chief medical officer at the Jefferson Barricks. The instrument is reported to resemble a cannon with a steel cone at the muzzle. It is mounted on a bronze bell-shaped base. The cylinder is 71 in. long, 12 in. in diameter and is wrapped with 1,500 lb. of wire. It is powered from a 250-volt, 50-hp. generator located in the basement.

✦

Bridge and new compensated vacuum-tube voltmeter

A ROBUST THERMIONIC VOLTMETER is described in the *Philosophical Magazine,* July, 1932. The author, A. S. McFarlane, states that it measures accurately to tenths of a millivolt while its zero remains unaffected by gross changes in the A and B voltage supply. Two arms of the Wheatstone Bridge consist of triodes, and an expression is deduced and verified for the condition that the bridge may be simultaneously balanced and compensated against fluctuations in the supply voltage.

Acoustically compensated volume control

for radio and phonograph sets

By I. WOLFF and J. I. CORNELL
Engineering Department, RCA Victor Company, Inc.

IT IS commonly observed that there is usually some optimal loudness at which reproduced music or speech from a radio set or phonograph sounds most pleasing. The general effect is that music loses its body when reproduced at low volumes and speech sounds acoustically tubby when reproduced at high volumes.

The cause for this effect can be traced to the variable frequency response of the ear to tones of different intensity. Careful measurements have been made, principally at the Bell Laboratories, to determine the loudness (psychological effect) of various pure tones on the human ear. These experiments have usually been conducted by having a number of listeners compare a pure tone whose intensity and frequency can be varied with some standard tone, generally at 1,000 cycles. Corresponding to every reasonable intensity of the 1,000-cycle tone, there is an intensity of the tone of the other frequency which will sound equally loud. If the points corresponding to equal loudness for a series of tones covering the frequency range are plotted in terms of the physical intensity (sound pressure), a curve known as a "loudness contour" curve is obtained. This curve, as its name and method of attainment imply, shows the various intensities which are required in order to maintain the same loudness at different frequencies.

It is found that equal increments of sound intensity do not cause the same increase in loudness at all frequencies and the loudness contour curves crowd together considerably at the low frequency end, indicating that when a complex tone is increased in intensity the low frequencies become relatively more important, and when it is decreased in intensity the low frequencies become relatively less important. If the tone is attenuated sufficiently, the low frequencies even drop below the threshold of hearing, while the higher frequencies may still be readily distinguished. A series of loudness contour lines, taken from a paper published in the *Physical Review* by B. A. Kingsbury, is shown in Fig. 1 and illustrates this effect.

Let us assume that the volume control on the radio set is so constructed that it does not change the frequency response of the set. Most volume controls have been built with this aim in view. Let us also assume that the pickup of the sound and the reproduction of the sound cause little distortion of the frequency response. Under these conditions, the reproduction should sound most natural when it is reproduced at the same intensity as it would be heard by an observer listening at the place where he would normally be located to hear the original performance. Due to a proper regard for the feelings of the listeners' neighbors, or possibly to the listeners' own sensibility, radio sets and phonographs are very often run at such a volume that the sound intensity is considerably less than that at which it would normally be heard. In such cases, the effects which have been mentioned above occur and the body of the music is badly lost. If a volume control is constructed so that the low frequencies are raised in almost an inverse ratio to the relative sensitivity of the ear in going from normal volume to the volume at which the sound is to be heard, a compensation results which makes up for the different frequency sensitivity of the ear at the lower volume. Such a volume control is known as an "acoustically compensated volume control."

The application of this type of volume control to a radio receiver presents certain difficulties and requires the redesign of the volume control system. The so-called volume control, in many radio receivers, is not strictly a volume control, but a sensitivity control, since it regulates

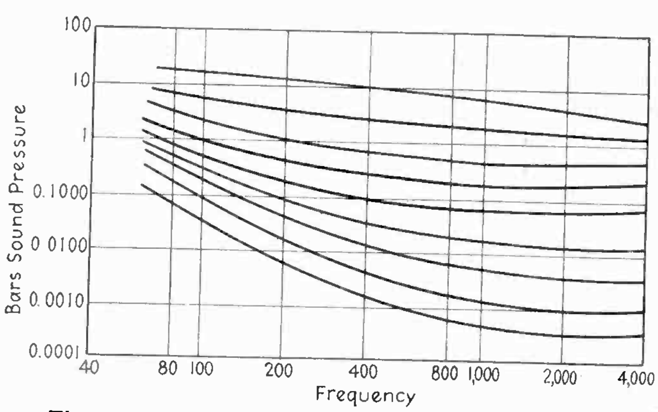
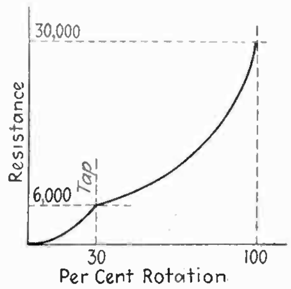
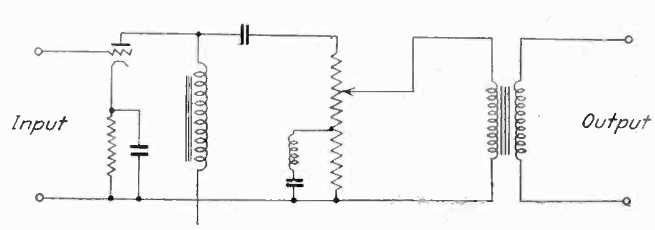
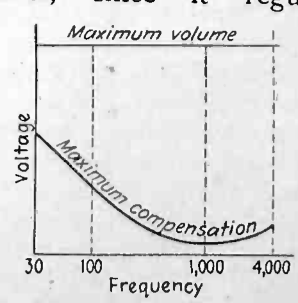


Fig. 1—Equal loudness contours—response of human ear







Left—Fig. 2—Characteristics of volume control resistor

Above—Fig. 3—Circuit diagram of acoustically compensated volume control

Right—Fig. 4—Voltage frequency characteristic of control

the radio frequency amplification to compensate for the variation in intensity of the voltage across the antenna and no definite relation exists between the position of the control and the output level of the reproduced sound.

It is essential that a definite relation be established between reproduced sound output and volume control setting and that this level be maintained irrespective of the variation in intensity of the voltage across the input of the receiver. This requirement necessitates a high gain radio frequency amplifier provided with an automatic sensitivity control capable of maintaining the voltage input to the demodulator substantially constant, irrespective of the variation in signal intensity within the sensitivity limits of the receiver. With these conditions established, compensation can be incorporated in the volume control of the receiver to give the required aural compensation for different output levels.

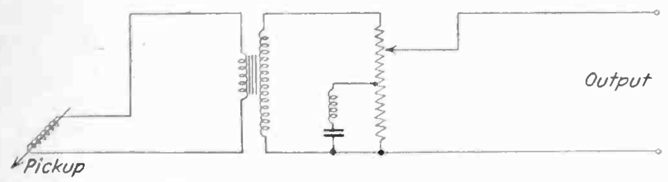


Fig. 5—Circuit diagram of control applied to phonograph

The volume control is located in the audio channel between the plate circuit of the second detector of a superheterodyne and the input to the first audio stage. It may take the form of a tapped potentiometer to vary the voltage input to the audio amplifier stage so as to obtain acoustic compensation. The shape of the resistance rotation characteristic of the volume control is preferably logarithmic in order that the ear may perceive equal increments in volume levels for an equal degree of movement of the control element of the volume control. It has been found desirable to make both portions of the contr l logarithmic. The resistance characteristics of the control found satisfactory in this receiver are as shown in Fig. 3.

To compensate for the deficiencies in the frequency characteristic of the human ear, and to provide a sound pressure frequency characteristic of the output of the receiver which varies inversely with the ear frequency characteristic (related to normal volumes), an impedance network has been connected from the tap to low side of the volume control. This impedance network, consisting of a series tuned circuit, is resonant at approximately 1,000 cycles and has a relatively broad tuning response characteristic which allows the mid-range frequencies to be attenuated more than the low and high frequencies as the control setting is reduced.

Electrical characteristics of the volume control

The volume control and compensation systems used in this receiver are shown in Fig. 2 and consist of a potentiometer having a total resistance of 30,000 ohms with a tap at 6,000 ohms. The compensation circuit is connected in shunt with the 6,000-ohm section and comprises an air core inductance of 50 millihenries and a 0.5 mfd. capacitor. The ohmic resistance of the choke coil is approximately 520 ohms. The inductance and capacitor are broadly resonant to frequencies in the range of 1,000 cycles, as is shown in Fig. 4. The upper curve in Fig. 4 shows the frequency characteristic of the volume control system with the movable arm set at the high potential end or point of maximum output. The lower curve is the frequency characteristic for the point of maximum compensation. The response characteristic of the system for other adjustments will be located between these limit curves approaching, in shape, the curve to which it is more adjacent.

When the arm of the potentiometer is at the top, maximum compensation occurs and the voltage frequency characteristic is determined by the impedance frequency characteristic of the compensation circuit. Here the signal frequencies in the mid-range are highly attenuated in comparison with the low and high frequency registers and the degree of compensation is determined by the constants of the shunt network.

In the circuit described above, the attenuation of voltage, with the arm at the top, is 14DB with the compensation circuit disconnected. Connecting the compensation circuit results in an additional attenuation of 34DB for frequencies in the region of 1,000 cycles. The voltage output at 100 cycles is up 16DB from that at 1,000 cycles at the point of maximum compensation.

Reducing the volume control setting below the point of maximum compensation has little effect on the shape of the voltage frequency characteristic of the volume control circuit. Care must be exercised in determining the value of the tapped portion of the volume control in order that subsequent circuit constants are not affected when the volume control is adjusted to positions below the point of maximum compensation.

A practical difficulty experienced with this system, at low volume levels, where the low frequencies are exaggerated to give the desired acoustical effect has been that of disagreeable low frequency distortion introduced from certain broadcast signals which has necessitated the addition of a suitable filter to attenuate frequencies below 70 cycles in order that such disturbances as interchannel beat and station generator noises do not mar the quality of the program being received. It is apparent that if audio compensation becomes a standard feature in broadcast receiver design, more care will have to be exercised in broadcast transmitters in order to minimize these low frequency disturbances.

Use with phonographs

The problem of using the acoustically compensated volume control with a phonograph is much simpler. Most records are recorded with the average intensity maintained close to some standard level and any adjustment of the frequency compensation for one record holds for practically all other records. The volume control may, therefore, be compensated without difficulty. A typical circuit used in a commercial phonograph design is shown in Fig. 5. This system also incorporates a tapped control using a shunt resonant circuit, characteristics of which are similar to those previously described.

It may be said that listening tests have substantiated the theoretical considerations as regards the effect of changes in intensity on the apparent frequency characteristic, and that considerable improvement is obtained with the acoustically compensated volume control. There are, of course, a number of other psychological factors which enter the picture, such as the fact that complex tones rather than pure tones are being listened to and that the ear is not a linear receiving device, which complicate the result and keep the low intensity sound from sounding exactly like that reproduced at the higher intensities. Nevertheless, the improvement is so substantial, that the pleasure obtained in listening to radio and phonograph reproduction at low volumes is increased many times.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI — FEBRUARY, 1933 — Number 2

"Unremitting effort and research"

THOSE were inspiring words uttered by Alfred P. Sloan, Jr., president of General Motors, as he traced the policy of his company with respect to scientific research during 1932.

"In a year of economic and financial depression General Motors has not only maintained its standards of value and quality, but has introduced new inventions and discoveries resulting from unremitting effort and ingenuity of its research and engineering staffs," said he, and continued. "The inevitable progress and momentum of America go on in spite of depressions, and the large corporations which play so great a part in shaping America's civilization recognize their moral obligation to allow no lag due to adverse conditions to retard their scientific advance."

The status of research in the radio field has not been equally fortunate these last few years. May the example of the older and more successful automotive industry serve to restore executive confidence in research in radio.

New musical piquancies

THE success of the recent experiment by Capt. Taylor Branson, leader of the United States Marine Band, in Washington, D. C., shows the possibility of combining brasses with many gentler solo instruments to give new piquancy to radio music.

With the aid of NBC engineers, Captain Branson achieved an almost perfect tonal balance between the piano and his military band, which numbers 100 pieces. It was the first time the Marine Band has ever broadcast using the piano as a solo instrument.

Helen Corbin Heinl, Washington pianist, was the soloist. She played such selections as Beethoven's "Moonlight Sonata," and Liszt's "Liebestraum" no louder than she would have played them alone, and without the slightest forcing of the tones.

The achievement was heard over a coast-to-coast network. Listeners report that the piano stood out as clearly as if accompanied by a symphony orchestra.

The "Giant Violin," by which an ordinary Stradivarius is amplified a thousand or ten thousand times, and then combined with a brass band, is another experiment along this line, soon to be broadcast.

Other possibilities suggested by the resourceful and open-minded Dr. Stokowski, include similar amplification of the flute, cello, glockenspiel, xylophone and celesta.

"Electrostatic engineering"

DR. KARL COMPTON, of Massachusetts Institute of Technology, did well to coin a new phrase "electrostatic engineering" as defining the new technique that is rapidly being built up employing electrostatic rather than the electromagnetic effects that have concerned electrical engineers almost wholly so far.

Many examples of this new "electrostatic engineering" are already in evidence. The 15,000,000-volt electrostatic generator now nearing completion at South Dartmouth, Mass., may wring new secrets from the atom and from the X-ray spectrum. Piezo-crystals are now being used as relays by direct mechanical action on contacts, providing relays that "hold in" with no current expenditure, merely shelf-loss battery charge. Condenser microphones are already familiar; condenser loudspeakers may yet fulfill the promise they inspire. Radio condensers are revising small-motor design.

Electrostatic electricity was the cynosure of Benjamin Franklin's day. It seems destined to a new ascendancy 150 years later, in the post-depression 1930's.

Four possibilities for cosmic rays

THE newspaper public has been treated to accounts detailing two opposing theories to explain the cosmic radiations that pour in upon us from space, as presented by Dr. Millikan and Dr. Arthur Compton. But these two theories do not exhaust the list of possibilities, for there are at least four reasonable hypotheses which later investigation brings to light. These suggest that cosmic rays may be—

Electro-magnetic waves of enormously high-frequency, the "birth-cries" of atoms being born in inter-steller space. (Millikan.)

Electrons of high energy and velocity, comparable to 1,000,000,000 volts. (Compton.)

Neutrons, or pairs of positively and negatively charged particles travelling with great velocity.

Combinations of all of the above-mentioned radiations.

As new electron-tube detectors are developed to indicate and measure cosmic rays, we learn more about this baffling mystery of inter-space. And out of such pure philosophical studies may come new light on commercial electronics as well.

Forbidding short-wave sets on autos

ALREADY several cities have police ordinances forbidding the use of short-wave radio sets on any automobile, unless authorized by the local officials. The purpose of course, is to prevent criminals from equipping their own cars with receivers that will let them listen in on the warnings sounded against them. Now a bill is before Congress imposing similar restrictions against all automobile receivers which can pick up police signals. Enactment of this amendment to the Radio Act would permit only police cars to be equipped with short-wave receivers.

While the purpose of these ordinances is commendable, their practical result will be to hinder criminals little or not at all, while becoming an intolerable nuisance to law-abiding citizens who may want to utilize short-waves in the future. We urge the repeal of all such short-sighted, restrictive laws.

NEWS NOTES

X-rays ionize at 100 ft.—Dr. J. W. M. DuMond has been able to use a small X-ray tube to ionize an electroscope 100 ft. distant. Speaking at the California Institute of Technology, he suggested this ionizing action might be employed in war to short-circuit airplane engines, and so wreck attacking planes.

Motion picture engineers at New York April 24-28—The regular semi-annual meeting of the Society of Motion Picture Engineers will be held at the Pennsylvania Hotel, New York, April 24 to 28. W. C. Kunzman, of Cleveland, is chairman of the convention committee. O. M. Glunt, chairman of the papers committee, promises a meeting of unusual interest.

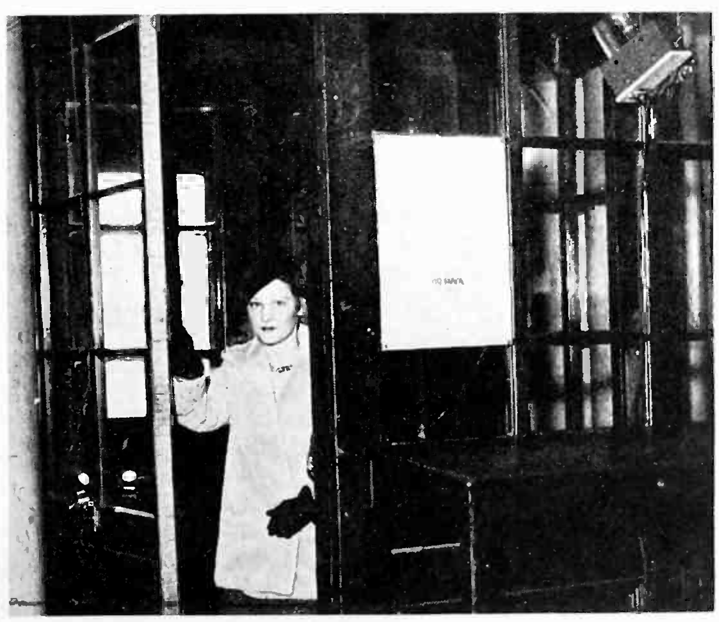
Dr. A. N. Goldsmith has resigned as vice-president and general engineer of the Radio Corporation of America to set up a consulting engineering practice with RCA as one of his clients. Dr. Goldsmith will continue his offices at 570 Lexington Ave., New York City, and will concentrate on radio, electrical entertainment, and acoustic and optical equipment and processes.

L. G. Pacent has organized a private consulting engineering firm with offices at 79 Madison Ave., New York City, and laboratories at Little Neck, Long Island., to specialize in the electrical radio, sound, electronic and motion-picture fields. Mr. Pacent will continue as president of Pacent Electric Company, but will devote most of his time to the new Pacent Engineering Corporation.

Exhibit of art in industry—Radio manufacturers interested in more attractive designs for receiver cabinets, will find stimulating suggestions in the collection of new designs and new materials for other industrial products, arranged by the National Alliance of Art and Industry in the Art Center, 65 West 56th St., New York City, which will continue open until Feb. 15. Alon Bement is director.

Broadcast over mercury-lamp beam—Under direction of E. K. Cohan, technical director, the Columbia Broadcasting System broadcast a program of musical numbers over the modulated beam from a Myers mercury-vapor induction-type lamp, located in the Chrysler Tower, New York. The modulated beam was picked up at the Columbia studios, half a mile away, and produced music of such excellent quality, that little or no difference could be noted between the light-beam and the usual telephone pair.

COUNTING LIBRARY READERS

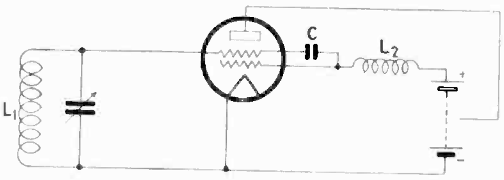


A photo-electric counter now keeps track of the 10,000 readers daily entering the 42d St. door of the New York Public Library. A human counter missed 200 to 300 a day

REVIEW OF ELECTRONIC LITERATURE
HERE AND ABROAD

Stabilization of oscillators

[Bruzau] A method is described by which the frequency of a low-power oscillator can be made practically independent of the voltages applied to the elements of the tube. A double-grid tube is used. The theory is discussed and various stabilizing circuits described, among which that of the figure is preferred—C is about 100 $\mu\mu$ *F.*, L_2 has about one quarter the inductance of L_1. No coupling must exist between these



two coils. Other methods of stabilizing this circuit (a resistance in series with the tuning condenser, the division of L_1 into two parts, one placed as now, the other in series with this condenser with no coupling existing between the two parts) are also discussed and experimental results given. —*L'Onde Electrique, Paris, September (published December 5) 1932.*

✦

Typical European Radio Stations

[Michel Adam]—Four of the most modern European emitters are Prague (120 kw.) Sottens (25 kw.), and Beromunster (60 kw.), both in Switzerland, and Westerglen (50 kw.) in Scotland. At Prague the microphone currents covering the range from 30 to 10,000 cycles are evenly amplified. The modulation may reach 100 per cent. The modulated current is amplified in two stages, the first stage comprising two 40-kw., 20,000 volt units symmetrically mounted, the second, twelve smaller tubes coupled to the first stage by means of a tuned circuit made up of silvered copper tubing held in the grooves of pyrex mandrils. The circuits are tuned by rotating a short-circuited coil placed inside the tuning coils. The power of the station can be cut in half by using only three of the six lamps in each symmetrical half of the second stage.

The Beromunster station which has to serve much mountainous territory is erected above an extended ground water surface. The antenna ground consists of two large circles of copper 15 and 30 m. in diameter with cables running along the diameters from one circle to the other, the total length of the buried conductors measuring 6,000 meters. Plate potential is obtained from a 270 kw. mercury arc rectifier.

The emitter in Scotland is connected to London by means of a cable 400 miles long.—*Revue gen. de l'Electricité 32: 771-779. 1932.*

✦

Recording on magnetic tape

[E. Meyer and E. Schüller, Heinr. Hertz Institute]—Steel tapes 10 to 15 m. long, 0.08 to 0.05 mm. thick, 3 mm. wide (see *Electronics*, May, 1931), proposed by Poulsen in 1900, now find practical application thanks to the combination with electronic amplifiers (Siemens and Halske). Air coils or coils with cores of silicon iron are used for recording; the voice coils have cores of permalloy. The factors influencing response at different frequencies are studied in detail.—*Zeits. techn. Physik. 13: 593-599. 1932.*

✦

Constant-amplitude oscillator

[F. Below, Berlin.] In the Loftin-White oscillator a large common capacity C and a mutual inductance L are used as coupling elements to get constant amplitude when the frequency f must be varied. The sum $6.28\ fL + 1/6.28\ fC$ or the regeneration, remains constant over a certain range. To determine this domain it is necessary to take into account that the resistance R introduced in the grid circuit increases with the square of the frequency according to the formula $R + 4\pi^2f^2k$. In order to start oscillations with the same amount of coupling at different frequencies, C must be very large and R very small. L is then given by $-ML_2/2 + (M^2L_2^2 - kR_i)^{1/2}$ where R_i is the tube resistance and L_2 the tuning coil.—*Hochfr. u. El. Ak. 40: 167-169. 1932.*

✦

THE ELECTRIC TONGUE

Utilizing a sensitive millivoltmeter Mr. R. C. Hitchcock measures the voltages produced by various fruits and liquids

Electrons in luminous discharge tubes

[M. J. Druyvesteyn, Phys. Lab. Philips' Eindhoven]—In a sodium vapor lamp (vapor pressure 0.005 mm. mercury) giving 30 candles per watt or 75 per cent of the possible efficiency, 25 per cent of the energy furnished is lost due to positive ions drifting toward the glass walls (3 to 4 cm. wide) and becoming neutralized. The current used was 0.2 to 3 amp. In neon too, the electrons travel in the direction of the positive electrode, whereas most of the positive ions diffuse to the wall. Besides the Dutch sodium-lighted highway (*Electronics*, August, 1932), sodium lamps have now also been installed near Zurich (Switzerland) and near London (England) on a road previously the scene of many accidents.—*Phys. Zeits. 33: 822-823. 856-863. 1932.*

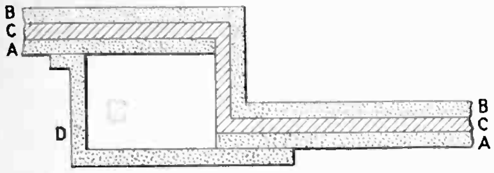
✦

Grid-controlled mercury vapor tubes

[A. Glaser] German General Electric Company (A.E.G.). After having recalled that in commercial thyratrons for 0.5 or 1,000 amp. the time required for starting the main discharge is of the order of 10^{-4} sec., and that an interruption of the plate current for 10^{-4} sec. gives back to the grid its power of controlling the passage of the arc, the influence of frequency, vapor pressure and the size of the hole in the grid electrode upon the grid potential required for starting the discharge is discussed. The higher the anode potential, the lower of course the grid voltage at which the main discharge starts, and for very low plate voltages, rapidly increasing positive grid voltages are necessary. The larger the hole the more marked the influence of the plate; at a certain size of the hole, three different grid potentials may be found at which the arc starts; for still smaller holes the grid versus plate voltage curve lies entirely in the region of positive potentials.—*Zeitz f. techn. Physik 13:549-558. November, 1932.*

Radio patents

[LG] GERMAN 539778. To make small variations in the inductance of one lead of a symmetrical circuit such an arrangement as that shown is used,



where *A, B* are the two conductors, *C* an insulator, *D* a bridge completing *A* and which can be moved to alter its inductance. — *Funk, Berlin, December 2, 1932.*

✦

X-ray photography of indirectly-heated tubes

[G. DÉJARDIN AND J. F. THOVERT, University of Lyons]—The nickel wire upon which the oxides of alkaline earths are deposited must be separated by quartz or magnesia from the hair-pin shaped tungsten wire which supplies the heat. Or the hair-pin shaped tungsten may be dipped into solutions (for instance, alumina with sodium silicate, aluminum nitrate with silica) and heated. The correct spacing may be tested with the aid of a 60 kv. X-ray outfit before the structure is placed into the lamp, and a 100 kv. outfit when it is inside the lamp and surrounded by metallic surfaces. When lead-glass is used a Coolidge tube may become necessary (100 to 120 kv., a few milliamp., 30 seconds exposure). See also *Electronics,* October, 1930—*Journal de physique 3: 159S. 1932. Revue gen. Electricité 32: 814. 1932.*

Piezo-electric properties of Rochelle salt

[E. SCHWARTZ, University of Hamburg.] In contrast to quartz crystals for which the piezo-electric effect is proportional to the pressure applied, the charges appearing on the most sensitive surfaces of a Rochelle salt crystal increase more rapidly than the pressure. A charge of 14.3 micro e.s.u. per dyne is obtained when a load of 3 kg. is applied as against 0.06 per dyne for quartz. Another complication is that the dielectric constant varies not only with the temperature, but also with the electric field produced by the charges on the surfaces. Excepting the least sensitive direction *c* it has abnormally high values (2,000 to 6,000 against 80 for water). The author thinks that by cutting sections perpendicular to the axis *c* of the prisms he will obtain material suitable for microphones (see also *Electronics,* May 1932 on piezo-electric loudspeakers).—*E.N.T. 9: 481-495. 1932.*

✦

Sound ornaments

[GRADENITZ] Details with good photographs of the ornamental forms which Fischinger has found to give certain musical effects when traced on film and fed to a normal sound projector: for example, a note with its octave, third, and fifth, the contrast between heavy and massive tones, and light, diffused ones; and especially the geometrical ornaments which give the timbres of bassoon, flute, xylophone, etc. [Article of considerable importance as a step towards the *direct* production of music from films]—*La Nature, Paris, November 15, 1932.*

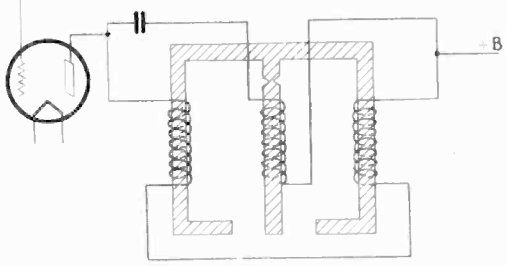
Results of the Madrid Conference

[H. GIESS, President of the German Delegation]—The waves for broadcasting purposes have been agreed upon as 1875 to 1131 m. or 160 to 265 kc., and 545 to 200 m. or 550 to 1500 kc. to the exclusion of 1364 kc. (220 m.). The different countries have to settle the distribution of these waves. The 600 representatives of 80 states and 85 societies have signed an agreement creating an international union of telecommunication embracing telegraphy, telephony and radio.—*Funk Bastler, December 23, 1932.*

✦

New loudspeaker system

[NOACK] Borchardt has developed a system using soft iron laminated field-magnets and armature, the latter being fixed flexibly to the neutral point of the former. The first coils (about 400 ohms) are to be connected between the



last anode and $+B$, and take only about ½ watt. They act as an effective choke for the audio frequencies. The armature coil is connected through a condenser, as shown in the figure.—*Funk Magazin, Berlin, December, 1932.*

✦ ✦ ✦

New amplifiers—detectors and oscillators

[*Continued from page 35*]

the tube will deliver 50 ma. of current at an r.m.s. voltage per plate of 225. The tube is a full-wave rectifier.

The 25Z5 is aimed at the universal receiver. It is a full-wave rectifier with separate connections brought out for each cathode terminal. Thus the tube can be employed as a half-wave rectifier or, what is more interesting, as a voltage doubler. Thus in the cheaper sets the 110-volt input from the line may be doubled without the aid of a transformer. As a half-wave rectifier the output current is approximately doubled compared to a less complicated structure. With 16 μf. condensers in the double circuit the voltage output is 180 volts at a current drain of 100 ma. and at 20 ma. the voltage is about 250 volts.

There are two possibilities for the combined detector-oscillator socket. One is a 5-grid tube having some of the characteristics of the Dow electron coupled oscillator discussed in the technical literature and widely used by amateurs and others. The other possibility is a pentode-triode. The characteristics of these tubes had not been definitely decided at the time of writing.

RECTIFIERS

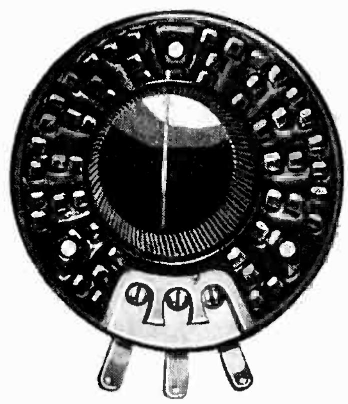
Type	Purpose	Bulb	Cathode Type	Cathode Volts	Cathode Amps.	A.C. voltage per plate (r.m.s.)	D.C. output current ma.
84	Auto radio, B-power	ST-12	Heater	6.3	0.5	225	50
96	Half wave, Mercury	S-12	Heater	10.0	0.3	350	100 ave.
98	Full wave, Mercury	S-12	Heater	6.3	0.5	350	50 ave.
5Z3	High vacuum full-wave	ST-16	Filament	5	3.0	500	250
25Z5	Rectifier, Voltage doubler	ST-12	Heater	25	0.3	125	100
ER-1	Vacuum, Half-wave	ST-12	Heater	6.3	0.3	250	50
HZ-50	Half-wave, high vacuum	...	Heater	12.6	0.3	125	....

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Rheostat

The Ward Leonard Electric Company, Mount Vernon, N. Y., offers a new design of Adjustat rheostat in which the "dead shaft" construction is completely insulated from current carrying parts, and simplifies single hole mounting on steel panels without the use of troublesome insulating bushings or washers.



A $2\frac{3}{4}$ in. circular refractory plate forms the base for the special resistance wire of low temperature coefficient of resistivity. The plate, wire, contacts and terminal connections are thoroughly protected against corrosion and damage by fused-on vitreous enamel.

The adjustat is regularly furnished from 1 to 25,000 ohms. It will dissipate 30 watts continuously with a temperature rise not exceeding 250 deg. C. Sixteen steps of control are provided, and terminals are arranged for potentiometer connection.—*Electronics, February, 1933.*

✦

Automobile spark-suppressor

The Globar Corporation, Niagara Falls, N. Y., announces a new automobile radio spark-suppressor for dampening the oscillations in automobile ignition circuits.

The disadvantage of intermediate contact between the resistor and its terminals has been eliminated in the construction of this suppressor, through the use of a high-fired resistance body to which the terminals are directly attached by a process which constitutes virtually a weld. The exposed metal parts necessary for attaching the suppressor to the spark plug and cable, are confined to the ends of the resistor, thereby reducing exposed metal surfaces to absolute minimum.

This suppressor can be furnished in three types, spark-plug, distributor, and splice-in.—*Electronics, February, 1933.*

Photoelectric controller

The Westinghouse "Photo-Troller" is a rugged industrial device which can be actuated by a phototube or by delicate contacts carrying only a few microamperes, and is specially adapted to applications such as counting, limit switches, door opening, automatic weighing, etc.

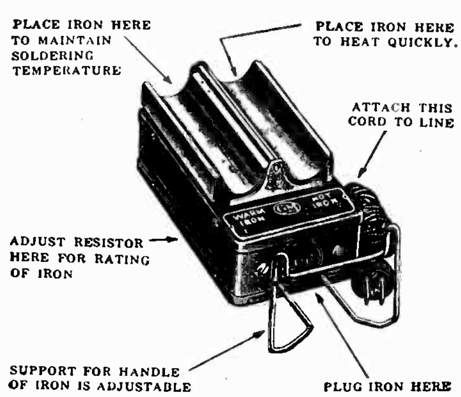
The phototube or sensitive contact operates a sturdy grid-glow tube directly which in turn closes a contactor capable of initiating any desired operation. Thus, delicate intermediate relays are eliminated and great reliability is obtained. Photo-Troller is assembled in a sheet metal cabinet with convenient door and knockouts. Units are available for any commercial voltage or frequency except d.c. Various light sources are available to operate at distances up to 22 feet from the phototube.

Auxiliary devices are available for use with the Photo-Troller which adapt it to a large number of unusual machine and process applications.—*Electronics, February, 1933.*

✦

Soldering-iron stand

G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, have announced a new type of soldering-iron stand that effects a saving of 30 to 40 per cent in power consumption and overcomes many of the



principal soldering troubles. The most serious difficulties in soldering work result from an overheated, dirty iron, and much defective soldering results from the tip of the iron becoming pitted and corroded from excessive heat. The new stand has two cradles. When placed in the left-hand cradle the iron receives only sufficient current to keep it at the minimum and yet proper soldering temperature for immediate use. The result is a material saving of power and greatly increased life of the heating element.—*Electronics, February, 1933.*

Grip-connectors

To meeting the demands of the experimenter, engineer and amateur radio fan, the Littelfuse Laboratories, 1772 Wilson Ave., Chicago, Ill., have designed a connector which may be slipped directly on the fuse ends. It has a thumbscrew for securing the wire, thus providing a fused circuit without the trouble of soldering to a mounting block. The connector grips the fuse cap snugly and the whole assembly hangs directly in the line.—*Electronics, February, 1933.*

✦

Heat-resistant insulated wire

Vega refractory (Chromoxide) insulated wire consists of copper wire having a refractory *heat resistant* coating comprised chiefly of inorganic material (as contrasted with organic coatings of other insulations) which is reacted integral to and baked on the surface of the wire. The insulation is a refractory chromium compound which is produced by the reaction of chromium oxide and an inorganic binding material applied to the wire at a high heat in combination with a water-insoluble organic binding material which is used for structural purposes.

The insulation is thin and flexible, having a space factor comparable to enameled wire, thus allowing a large number of turns in a small space when compared with other refractory insulations, as asbestos.

The insulation has high thermal conductivity. Its attractive green color is characteristic of the materials used and cannot burn out. The coating is in uniform thickness and will withstand handling.

Coils wound with Vega wire will withstand continuous operation at high temperature limits, without short-circuiting between turns, the manufacturers specifying that the insulation shall withstand continuous operation at Class B (A.I.E.E. Standards) temperature as contrasted with Class A (enamel, cotton or silk) insulation.

A feature of the insulation is its adaptability with flat type conductors. In the United States this development is covered by Ruben patents Nos. 1,896,040; 1,896,041; 1,896,042; 1,896,043 and pending applications. Vega wire is manufactured and sold by American Enameled Magnet Wire Company of Port Huron, Mich. — *Electronics, February, 1933.*

High-efficiency B eliminator

A NEW B ELIMINATOR for automobile radios has been announced by P. R. Mallory & Co. In this device instead of a tube rectifier, a vibrating reed operating in synchronism with the interrupter performs the rectification function. A single magnet supplies the power. This arrangement overcomes the power losses occuring in the rectifier tubes and yields an efficiency of 60 per cent. Five types are available depending upon the current output required. At 6.6 volts the type 10 with an output voltage of 200 at current drains of 40-45 ma. requires 2.1 amperes from the battery with a rated output of 8.4 watts.

The new eliminator weighs 9 lbs. The dimensions are $2\frac{11}{32}$ in. by $6\frac{11}{16}$ in. by $7\frac{3}{16}$ in. The small size enables it to be built-in to the radio set if desired. Models have been designed for 12 and 32 volt operation. The output voltage varies little with changes in current and therefore the unit can be used with class B amplification systems. A model is provided in a metal case together with a dynamic speaker for manufacturers requiring the utmost saving in space and weight. — *Electronics, February, 1933.*

✦

B power supply

THE CARTER GENEMOTOR CORPORATION, 361-365 W. Superior St., Chicago, has developed the new Carter Genemotor B power supply equipment for replacing B batteries in all kinds of radio sets, amplifiers, etc.

The new Carter 32-volt B power supply is finding a large market in rural sections. It is claimed that more than 700,000 32-volt farm light plants are in use and that a battery-operated radio set using B batteries is connected to each plant. The Carter B power supply eliminates B battery expense. There is a Carter B power supply unit for use with battery sets where no light current is available.—*Electronics, February, 1933.*

✦

Infra-red photo relay

THE ARGUS PHOTO RELAY is designed for operation on alternating or direct current supply mains and incorporates features that absolutely assure dependable and continued operation under all conceivable conditions, whether they be indoors or outdoors, stationary or mobile, high temperature, or extremely wet.

The photo-relay is housed in a machined aluminum casting. The "Unilet" is secured to the relay by means of water-proof flexible metal tubing, and the entire assembly is absolutely waterproof. Cork gaskets between the upper and lower halves will permit operation of this unit over a long period of time entirely submerged in water. The entire assembly is rigidly mounted to a bakelite panel which permits easy access for adjustment. A jack is also provided to permit reading the plate current of the amplifying tube with an external milliammeter.

A calibrated light-admittance tube is provided when the relay is to be used with the beam projector in all daylight applications, such as traffic or pedestrian counting, drinking fountain control, and the opening of garage doors by means of headlights.

The projector is of the focusing type and is designed to produce a powerful concentrated beam of light and will be found suitable for operating the relay over great distances such as a wide highway, boulevard or race track. The regular model may also be fitted with a special filter that eliminates all the visible portion of the beam, leaving only the infra-red. The resulting beam is effective up to a distance of 50 feet. This invisible beam, or ray, focused on the photo-relay makes an excellent burglar alarm. Infra-red projectors are also available that are effective up to distances of 300 feet, upon special order to the makers, the Argus Electric Company, St. Charles, Ill.—*Electronics, February, 1933.*

✦

Midget "Megger" tester

A NEW MIDGET "MEGGER" TESTER is being offered by the James G. Biddle Co., Philadelphia, as an important addition to its group of "Megger" insulation testing sets.

The distinguishing characteristics of this instrument are its small size and weight, which have been reduced to almost pocket dimensions,—$5\frac{3}{4}$ in. by 4 by $2\frac{3}{8}$ in.—and the weight is only 3 lb.

In common with other Megger instruments, the Midget tester consists of a true ohmmeter, direct-reading like a voltmeter, combined with a special d.c. hand generator. The scale reads as high as 20 megohms and the generator supplies testing current at 500 volts, thus obviating necessity for depending on batteries or any other outside source of current.—*Electronics, February, 1933.*

Multi-range meter

THE SENSITIVE RESEARCH INSTRUMENT CORPORATION of 4545 Bronx Blvd., New York City, announces a new 27 range Universal a-c and d-c Polyrange instrument, having distinct advantages over old designs. It has 13 ranges in direct current reading from 0.00002 volt up to 1,000 volts with a resistance of 5,000 ohms per volt and in current from

0.000002 ampere up to one ampere. The accuracy of these ranges is one-fourth of 1 per cent.

By turning a single knob, the meter becomes a 14 range a-c instrument, covering all frequencies up to 5,000 cycles with an accuracy of one-half of 1 per cent. It measures current from 0.002 ampere to 3 amperes and in voltage from 0.06 volt to 1,000 volts, resistance 100 ohms per volt.

The instrument is so designed that if the a-c side should be inadvertently burned out, the meter can still be used as a d-c meter until such time as is convenient to have it repaired. This instrument covers almost all of the meter measurements needed in the laboratory.—*Electronics, February, 1933.*

✦

Prismatic derivator

IN STUDYING THE OPERATION of electrical instruments and apparatus, as well as all kinds of radio tubes, characteristics have frequently to be interpreted graphically. The methods which have been used so far for this purpose, have as a whole not been very satisfactory, owing to the human element being too great a source of error. To aid in this work, a new tool, the Askania prismatic derivator, employs a small prism which when placed over the curve to be interpreted makes it possible, by optical magnification, to determine accurately tangents and normals to mathematical curves. The easy and rather foolproof operation of the instrument without particular care or practice, makes it a useful tool for engineering departments of industrial plants, laboratories, technical schools and other institutions. The instrument is furnished by American Askania Corporation at Houston, Texas, and Chicago, Ill.—*Electronics, February, 1933.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Radio and Communication Circuits

Differential volume control. Diversity receiving system comprising several antennas having different fading characteristics, amplifiers coupled to each antenna and means for making a change over from one signal to another more stable and less noticeable. H. H. Beverage assigned to R. C. A. Filed December 11, 1928. No. 1,888,065.

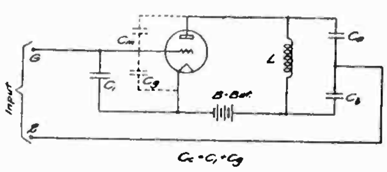
Radio receiving system. A series of resonant circuits coupling two tubes together and forming therewith a filter having the characteristic of a low-pass filter for frequencies higher than the desired frequency. J. M. Miller assigned to Atwater Kent Mfg. Co. Filed Sept. 27, 1930. No. 1,888,430.

Tuned receiver tube. Two triodes in a single envelope and coupled together by piezo-electric crystals so that the second tube responds only to a predetermined frequency. Siegmund Loewe, assigned to R. C. A. No. 1,875,059.

Discharge tube. A cold tube arranged to actuate a potentially controlled relay system. A. M. Skellett, assigned to W. E. & M. Co. No. 1,877,607.

Power Circuits Amplification, Etc.

Reducing reaction. A tube with input and output circuits in a Wheatstone bridge arrangement to suppress oscillations of the tube. Stuart Ballantine, assigned to R.C.A. Filed July 14, 1925. No. 1,889,741.



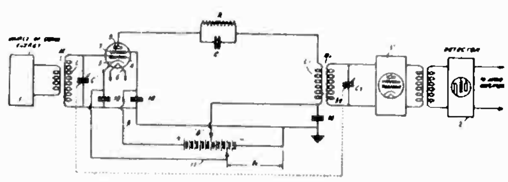
Photocell compensating system. Method of recording by means of a shutter, etc., several longitudinal recordings on a single film. G. B. Scheibell, Newark, N. J. Filed August 1, 1930. No. 1,886,125.

Push-pull amplifier. In series with a normal steady bias to a push-pull amplifier is a resistance shunted by a condenser. When an appreciable amount of grid current flows, the bias to the tube is increased by the drop across this resistance. Eugene Peterson, assigned to B. T. L., Inc. Filed June 20, 1928. No. 1,893,302.

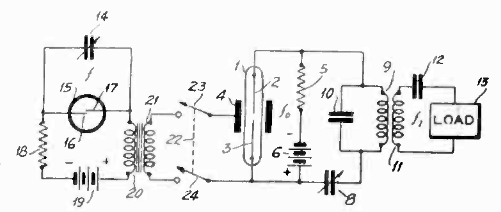
Wired radio. Method of receiving wired radio signals on a space radio receiver. R. D. Duncan, Jr., assigned to Wired Radio, Inc. No. 1,892,696.

Push-pull system. A coupling device to connect a driver and a push-pull amplifier in which the secondary winding has an impedance lower than the input impedance of the driven stage when the grid of this stage becomes positive. J. O. Baker, assigned to G. E. Co. Filed Oct. 20, 1931. No. 1,890,489.

Dynatron amplifier. Combination with a dynatron, a tunable resonant network whose impedance at resonance varies with the frequencies to which the network is tuned and means in series between the tube anode and the network in the output circuit for maintaining the total impedance of the output circuit constant during tuning. P. O. Farnham, assigned to R.C.A. Filed Oct. 17, 1931. No. 1,890,503.

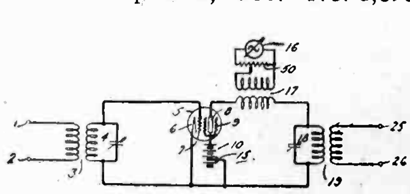


Relaxation circuit. Relaxation oscillator for recurrently energizing the oscillation circuit at a frequency which is an aliquot part of the desired frequency, said circuit including a glow discharge tube having an external control electrode, a resistance and a source of direct current in series. Another relaxation oscillation circuit including a similar tube acts as demodulator. August Hund, assigned to Wired Radio, Inc. Filed Oct. 1, 1931. No. 1,893,029.



High-gain amplifier. A system for obtaining current amplification upward of 1,000,000 by negatively biasing the grid of the tube to such an extent that the positive ion current is predominant and using a resistance for the grid circuit having a magnitude of 1,000 megohms or above. Joseph Razek and P. J. Mulder, Drexel Hill, Pa. Filed Dec. 22, 1930. No. 1,890,750.

Pentode circuit. Plate of the tube is essentially at the same potential as the cathode, while the screen grid has a positive potential. The a.c. is supplied to the anode and means is provided for adjusting the intensity of the a.c. whereby the ratio of useful current to noise producing current is increased. F. C. Llewellyn, assigned to B. T. L., Inc. Filed April 12, 1930. No. 1,893,031.



Electronic Applications

Fire control. A light-sensitive cell subjected to rays from a burning film and an electro-mechanical means acting upon the inflammation of the film. W. H. Dewitt. Filed May 5, 1931. No. 1,890,804.

Power conversion. Method of connecting a d.c. supply circuit to an a.c. load device. A. S. Fitz Gerald, assigned to G. E. Co. Filed May 12, 1931. No. 1,891,084.

Remote control system. Apparatus for determining and equalizing differences in the positions of two shafts located at a distance apart. J. Vopel and Rudolph Oetker, Berlin, Germany. Filed June 6, 1931. No. 1,890,891.

Timing device. Combination of a power supply, a translating device and electron tube and means for impressing upon the control electrode a potential rendering the tube conductive to effect completion of the circuit of the time dividing device. C. Stansbury and G. C. Brown, assigned to Cutler-Hammer, Inc. Filed Dec. 10, 1931. No. 1,892,017.

Power conversion. A d.c. supply circuit with several resonant circuits, each including a capacitor, a pair of tubes, and a discharging circuit. F. W. Frink, assigned to G. E. Co. No. 1,891,924. Filed Nov. 22, 1930.

Vacuum switch. An evacuated receptacle and a switch mounted therein and means for operating the contacts from without. D. C. Prince, assigned to G. E. Co. Filed March 23, 1928. No. 1,892,538.

Comparison of the intensity of light rays. A comparison by means of a rotating disk or shutter and a light sensitive cell. F. C. Whalen, London, England. Filed May 22, 1931. No. 1,890,837.

Material sorting machine. Method of actuating power shears to cut off material at a given length. The device uses a three-element tube. W. H. Spire, assigned to Thompson Products, Inc., Cleveland. Filed Sept. 14, 1931. No. 1,883,047.

Gas determination. Apparatus for determining the condition of gas comprising a chamber in which condensation changes the light reflected into a light-sensitive element. M. C. W. Tomlinson, assigned to W. E. Co. Filed Feb. 16, 1929. No. 1,883,116.

Printing telegraph. Patents granted to H. Chireix and H. Goudet, Paris, France, for high speed printing telegraph. No. 1,893,158. And for a high speed multiplex telegraph. No. 1,893,159.

Patent Numbers

The following table gives the numbers of patents issued in the United States since the million-mark was reached. For example patents issued in 1932 bore numbers between 1,787,424 and 1,892,662.

Jan. 1			
1912	1,013,095	1923	1,440,362
1913	1,049,326	1924	1,478,996
1914	1,083,267	1925	1,521,590
1915	1,123,212	1926	1,568,040
1916	1,166,419	1927	1,612,790
1917	1,210,389	1928	1,654,521
1918	1,251,458	1929	1,696,897
1919	1,290,027	1930	1,742,181
1920	1,326,899	1931	1,787,424
1921	1,364,063	1932	1,892,662
1922	1,401,948		