DECEMBER, 1932

Radio Engineering

IN THIS ISSUE

TWELFTH YEAR OF SERVICE

The Journal of the Radio and Allied Industries

Blå AZZURRO Modrý 藍 Kuavoũv AZUL BLEU Kék Blau Albastru

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and only ONE Answer . .

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"How can we identify the BEST tube made"...asked the people of the earth. And in their score of different tongues, seventy-eight Nations unanimously answered . . . BLUE . . . the BLUE tube . . . ARCTURUS BLUE.

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RADIO ENGINEERING

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Vol. XII **DECEMBER, 1932** **Number 12**

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Departments

A GOOD SIGN

A MIDWESTERN manufacturer of tube sockets a few days ago received from a large eastern manufacturer of radio receivers a letter containing the following paragraph:

"We have just noticed your advertisement in the current issue of RADIO ENGINEERING. in which you are featuring the large socket which you furnished us during the 1930 season. Of the many sockets we have used, we feel that this particular one gave us the best results of all."

The socket referred to, being a dependable, well made unit of proven materials, sells for about twice the net price of certain other makes.

It is a good sign in the radio business that set manufacturers are now alive to the economy of well designed and properly made parts and accessories. Manufacturers who have adhered to safe standards are beginning to hear the hum of industry around their plants.

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

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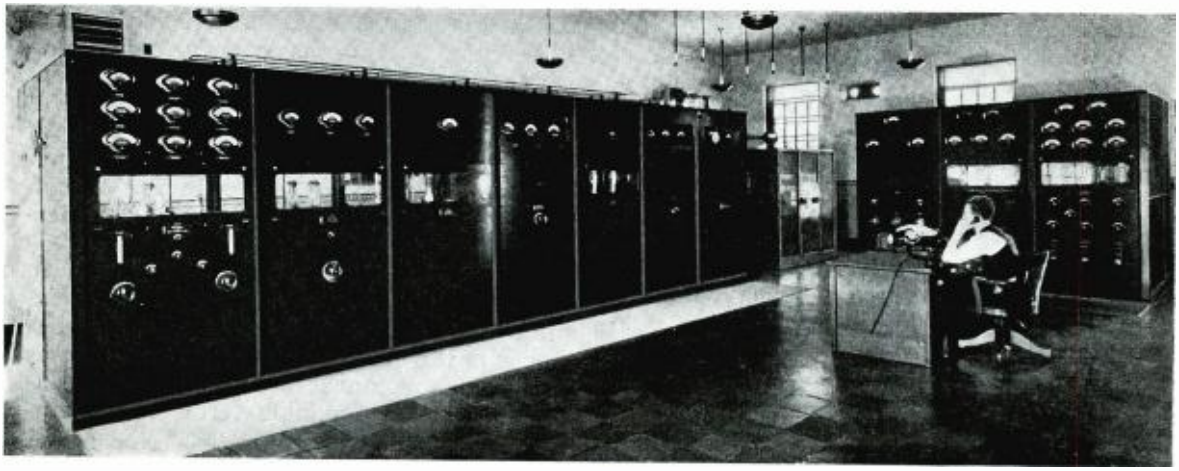
Broadcasting equipment by Western Electric . . . *from the smallest to the* LARGEST!



There are now over 175 Western Electric equipped radio broadcasting stations. These range in power from 50 watts to 50 kilowatts—an indication of the wide selection which Western Electric offers in broadcasting equipment.

In addition to transmitters Western Electric broadcasting products include:

Speech Input Equipments for station and for studio.

Tubes which maintain their characteristics throughout an unusually long life.

Pick-up apparatus, of which the Moving Coil Microphone is an outstanding example.

All Western Electric radio broadcasting apparatus is recognized for its highly efficient operation. Into every piece of equipment goes the long experience of Western Electric in making telephones and other sound transmission apparatus.

Whatever your broadcasting requirements, make Western Electric your standard. For detailed information on broadcasting equipment to best meet your needs, address the distributors, Graybar Electric Company, Graybar Building, New York.

Western Electric

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Editorial

DECEMBER, 1932

HUM FROM BROADCAST STATIONS

THE very creditable progress made during the past three years by design engineers in radio manufacturing establishments, in improving selectivity, accounts for the excellent performance of radio receivers now being marketed. The manufacturers also have met the demand for receivers which reproduce the lowest required frequencies. This has cost a lot of money.

It is but a few years since in radio engineering circles one frequently heard the plea that radio manufacturers produce receivers that would bring in all that the broadcast stations sent out. Today, the situation in this respect appears to be somewhat embarrassing for the broadcasters—modern receivers are bringing in more than they need of what is sent out. The large amount of hum from various broadcast stations is disturbing in receivers and, where the source of the hum is not understood, causes criticism of really good receivers.

No doubt the engineers of the Federal Radio Commission have the subject in the basket for live problems. No doubt, also, the engineers at the well equipped broadcast stations are aware of the disturbance widely observed, and plan to work toward minimum hum at as early a date as possible.

▲

ELECTRIC RAYS FROM BEYOND

IT would appear that the most recent observations of the astro-physicist have in some measure robbed some of the so-called cosmic rays of their claim to cosmic origin. Late reports are to the effect that some of the more easily distinguishable radiations from the upper terrestial reaches have been localized as to their source and that this corresponds approximately with the height above the earth of the primary and secondary Kennelly-Heaviside ionized areas.

The persistence with which several investigators are pursuing inquiry into the nature of and the source of irregular manifestations observed at the earth's surface, the birth of which coincides with spontaneous effects of unknown cause, or is a regeneration effect of non-periodic characteristics, may yet be rewarded by important discovery.

The comparatively local origin of the most frequently observed ray effects and their relation to the discoveries of Professor V. F. Hess, formerly of the United States Bureau of Mines, now in Vienna, in the field of cosmic ultra-radiation, may point to the conclusion that there are families of rays.

Recalling the life history of other discoveries which over a long period of years progressed from the speculative stage to useful reality, we may believe that extensions of knowledge and of truth are unceasingly, patiently tapping upon the windows of human intelligence seeking entrance and understanding.

Man, lacking super sense-perception, with which to interpret all things, and being familiar with but a few of nature's codes, gropes in the dark until his exploring senses encounter substance susceptible of translation into understandable terms and quantities.

▲

CHRISTMAS

GOOD citizens whose sunny dispositions enabled them in 1932 to go through the time honored formalities of Thanksgiving Day, should have no difficulty in approaching and overcoming the full stocking demands of Christmas. The sox appeal must be met. Let every man believe that any deficit negotiated at Christmas will be obliterated soon after the advent of the New Year.

Donald McNicol

Editor.

WE MAKE A GOOD LINE—NOT POOR EXCUSES!

The Clarostat Mfg. Co.

This short phrase sums up Clarostat's sales policy. Unless you too follow this line of reasoning, it will be impossible to enjoy ultimate success and outstanding leadership.

High quality is the foundation upon which our organization has been built. As a pioneer in the radio and electrical fields, we set that course, and it has brought us acknowledged International Leadership.

Clarostat controls cost no more than others; in the long run, they cost much less. Break-downs in the volume control circuit of receivers are eliminated when our controls are factory installed. You won't lose customers, you won't have to make excuses and costly replacements when a Clarostat is in the job.

By eliminating replacements due to faulty materials your overhead is considerably reduced—a most important factor in building towards the future. This we learned from experience. Clarostats are made better . . . they perform better!

You do not have to experiment or solve any of your control problems. Our engineering department will do that for you, as we have done for many others. Our modern tool and machine shop, complete in every detail, our stock of standard and special parts for assemblies—all are yours for the asking. There are no catches, this is a regular part of Clarostat's service—it is a further reason why leading receiver manufacturers use Clarostat Controls, and consider them the Standard by which other controls are judged.

Type P-185 Control Fitted With Switch Dustguard Cover Plate

This type wire-wound control is available with or without coverplate switches. These potentiometers are provided with three terminals and may be had in any taper desired. By using the center contact arm terminal and one of the resistance element terminals, they may be used as rheostats.

Type P-58 Control Without Switch

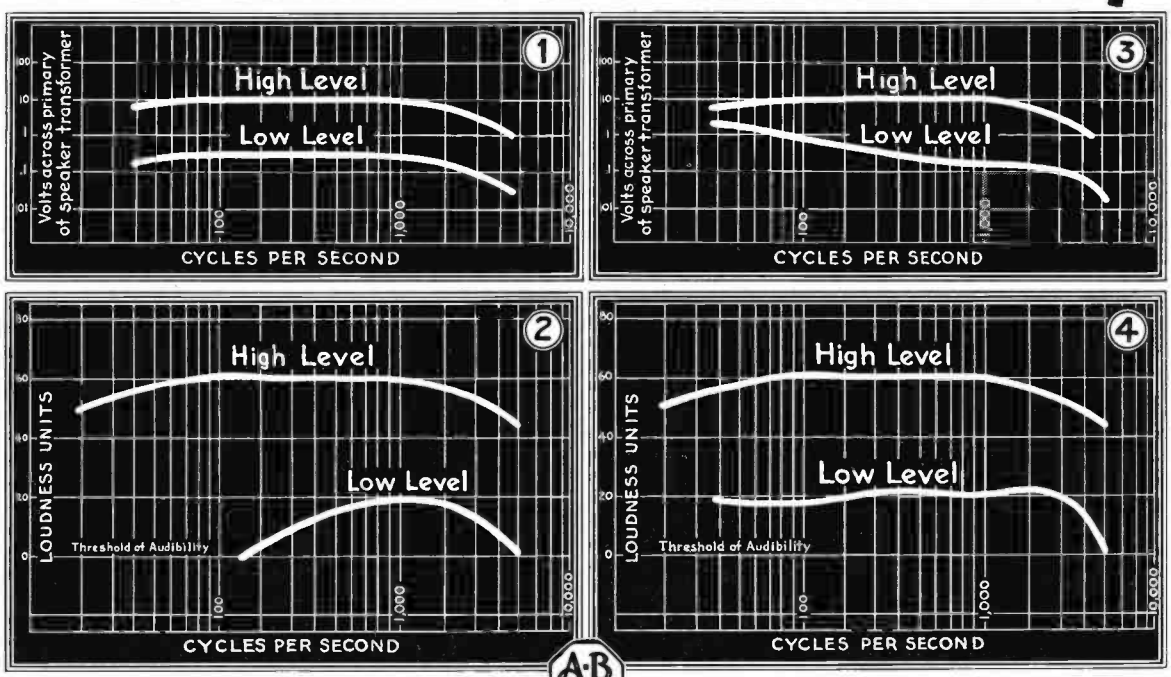
This standard type control provides minimum volume at its extreme left setting, and tapers smoothly and efficiently to maximum volume by clockwise rotation. Model P58 is available in single, dual and triple control units on one shaft — with or without switches built-in.

Let Us Know Your Control Problems!

CLAROSTAT MFG. CO. INC.

285 NORTH 6th STREET BROOKLYN, N. Y.

Compare the Performance of these Two Receivers!

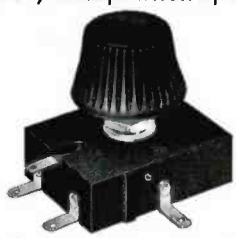


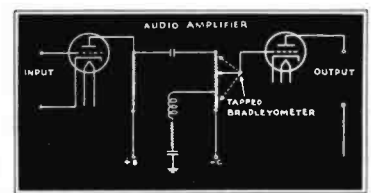
This Receiver Has Ordinary Volume Control NO Tone Compensation

From the upper curves (No. 1), it is obvious that with the conventional type of audio level volume control, all frequencies are attenuated equally when the volume is reduced. Owing to the characteristics of the ear, this results in an unequal change in loudness of tones, as shown in the lower curves (No. 2). These curves show that the low and extremely high frequency tones are reduced in loudness as compared with the middle register. This makes the set sound thin and unsatisfactory except when operating at high levels.

This Receiver Has Bradleyometer Volume Control WITH Tone Compensation

From the upper curves (No. 3), showing results with the Tapped Bradleyometer connected as shown in the lower diagram, it is obvious that all frequencies are *not* attenuated equally when the volume is reduced. This results in an equal change in loudness of all tones as shown by the lower curves (No. 4). By using tone compensation, made possible with the Tapped Bradleyometer, an outstanding improvement in reproduction at low levels is achieved. Investigate the Tapped Bradleyometer by writing for further details, today.





ALLEN-BRADLEY COMPANY, 126 W. Greenfield Ave., Milwaukee, Wisconsin
Manufacturers of Bradleyunits, Bradley Suppressors, and a complete line of industrial control apparatus

RADIO ENGINEERING

FOR DECEMBER, 1932

Triple grid power amplifier tubes

By E. W. HEROLD*

New type tubes provide large power output in class B operation.

▲

OUTPUT vacuum tubes for audio-frequency amplifiers have always been of major interest in modern radio and other sound reproducing apparatus. Until a few years ago, the most satisfactory system made use of two triodes connected in opposition, each operated at a point somewhere near the center of their working characteristic. The operating efficiency of such amplifiers was inherently low especially when utilized for the amplification of speech and music which encompassed a large range of amplitudes. High output powers were obtained only by the use of large output tubes, capable of withstanding the comparatively large plate dissipation necessary. About two years ago the power pentode was introduced in this country. This development almost doubled the efficiency of the output tube and increased its power sensitivity tremendously. Both of these factors led to its widespread adoption both singly and in push-pull fashion. A more recent development which has received much attention is the use of two tubes connected in opposition and operated at a point very near cutoff. With the use of vacuum tubes operated in this fashion, which is defined as class B operation, very high operating efficiencies are obtained and a large power output is obtained from relatively small vacuum tubes.

Since each of the above methods of operation has certain advantages not found in the others, all three are still in use and the manufacturer of vacuum tubes is faced with the problem of designing tubes for each purpose. Class B operation is becoming increasingly important because of the advantages mentioned above and tube designs of particular merit for class B use have been developed. Many, however, advocate the conventional pentode as an output device, so that there is also a need for this type of vacuum tube. The low distortion which may be obtained by the use of triodes connected in push-pull makes this combination attractive to others. It will be seen, also, that a power triode is still necessary to those who wish to use the increased output obtained from class B amplification by swinging the grid positive, thus drawing grid current and consuming grid power which must be supplied by the preceding amplifier stage. The desideratum of negligible harmonic distortion (in amplifiers which cannot make use of a sharply tuned plate circuit to suppress the harmonics) because of the non-linearity of the grid-current-grid voltage characteristic, requires the use of an input having very good regulation. The latter requirement is most easily met at the present time by the use of a fairly low impedance power triode in the preceding stage.

*Research and Development Laboratory, RCA Radiotron Co., Inc.

Many New Tube Types Confusing

The greatly increasing number of tube types, of late, involves certain disadvantages to manufacturer and consumer alike. For this reason it has been deemed advisable to combine, wherever possible, several functions within the single glass envelope and in the single mount structure of a vacuum tube. The recently introduced 57 and 58 line of vacuum tubes exemplifies the practice in connection with tubes used at radio frequencies. It will now be shown how similar causes have led to the development of an audio-frequency power output tube which fulfills each of the three dissimilar requirements mentioned above.

It will be noticed that the lately introduced 46 tube, by bringing out connections to two grids, may be used in either of two ways. By using the first grid as a control element and connecting the second grid to the plate, a low mu triode capable of fairly large power

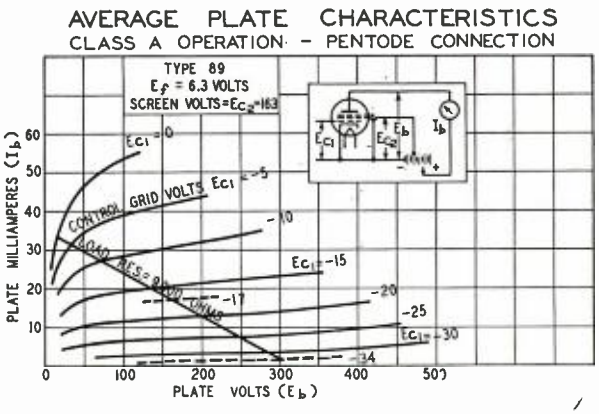


Fig. 1.

output is obtained. By connecting the two grids together and using them as the control element, a very high mu triode is obtained having characteristics making it particularly suitable for class B operation. If a third grid be introduced and a connection brought out from it, the usual suppressor grid pentode may be obtained without appreciably impairing the efficiency of the first two functions should it be desired to use the tube in either of these ways. This is accomplished by connecting the third grid to the cathode when using the tube as a suppressor grid type pentode and connecting it to the plate when the tube is used as a triode of either the low mu or the class B variety. The result is a tube which can be used in a multiplicity of ways and which is particularly suited for operation as a class A output pentode, as a zero bias class B triode, or as a low mu triode.

Multiple Purpose Tubes

The triple purpose feature has been incorporated in the design of the RCA-59 and C-59, a high output 2.5 volt heater type tube for a-c. operation, and the RCA-89 and C-89, a heater type tube designed for the output stage of automobile receivers. The 59, because of its heater type construction, permits low hum levels to be attained without difficulty in audio-frequency applications. Using two of these tubes in a class B connection, a power output is obtained sufficient to satisfy the most critical, whereas, a decidedly higher power sensitivity may be obtained in the pentode connection at a sacrifice in power output. The tube may also be used in low mu triode fashion, either as a driver or as an output tube, offering the usual possibilities of extremely low harmonic distortion when connected in push-pull. The triple purpose feature is of particular value in the type 89, the automobile output tube, inasmuch as the high efficiency possible with two of these tubes in a class B connection makes dry battery plate supply feasible even with high output power. On the other hand, for those finding pentode or triode operation desirable, the 89 delivers considerably more power output than heretofore possible with the plate voltages used. Other applications of the 59 and the 89 can, of course, be discovered by those familiar with the particular problems at hand.

The tubes will now be discussed in the light of their three major applications.

Suppressor Grid Output Pentode

For use in this fashion, the third grid, the one adjacent to the plate, is connected to the cathode and used as a suppressor grid for the secondary electrons which would otherwise reduce the plate current at low plate voltages and introduce undesirable curvature in the plate volt-ampere characteristic. This method of eliminating the effect of secondary emission is well known and needs no elaboration. The second grid is used as an accelerating grid and is tied to a high voltage, usually as high as the plate voltage. The first grid is the control grid and has a negative biasing potential applied.

As a pentode, the 59 has been designed to deliver approximately 3.0 watts of audio power per tube with a plate and screen voltage of 250, whereas the 89 is capable of delivering over 1.5 watts per tube using a voltage of 180 applied to plate and screen.

The general characteristics may be tabulated:

Tube	Ef	If	Eb & Ec2	Ec1	Ib	Ic2	Sm	Load	P.O.
59	2.5	2.0 A.	250	-18	35 m.a.	8 m.a.	2700	6000	3.0
89	6.3	.4	135	-13.5	13.2	2.0	1500	10000	.75
			163	-17	17.0	2.5	1575	9000	1.25
			180	-18	20.0	3.0	1635	8000	1.50

The usual characteristic curves for this type of operation of an average 89 are shown in Fig 1.

DYNAMIC TRANSFER CHARACTERISTICS
CLASS B OPERATION

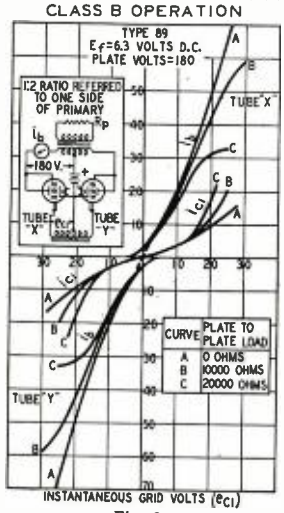


Fig. 2.

Class B Zero Bias Output Tubes

For use in this manner, two tubes are connected in opposition. The third grid of each tube is connected to the plate of the same tube and the first two grids of each tube are connected together and used as the control element of that tube. The result of this combination is a triode having such a high amplification factor that with zero bias on the control element, the plate current is quite low, being near the cutoff point of the transfer characteristics, as shown in Fig. 2. This is the normal operating point of the tube and an alternating signal applied to the grid causes the plate current to rise on the half cycle

AVERAGE PLATE CHARACTERISTICS
CLASS B OPERATION

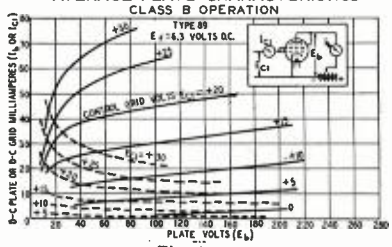


Fig. 3.

in which the grid is positive, and to decrease almost immediately to zero during the other half cycle. Since the tubes are connected in opposition, the other tube of the pair operates in opposing fashion; i. e., when the grid of one tube is negative and the tube is virtually inoperative, the grid of the opposing tube is positive and causes the plate current to rise in correspondence with the half cycle of the incoming signal. The combination of the outputs of these two tubes in the proper manner gives an output essentially similar to the input in wave shape. The control grids of the tubes when operated under the above conditions draw an appreciable current and because of the non-linearity of the grid voltage, grid current characteristic, a signal source of very good regulation must be provided. Such a source is most easily obtained by the use of a low impedance driver triode operating the grids through a step-down transformer.

A more detailed discussion of this type of operation may be found in two papers by L. E. Barton (Proc. I. R. E. 19, 7, July, 1931, and 20, 7, July, 1932).

The general characteristics of the 59 and 89 as zero bias class B amplifiers are:

	59		89
Heater voltage	2.5		6.3
Heater current	2.0		.4 a.
Plate voltage	300	400	180
Grid Voltage (No. 1 & No. 2 grids tied together)	0	0	0
Plate current	7-10	10-15	3-4 m.a.
Maximum peak plate current	150	200	75

A pair of 59's when driven by a third

OPTIMUM OPERATION CHARACTERISTICS
CLASS B OPERATION

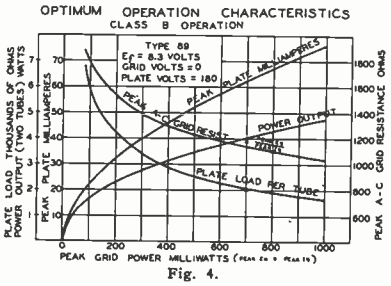


Fig. 4.

59 connected as a triode will deliver well over 20 watts of power output. The 59's used as class B will deliver approximately the same output as a pair of 46's with similar driving power, but, of course, permit low hum levels to be attained with greater ease than is possible with the filament type tubes.

Fig. 2 shows the transfer characteristics of a pair of 89 tubes when plotted with various loads, in such a fashion as to indicate approximately the resultant characteristic (shown by the dotted portion) of the two tubes when connected in opposition.

Fig. 3 gives a family of plate and grid current curves of much more general value.

To give an approximate estimate of the power output and the best operating conditions of two 89's when connected in opposition, Fig. 4 has been prepared. These curves were computed from the static characteristics of Fig. 3 and show the power output, peak plate current, load resistance and peak a-c. grid resistance as functions of the peak grid power at optimum conditions. Under the conditions indicated, the total plate harmonic distortion at full signal input is less than three per cent, so that the distortion is largely determined by the driver harmonic distortion and the distortion due to the non-linearity of the grid voltage, grid current curve, both of which are minimized by the use of a large step-down ratio in the input transformer, although the use of too great a step-down ratio in the transformer

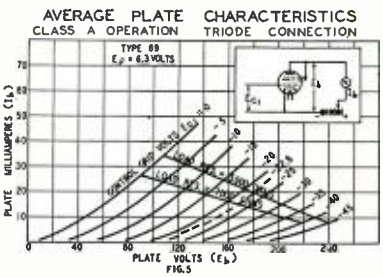


Fig. 5.

results in a considerable sacrifice of power output. In a particular case, if the driver tube is the 89 connected triode fashion and operated at a plate voltage of 160, the power output of the class B stage will be 3.5 watts, the ordinate of the power output curve corresponding to an abscissa of 480 milliwatts peak (the peak input power is twice the rated r.m.s. power output of the driver multiplied by the input transformer efficiency, assumed 80 per cent). The output of 3.5 watts has been checked experimentally with a transformer ratio of such a value as to give an overall distortion of about eight per cent. To reduce the distortion to an overall value of five per cent, it is necessary to increase the transformer ratio

Tube	E_f	I_f	E_b	E_{c_1}	I_b
59	2.5	2.0	250	-28	26 m.a.
89	6.3	.4	160	-20.0	17.0
			180	-22.5	20

until the driver tube is operated into a load of three times the normal load as a power output tube. This procedure approximately halves the output of the driver and gives a power output of 2.5 watts from the class B tubes, a figure which is checked by Fig. 4 (reading the ordinate corresponding to a peak input power of 300 milliwatts multiplied by a transformer efficiency of 80 per cent).

It should be noted that the power output-power input relationship shown in Fig. 4 is approximately half of the parabola.

Power output $=$ k (peak power input) $^{1/2}$ in which the constant k would be expected to contain some function of the plate voltage. From the static characteristics, it has been found that approximately,

$$k = .005 \text{ (plate voltage)}^{4/3}$$

This formula enables approximate calculation of the power output with other plate voltages than that used in the preparation of Fig. 4.

Class A Triode

As has already been indicated, the use of either the 59 or the 89 as a low impedance triode is made possible by connecting the second and third grids to the plate. Negative bias is now necessary on the first grid for proper operation. The characteristics of the tubes when used in this way are:

rp	S_m	μ	Load	U.P.O.
2300 ohms	2600	6	5000	1.25
3000	1560	4.7	7000	.300
2750	1710	4.7	5000	.430

Fig. 5 shows the plate voltage family for an 89 when used as a low impedance triode.

▲ ▲ ▲

Bureau of Standards radio work

THE annual report of the director of the Bureau of Standards, Washington, covering the past year lists the following projects as having had the attention of the Bureau:

Primary frequency standard. The accuracy of this standard was further increased to 1 part in 10,000,000. Precise studies were made of the functioning of the various elements of the standard. An auxiliary unit was constructed to guard against stoppage of the four original oscillators, and special equipment was installed to protect against failure of the power supply.

Secondary frequency standards. New piezo oscillators were designed and constructed and were found to be remarkably constant in frequency. They are of wide application as standards and as control units for radio transmitters.

Standard frequency dissemination. The standard frequency service was extended and improved. Regular transmissions were provided on a frequency of 5,000 kilocycles per second for four hours every Tuesday. The accuracy was better than 1 cycle per second (1 part in 5,000,000). Some of the transmissions were controlled by wire-line transmission of a frequency from the national primary standard.

Measurement of radio field intensity. Methods and apparatus developed for the automatic recording of field intensities of distant radio stations were applied to a study of effects produced by the synchronization of two pairs of broadcasting stations. Research on the accuracy of measurement of field intensity and on short-distance absorption of radio waves was completed.

Measurement of height of ionized layer. The ionized layer in the atmosphere, more than 70 miles above the ground, has been determined to be the major determining factor in the long-distance transmission of radio waves. The measurement of the height of this layer is of primary importance in interpreting transmission conditions and increasing our knowledge of radio-wave propagation. Such measurements were made on one day each week, using improved equipment. This included an automatic recorder, which will allow continuous measurement of the height in the future.

Radio research facilities. Two experimental radio stations were established in the suburbs of Washington. One is a transmitting station located on the animal husbandry farm of the Department of Agriculture near Beltsville, Md. The other is a receiving station; for this 200 acres of land were purchased near Meadows, Md. Six small frame buildings were erected. Facilities are thus provided for an improved standard frequency transmission service and for researches on radio-wave transmission.

▲

RADIO HOUSE, LONDON

IN Broadcasting house, the headquarters of B. B. C., London, there are approximately 660 vacuum tubes in service; the average filament heating load is 1,700 watts, and the plate load 1,300 watts.

Useful equipment for receiver tests in shop or field

By J. A. Myers, Jr.

FROM time to time, due to the introduction of new types of tubes and to changes in radio receiver design, the radio service department is confronted with the necessity of purchasing new test equipment or of remodeling that already in use. New equipment is in some instances rather expensive, and peculiarities in the design of commercial instruments make changes difficult, to say the least.

The analyzer shown schematically in Fig. 1, was developed to fit the needs of servicing both in the shop and in the field. The switching arrangement is such that meter ranges may be added or changed with a minimum of difficulty. Almost all the parts are standard merchandise and are easily procurable. This instrument will make every essential d-c. test on a radio receiver as well as measure a-c. filament and line voltage. A high a-c. voltage range was not included because it was felt that the need of such an instrument did not warrant the added expense.

The ranges of the d-c. meter are adequate for measuring all plate, grid and screen-grid currents, and plate, control grid, screen grid and cathode voltages encountered in sets using modern tubes. Screen-grid tubes, both power pentodes and r-f. pentodes and full-wave rectifiers may be tested without the use of adapters. The d-c. meter is a Weston type 301, 0-1 milliammeter. The a-c. meter is a Weston type 476 triple range voltmeter. The multipliers for the d-c. voltmeter are 1-watt resistors of the precision type.

By the use of separate push-button switches for each range the danger of damaging the meters by overload is reduced to a minimum and the operation of the instrument is speeded up. There is a total of sixteen of these switches used; thirteen of them are standard double-pole single-throw push-buttons, the other three are special six-blade push-buttons used to break into the plate, grid and cathode circuits for current measurements. There are eight other switches on the panel: S_1, S_4, a meter reversing switch and an a-c. to d-c. switch, which are jack switches; S_2, S_3, and S_5, and a voltmeter return switch which must be closed for external use of the d-c. voltmeter. The multiplicity of switches might seem to be confusing. Actually, however, the operation of the analyzer is quite simple and for speed and thoroughness compares favorably with modern commercial instruments.

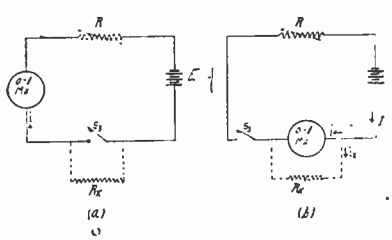


Fig. 2.

Current Measurements

For current measurements three milliampere ranges are available, the 1 ma. range of the meter and through the use of shunts, two others of 10 ma. and 100 ma. These ranges were chosen because they are very good ranges for measuring the currents of practically all receiving tubes and because they can be read directly from the meter scale without re-calibration. The milliammeter range changing switch S_4 is a double-pole double-throw jack switch with a zero center position. The Weston type 301, 0-1 milliammeter has a resistance of about 27 ohms. The shunts used have resistances of approximately 3 ohms for the 10 milliampere range and 0.3 ohm for the 100 milliampere range and can be made from a discarded rheostat or filament resistor. For calibration of the shunts the meter itself can be used as a standard if no other is available. With a battery and a variable resistance connected in series with the meter, adjust the voltage until the meter reads full scale. Connect the resistance wire for the 10 milliampere shunt in its proper position in the circuit and vary its length until the meter reads 0.1 milliampere. The same procedure can be used in going from the 10 milliampere to the 100 milliampere range.

The d-c. voltmeter has ranges of 10, 100, 300, 500 and 1,000 volts. These scales may be calibrated or not as the user chooses. The 10, 100 and 1,000-volt scales may be read directly from the milliammeter scale and it will be found that a little practice in using the other ranges will make calibration quite unnecessary.

Resistance Measurements

There are two additional features of interest, an output meter and a double range ohmmeter.

The ohmmeter, using a 4.5-volt C battery as a power supply and the milliammeter of the analyzer, covers a range of resistance values from about 0.3 ohm to 450,000 ohms. The two ranges overlap and give readings, sufficiently accurate for service requirements, over the entire band. The two circuits used are shown in Fig. 2. In operation the test leads of Fig. 2a are shorted and the resistance R is adjusted to give full scale deflection of the meter. When the unknown resistance R_x is connected in the circuit the value of R_x is given by the formula:

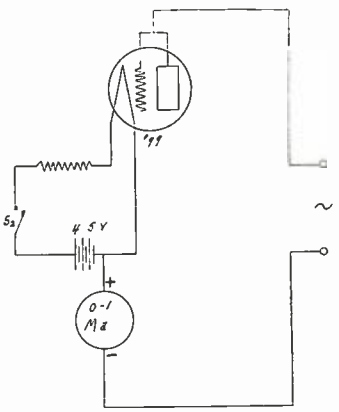


Fig. 3. Output meter circuit.

$$R_x = E\left(\frac{1}{i} - \frac{1}{I}\right).$$

Where:

E = Voltage in the circuit.

i = Meter reading with R_x in the circuit.

I = Full scale reading of the meter.

When S_3 is closed the circuit of Fig. 2a becomes that of Fig. 2b and the test leads are connected directly across the meter. R is first adjusted so that the meter is reading full scale. Then the unknown resistance is connected as shown. The value of R_x is given by the formula:

$$R_x = \frac{i\,R\,R_m}{E - i\,(R + R_m)}$$

Where:
i = Current through the meter with R_x in the circuit.
R = Compensating resistance.
R_m = Resistance of the meter.
E = Voltage in the circuit.

Using a 199 tube as a rectifier, the d-c. milliammeter makes a very useful output meter. The circuit is shown in Fig. 3. The filament of the tube is heated by the current from a 4.5 volt C battery and is controlled by switch S_2. Since this type of output meter requires a fairly high voltage to give a good deflection of the meter, it must be connected across the primary of the output transformer in sets using dynamic speakers having low impedance voice coils.

For external use of the meters tip jacks are provided. When the d-c. meter is to be used the voltmeter return switch must be closed. For all other operations this switch is left open.

The cathode current and voltage ranges are connected to read, normally, currents and voltages that are positive with respect to the filament; for example, screen voltage and current of pentodes. In testing pentodes, S_5 should be thrown to the filament position.

A 199 tube was used in the output meter because there were several on hand and because of the low power consumption of the filament. Any other small tube could be used with equally good results.

S_2, S_3, and S_6 are miniature toggle switches.

The six-blade push-buttons used for making current measurements serve to speed up the operation of the analyzer. Possibly other arrangements may suggest themselves to the builder.

For normal operation of the analyzer, open the voltmeter return switch, place the test plug in the tube socket and the tube in the proper socket on the panel and proceed as follows: With the a-c. to d-c. switch in the d-c. position:

Plate current: S_4 to desired range and press plate Ma. button. For second plate of full-wave rectifiers press S. G. Ma. button.

Screen-grid current: S_4 to desired range and press S. G. Ma. For screen-grid current of pentodes press cathode Ma. button.

Plate voltage: S_4 to center position (normal). Press button for desired range. Voltages may be measured with respect to either cathode or filament by throwing S_6 to cathode or filament position.

Normal grid volts: All switches normal. Press desired grid volts button.

Control grid volts on S-G. tube: Reverse S_1. Other switches as before. Use regular grid volts ranges.

Screen-grid volts: Reverse meter. Other switches normal. Use regular grid voltage ranges. For screen grid voltage of pentodes—all switches normal. S_6 to filament side. Use cathode voltage ranges.

Cathode voltage: S_6 to filament position. Use cathode volts ranges.

D-C. filament volts: Use d-c. filament button reversing meter if necessary.

A-C. filament volts: a-c. to d-c. switch to a-c. position. Use one of the a-c. filament volts ranges.

Output meter: Close the switch S_2. Connect the output of the receiving set to the terminals marked output. The rectified output can be read on the d-c. meter. To extend the range connect the 10 milliampere shunt in the circuit.

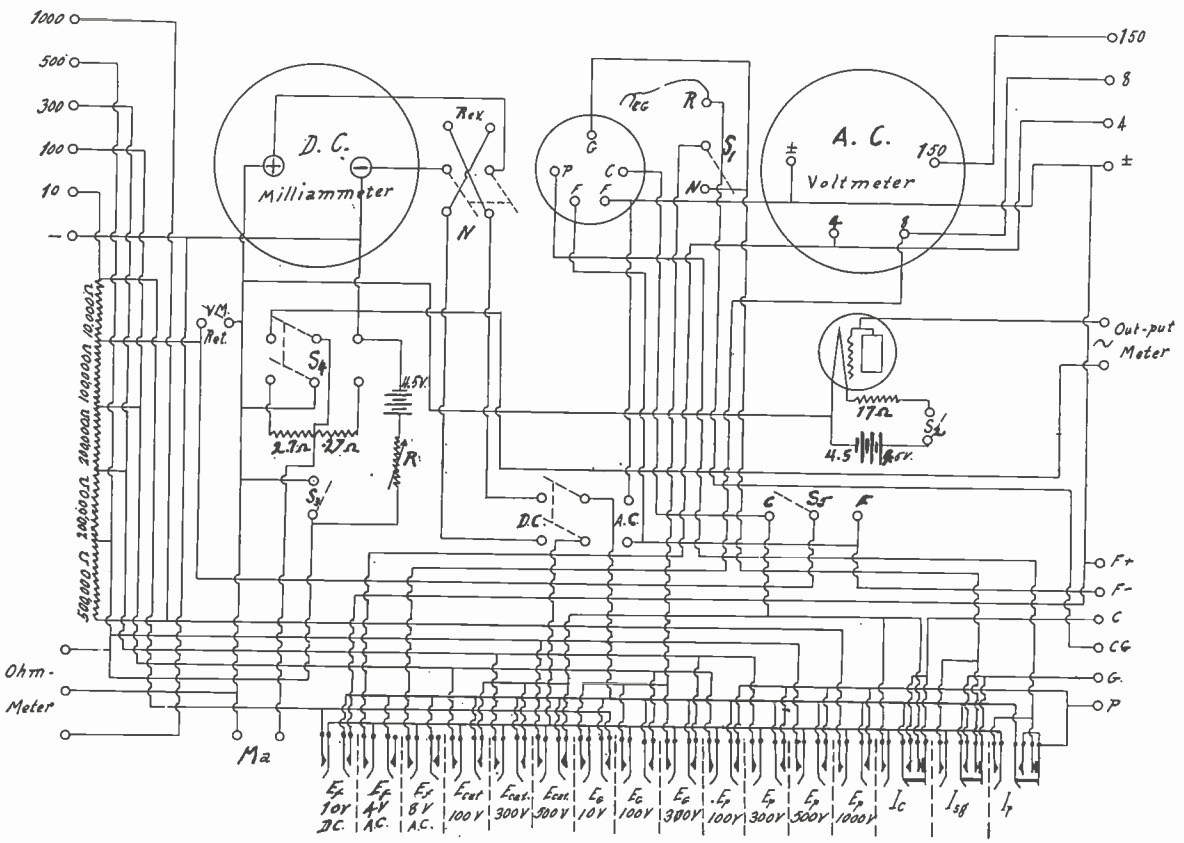


Fig. 1.

A radio transmitter for the itinerant flyer

By J. B. Bishop*

With the rapid growth of the aviation industry in the last few years a need arose for a light weight radio transmitter to enable airplanes to communicate with their ground stations by telephone. The need was most urgent for the large transport planes carrying passengers over established routes, and as a result the No. 8 type radio transmitter was developed. It has proven highly satisfactory for the service for which it was designed but it is not particularly suitable for the lighter types of aircraft, such as are commonly used by the itinerant flyer. For these ships with their already limited load-carrying capacity, reduction in size and weight is even more important than for the larger ships, although the range of the transmitter need not be so great. To meet this need, the Laboratories have developed the 11A radio transmitter, which weighs scarcely eighteen pounds, occupies little more than three-quarters of a cubic foot of space, and may be expected to furnish ample signal strength to a radio receiver located within a radius of 30 to 40 miles.

The pilot whose radio equipment includes this transmitter as well as a weather and beacon receiver, such as the Western Electric 9D radio receiver, has many advantages over the pilot flying with the receiver only. He may ask for and receive special information pertinent to his flight at any time without waiting for a scheduled broadcast of general weather information. As weather conditions change rapidly and vary greatly from place to place, the exact knowledge of the progress of a storm is extremely important to the pilot and will often enable him to proceed with assurance and safety around the storm area. In case of fog there is frequently sufficient "ceiling" for a safe landing at the port of destination or a nearby emergency field while the surrounding country is completely "closed in." With these conditions accurately known, the pilot may safely fly above the clouds to his destination and land without delay or danger. On arrival at a strange airport, the itinerant flyer, before landing, may wish to know the condition of the field, the direction and velocity of the wind and what obstructions, if any, are liable to interfere with his landing. Equipped with the radio telephone, he merely calls the operator of the airport station for this information. By no means the least important safety feature of the radio telephone is realized in the ability of the pilot to secure immediate assistance from a nearby airport should he be forced down at some point other than his destination.

The Federal Radio Commission has provided for this radio telephone service to itinerant aircraft by assigning the frequency of 3105 kc. for transmission from plane to ground and the frequency of 278 kc. for transmission from ground to plane. This assignment for ground to plane transmission permits the use of the weather and beacon receiver in the plane for reception from a suitable airport radio transmitter. The

*Radio Development Department, Bell Telephone Laboratories, Inc.

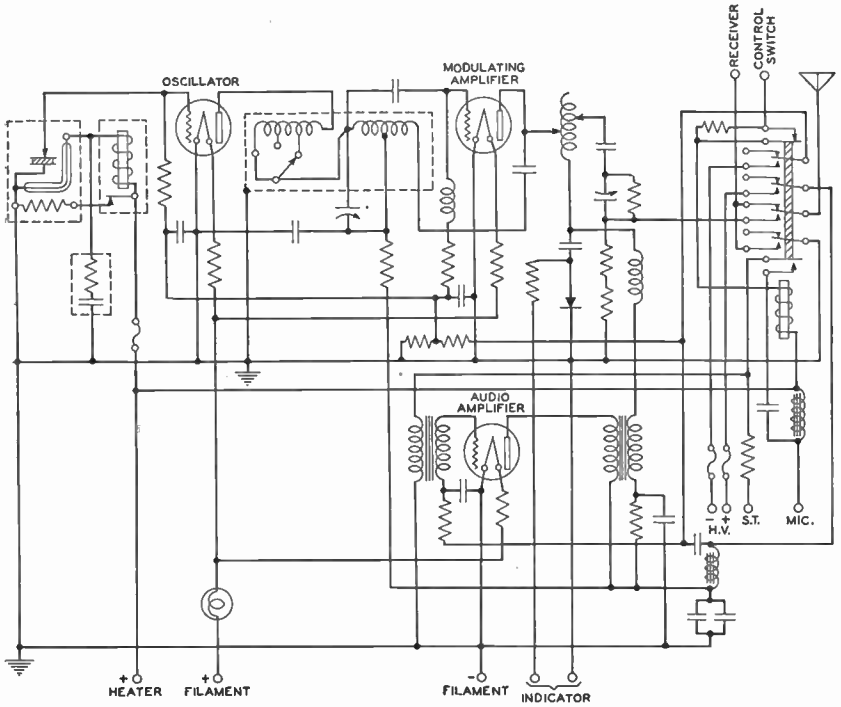


Fig. 1. Schematic diagram of the 11A transmitter.

higher frequency of 3105 kc. is more satisfactory for plane to ground transmission, as it allows the use of a fixed type of antenna on the plane with satisfactory transmission for day and night operation. Although operated at this frequency for the itinerant flyer service, the new airplane radio transmitter may be used for other services on any frequency from 3000 to 6500 kc. When operating on 3105 kc. a flyer will be heard not only by the airport stations in the vicinity but also by aeronautical ground stations operated by the Department of Commerce whose attendants are instructed to stand watch on this frequency for emergency communications.

Although the new transmitter has been reduced to diminutive proportions, no features important to the service it has to render have been omitted. The carrier frequency is determined by a temperature controlled quartz crystal and the set may be quickly adjusted to transmit on any frequency within its range of 3000 to 6500 kc. by inserting the proper crystal and making a few simple adjustments. Substantially complete modulation is obtained during loud passages of speech and the response characteristic is practically flat from 300 to 6000 cycles. The output circuit is arranged to work into almost any airplane antenna that would be practicable to erect. One of the outstanding features of the design, and one which has done much to make possible the reduction in size and the simplicity of the new transmitter, is that it employs only three vacuum tubes.

The schematic diagram of the transmitter is shown in Fig. 1. One vacuum tube, a 205D, serves as a combined oscillation generator and frequency doubler by selecting the second harmonic of the oscillator frequency with a tuned circuit for input to the second tube. The second 205D tube, operating as a power modulating amplifier, is neutralized by the Rice method with a fixed condenser and supplies modulated power to the antenna through a series tuned circuit consisting of a tapped coil and a variable condenser. A stopping condenser and static leak resistors protect the antenna from plate supply voltage and static charges. A copper-oxide-disc rectifier located in the output circuit is connected to an external d-c. meter which indicates the amount of antenna current as well as the degree of modulation present at any instant. The third tube, a 252A, is used as a speech amplifier with transformer coup-

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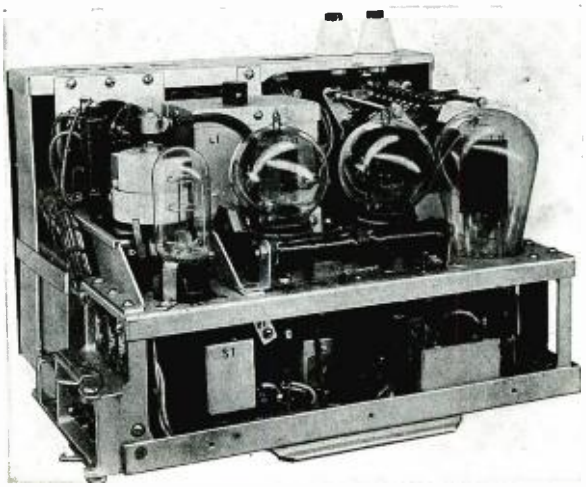

Fig. 2. The extremely compact arrangement of the transmitter is evident when the sides and top are removed. The bulb at the left is the ballast lamp used to control current to the filaments.

A note on grid-bias modulation

By L. B. Hallman, Jr.

IT is a well established fact, experimentally, that the capacity of a class B amplifier modulated by varying the grid-bias must be approximately ten times the carrier power to allow for peaks at, or near, 100 per cent. modulation. The writer has never seen a detailed explanation of why so comparatively large an amplifier is necessary. Because of the small amount of modulator power required this type of modulation has attracted considerable attention.

Assuming that the tube is to be used to its maximum capacity, it is clear that, with no modulation, the plate current waveform would closely approximate that shown in Fig. 1. Here the plate current is a sine wave for the first half-cycle and zero for the succeeding half cycle. I_s represents the saturation plate current. Expanding this function in a Fourier series we find the amplitude of the fundamental component (that is, the component to which the plate tank circuit is tuned) to be $I_s/4$. Thus if the resistance offered by the tank circuit to this component is R, the power output is

$$(I_s/4\sqrt{2})^2R = RI_s^2/32$$

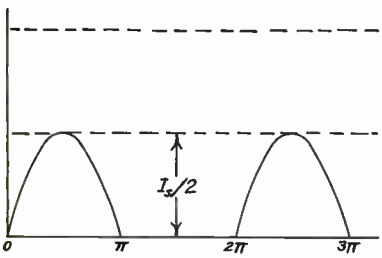

Fig. 1

At this instant, however, the tube is operating as a straight class B amplifier biased near cutoff. Consequently we may expect an efficiency, in practical operation, of around 70 per cent. Assuming this value we find the power input to be

$$P_{o1} = RI_s^2/22.4 \ldots\ldots (1)$$

If now a modulation depth of 100 per cent is applied the grid-bias is shifted, on peaks, from cutoff to the mid-point of the characteristic. Choosing the instant of maximum swing we have the plate current waveform shown in Fig. 2.

Here the amplitude of the fundamental is, of course, $I_s/2$ and the power output is

$$(I_s/2\sqrt{2})^2R = RI_s^2/8$$

It is clear, however, that the tube is now operating as a straight class A amplifier. Consequently the efficiency in practical operation will hardly be over 40 per cent. The power input is then

$$P_{m1} = RI_s^2/3.2 \ldots\ldots (2)$$

The ratio of the tube capacities required on 100 per cent. modulation peaks and with no modulation will then be given by dividing (2) by (1). This gives

$$(RI_s^2/3.2)\,(22.4/RI_s^2) = 7.0$$

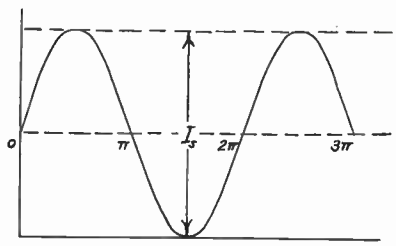

Fig. 2

If the efficiency of the class B amplifier is 60 per cent. and the class A amplifier 30 per cent., this factor works out to be 8. It is clear then, when taking into consideration normal variations in efficiency between different practical setups, that the value of 10 is probably none too large. Also it should be pointed out that when working the tube up to its maximum capacity, which was assumed in the foregoing analysis, the grid will be swung positive and draw current for a good portion of the positive half-cycle. This draws power from the modulator, and unless it is large enough to supply the load distortion will result. For this reason it may be desirable not to utilize the full capacity of the tube.

WHEN TELEVISION COMES

TELEVISION promises to open up new fields for the broadcasting industry, which has increased its income even during this period of depression, according to *The Index*, published by The New York Trust Company.

"Perfection of television," *The Index* states, "with its myriad of possibilities, will possibly open up a new field in the manufacturing industry similar to that enjoyed during the past decade by the manufacturers of radio receiving sets. At the same time it may necessitate the investment of millions of dollars in new television equipment by the broadcasting industry, which, as organized at present, will probably form the basis for such a commercial development.

"Last year the gross receipts of the various individual (broadcasting) stations ranged from a few hundred dollars to over $1,600,000. The revenues of the two major companies rose from $10,253,000 in the year 1928 to $27,600,000 in the year 1931. Advertising revenues of one of these companies increased approximately 22 per cent during the first six months of this year as compared with the corresponding period in the year 1931, while the increase for the other amounted to 33.9 per cent.

"In the year 1930 the number of clients utilizing the advertising facilities of the two major broadcasting systems closely approximated 300 and this number increased to some 350 in the year 1931."

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RADIO RECEIVER DISTRIBUTION IN NEW YORK AREA

A REPORT just released by the Merchants' Association of New York, states that in the matter of radio sets, there is not nearly so much difference in habits of ownership inside the city and outside the city. 61.6 per cent of the families in the area had radio sets in 1930. Again this average outstrips that for the United States as a whole where only 40.3 per cent of the families had radio sets. In New York City 59.1 per cent of the families had radio sets. In New York State counties outside of the city, 68 per cent of the families had radio sets. In New Jersey counties 64.4 per cent of the people had radio sets and in Fairfield County, Conn., 61.2 per cent of the people. Summing up the statistics which are contained in the Merchants' Association analysis, it is found that in 1929, 810,925 persons in the New York trading area made income tax returns: that in 1930 there were 1,834,475 families who had radio sets and that there were registered in the area in 1931 1,662,854 passenger automobiles and 288,459 commercial motor vehicles.

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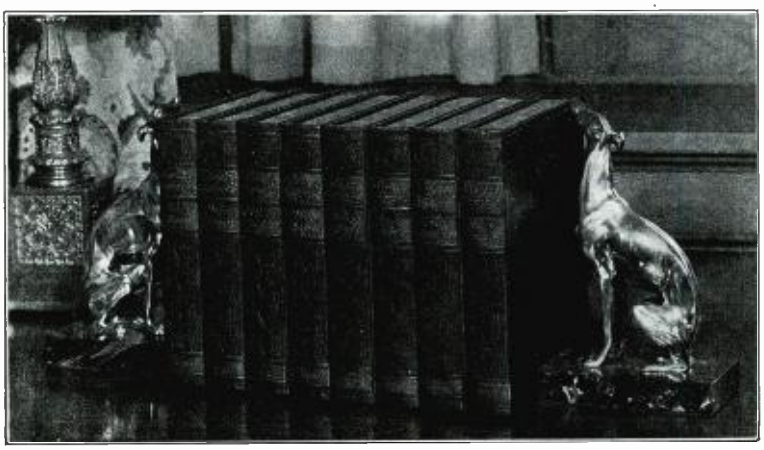
THE CANADIAN PLAN

What has been referred to as the "Canadian plan" of broadcast frequency allocation, presented at the recently held Madrid conference, proposes that seven additional channels below 540 kc. be assigned to broadcast service.



A receiver that resembles a set of books.

Crosley production increases—

New receiver models introduced

THE radio division of the Crosley Radio Corporation, Cincinnati, Ohio, has been increasing its employment steadily for the past four months and at present has more than 1,000 persons on its payroll, an increase of approximately one hundred per cent over last month.

Production at the Crosley plant is to be stepped up to 20,000 sets weekly, it is reported. Though the operation of full time day and night shifts production thus far has reached a 2,000 sets per day output. Inability to obtain raw materials promptly coupled with necessity of carefully training new employees for more than a week before they are qualified for the work assigned are given as factors making it impossible for the Crosley concern to attain its revised production schedule immediately.

In order to meet this greatly increased schedule, additions to both day and night shifts are being made as rapidly as new employees can be trained, rather than forcing present employees to work overtime.

"We have inaugurated this policy in order to provide jobs for as many unemployed as possible," Powel Crosley, Jr., president of the Crosley Radio Corporation said recently, pointing out that in his opinion industry's chief obligation at this time is that of giving work to as many individuals as possible.

In the matter of securing materials the Crosley concern has been forced to take extraordinary measures even to attain its present 2,000 sets per day production. Important materials and parts are being shipped into Cincinnati by airplane and express while special trailer trucks make as many as fifteen to twenty deliveries daily. Recently, in order to avoid shutting down assembly lines and sending workers home, it was necessary to press Mr. Crosley's personal plane into service to rush a delayed shipment of materials to the factory from a nearby city.

"The pronounced increase in demand for radio receiving sets, particularly the new lower priced models we are now featuring, is definite evidence that general business conditions are on the upgrade and that a marked improvement will continue to be noted throughout the fall and winter months," declared Mr. Crosley.

"The fact that our recent large commitments for materials found practically all sources of supplies unable to fill our orders promptly indicates these various allied industries have been operating with virtually empty warehouses and awaiting signs warranting a revival of production activity.

"Now that these industries are being stimulated by these orders for supplies from our own plant and those of others, thousands of men and women throughout the country are being called back to work," he added.

New Models

Distinct departures from the traditional in radio cabinet design, new Crosley sets have been built with the object of bringing the radio receiving set into the "package merchandise" and gift-shop field. Officials of the Crosley company are of the opinion that this heretofore neglected outlet is well worth considerable promotional effort and they plan an intensive campaign to develop this field which in the past has been for the most part overlooked by the radio industry.

The Crosley "Book Case" (Library Universal) is another novelty designed receiving set which is expected to catch the eye of the "over-the-counter" buyer. Appropriately, this cabinet represents a beautiful set of antique leather bound volumes titled "Music," "Religion," "Education," "News," "Politics," "Sport," "Entertainment" and "Humor."

Placed on a table or on a shelf among other books there is nothing about this unique cabinet to lead one to believe it to be anything other than a set of fine old books. The book backs are mounted on two swinging doors which when opened reveal the switches and dials of the conventional table model receiver. Its dimensions are: 10¼ inches high, 13½ inches wide, and 8 9/11 inches deep.

This model houses the 5-tube superheterodyne chassis in which is incorporated such exceptional features as: balanced image suppressor pre-selector, combined volume control and on-off switch, new heater type tubes, illuminated hairline shadow dial with vernier

(*Concluded on page* 20)

One more step in universal communication

FROM the laboratories of the RCA Victor Company, at Camden, comes word of the development of a tiny two-way radio telephone and telegraph receiver and transmitter, in one unit, for emergency and mobile communications over short distances.

Weighing only 22 pounds together with a battery unit, and taking up scarcely as much room together as two moderate sized "B" batteries, these remarkable little units, which have been named transceivers, are expected to find an immediate application wherever other means of communications are impracticable or uncertain.

The new RCA Victor transceivers will find a ready use in the police work of large cities where mobility and adaptability are especially important. They can easily be placed in police emergency wagons for use in handling large crowds or answering riot calls. By this new means, police reconnoitering a disorderly mob, or a building harboring desperate criminals, could maintain continuous contact with a central base of operations from which instructions can be issued to meet changing conditions.

In fire fighting, the new transceivers are especially useful for communication between firemen in the interior of a burning structure and the officers directing operations outside. It is often necessary to send firemen into a burning building to warn their comrades to leave when the walls show dangerous signs of crumbling. Because of their negligible weight and size, the transceivers can easily be strapped to a man's back without hampering his movements.

The new units may be called on to play another interesting role in the subway transportation systems. In subway disasters, similar to the kind that have occurred in the last few years, it is imperative that workers in the tunnels be in communication with surface rescuing parties. In the past, it has been necessary to run long telephone wires through the streets and drop them into the tunnel, with a great loss of valuable time. The transceivers would be a solution to this problem.

In Forestry Patrol

Recently, the New Jersey forestry service acquired a number of the new transceivers as of invaluable aid in spotting and reporting forest fires. Very instructive tests have also been made with communication between the front and rear of long freight trains. It was found that substantial saving in time can be effected by the little transceivers in this way. The U. S. army, too, has shown great interest in the RCA Victor transceivers and has made numerous successful experiments with them in army maneuvers. Transceivers have even been placed in saddlebags, with a cavalry officer holding the antenna like the long lance of the crusaders.

The operation of the transceivers is simple. The changeovers from "transmit," "receive" and "telegraph" positions are accomplished with a single changeover key switch. The circuit of the transceivers is of the super regenerative type which has been found to be most efficient below 10 meters. The tubes, which include three RCA-230's and an RCA-231, have interchangeable functions in the circuit. In the transmit position, two RCA-230's act as oscillators in a push-pull circuit with an RCA-231 as modulator and an RCA-230

New Transceiver, weight 22 pounds with battery unit. One-half watt power. Five meter waveband.

as audio amplifier. In the receive position, the two —230 tubes act as oscillating super regenerative detectors and the other —230 acts as the first audio amplifier, with the —231 as an output amplifier. For code transmission, the —230 speech amplifier oscillates at an audio frequency of approximately 1,000 cycles, which is keyed with a telegraph key.

The antenna is usually of the di-pole type, each section being approximately ¼ wavelength long, which for five meter transmission is about 40 inches. For plane, auto and other mobile use, it may be desirable to utilize a zeppelin antenna with a transmission line. The units have a range up to three miles, depending on the nature of the surrounding terrain, although it is possible to increase this range by raising the transmitter to a greater height above the ground.

The extremely low wavelength and low power of the transmitter insure against any interference with existing radio services, all of which, with the exception of experimental television broadcasting, operate at higher wavelengths and much greater power.

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TUBES FOR RADIO

THE situation with regard to new vacuum tubes for radio, due to the large array of tubes listed in various charts published, is confusing. The number of tube types of early manufacture still in use and the newer tubes now being installed in modern radio receivers total over two hundred.

So far as the tube manufacturers are concerned a large number of these tube types are now listed as obsolete.

Of the new types of tubes, the following have been described in RADIO ENGINEERING in this year's issues so far. In most cases the characteristics were given:

Triple Twin, Cable; R. C. A. 239, Arcturus 36, 37 and 38, Sylvania 239, in January. Arcturus 766 and 772, in February. Arcturus 136A, 7, 8, 9, and R. C. A. 234, in March. Wunderlich, and Sylvania Sx 82, in April. R. C. A. 46, 56, 57, 58, 82; Arcturus 703A; Speed 256; Sylvania 56, 57 and 58, in May. Arcturus 46, 56, 57, 58, 82, in June. Raytheon 49; R. C. A. 46, 55; Sylvania 41, 42, 44, 46, 82, 866; Cunningham C-57, in July. R. C. A. 55, 82, 83; Arcturus 58, in September. R. C A. 48, November.

AIRWAYS RADIO

ORDERS for nearly $100,000 worth of newly designed aviation radio-telephone apparatus have just been placed by five air lines, it was learned from the Western Electric Company. The orders were placed by United Air Lines, American Airways, Transcontinental and Western Air, Western Air Express and National Parks Airways.

The progressive policy of the country's transport operators in keeping their equipment abreast of latest improvements is indicated in the fact that, although the new type of radio-telephone equipment was announced only eight weeks ago, the latest orders bring the total already purchased up to $150,000.

More than half of the new orders are devoted to a refinement in one piece of apparatus alone, an improved quartz crystal unit which keeps the radio transmitters within the frequency channel assigned to them with an accuracy of about .01 per cent. Nearly 600 of these units will be shipped to United Air Lines, American Airways, Transcontinental and Western Air and Western Air Express for installation in their planes and ground stations and for reserve.

National Parks Airways has ordered two 400-watt transmitters and two of the new superheterodyne receivers to establish ground stations at its fields at Pocatello, Idaho, and Butte, Montana, and complete high frequency radio-telephone equipment for its seven planes. These installations will place the entire National Parks route from Salt Lake City, Utah, to Great Falls, Montana, and all its flying stock on a complete two-way communication basis.

Western Air Express has ordered a 400-watt transmitter to replace the existing 50-watt transmitter at its Denver field. It will also install new superheterodyne receivers in all of its nine ground stations at Burbank, California; Salt Lake City, Utah; Las Vegas, Nevada; Cheyenne, Wyoming; Denver and Pueblo, Colorado; Albuquerque, New Mexico; El Paso and Amarillo, Texas. The eight planes on the Denver division will also be completely equipped with the improved type radio-telephone.

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PATENT PROTECTION DEMANDED BY RADIO INDUSTRY LEADERS

AT meetings of radio industry leaders in New York recently, including the board of directors and receiving set, tube and parts divisions of the Radio Manufacturers Association, several important and vigorous measures to improve merchandising conditions and prevent unfair competition were adopted:

Chief among these was unanimous adoption by the RMA board of directors of a formal resolution calling on radio patent licensors, including the Radio Corporation of America, to take adequate action against unlicensed manufacturers. The resolution follows:

"Inasmuch as the manufacture and sale, without royalty payments, of unlicensed radio apparatus which infringes patents under which members of this Association are licensed and pay royalties, subjects such members to serious disadvantages in competition;

"THEREFORE, BE IT RESOLVED, that the owners of patents under which members of this Association are licensed and pay royalties be requested by this Association to enforce in every proper manner respect for their patents by the manufacturers and vendors of competing apparatus which infringes such patents."

This action immediately follows recent numerous lawsuits instituted by holders of loudspeaker patents against prominent chain-store, furniture and other purchasers of unlicensed products and is expected to result in similar action to protect receiving set manufacturers against unlicensed and irresponsible manufacturers.

▲

HIGH POWER TRANSMISSION AND RECEPTION AT ONE STATION

THE new Marconi beam station at Salisbury, Rhodesia, which was opened recently for the operation of high speed telegraph services between Great Britain and Northern and Southern Rhodesia and Nyasaland is notable for a new feature of particular interest.

The one station is used for both transmission and reception, the equipment for both services being installed in the same building and using side by side aerial arrays instead of being housed in separate stations at a distance of some miles in accordance with the usual practice. This innovation has considerable advantages from the point of view of economy, and has also proved technically satisfactory.

In addition to the telegraph service, the Salisbury Station is capable of utilization in the near future for overseas telephone services, and also for rebroadcasting services.

▲

300 KW. TUBES

It appears that the first European broadcast station to employ 300-kw. tubes is a station in Vienna.

ELECTRONIC DEVICES

AT a meeting of the American Institude of Electrical Engineers, Power Group, held in New York, November 29, interesting papers were presented by C. A. Butcher, of the Westinghouse Electric and Mfg. Co., and by W. S. Hill, of the General Electric Co., on the subject of electronic devices.

The term "electronic devices" has come into use to include mechanical systems operated or controlled by means of vacuum tubes or photoelectric cells.

While it is true that less than one-half of one per cent of the vacuum tubes manufactured are used in industries other than radio, there is growing a new technology based upon the use of power rectifiers and control tubes which in the future may present a considerable market for large size vacuum tubes of a type in principle only related to radio tubes.

At the A. I. E. E. meeting the speakers dealt with the practicability of mercury arc rectifiers in low-voltage commercial service and possible application to metropolitan networks; present applications and possibilities of electronic devices in power and control fields; the Kenatron, Pliotron, Phanotron, and Thyratron; their distinctions and uses.

▲

NO TRADE SHOW IN 1933

THERE will be no RMA trade show in 1933, according to a decision of the Association's board of directors at their meeting in New York, recently. After considerable discussion the board of directors voted to "skip" the annual trade show next year and learn decisively if business is impaired or retarded by the holding of a show. On this point there are conflicting opinions and the board decided to omit the 1933 trade show in order to determine whether business is hurt or helped by this annual industry event.

▲

I. R. S. M. MOVES

THE Institute of Radio Service Men moved its general headquarters office on November 1, to the Boyce Building, 510 North Dearborn Street, Chicago.

The board of direction states that the Boyce Building office has been selected after an investigation covering several months, during which time it was found necessary to move into temporary quarters twice in order to keep pace with the expansion of the association. The Institute issues a cordial invitation to everyone connected with the radio industry to visit them at any time.

PLAN OFFERED TO WIDEN BROADCAST BAND

SUBSTANTIAL progress is reported in the effort at the Madrid International Radiotelegraph Conference to widen the broadcast band. Bond Geddes, executive vice-president and general manager of the RMA joined with broadcasters and others in a conference in Washington at the State Department on October 24 regarding a definite proposal from the Madrid conference. Undersecretary of State William R. Castle presided over the Washington meeting and presented a compromise proposal on widening the broadcast spectrum. It would provide for addition of 70 broadcast kilocycles below the present broadcast minimum of 550 kc. and would displace some marine and other frequencies. The plan was presented to the Madrid Conference by Canada, Mexico and Cuba and is designed to provide these countries with sufficient broadcasting space, thus avoiding serious interference by Mexican and Cuban broadcasters with American radio listeners and stations.

The American delegation at Madrid asked the approval of the State Department to support the proposed treaty change, sponsored by the Canadian delegation and endorsed by Mexico and Cuba. The National Association of Broadcasters, the Federal Radio Commission through Commissioner Starbuck, and radio communication interests also favored the "Canadian compromise" and RMA support was given in conjunction with that of other radio interests, although the plan was opposed by Navy, Coast Guard and American shipping interests.

Paul B. Klugh of Chicago, who is the RMA representative at the Madrid Conference, was cabled of the State Department conference and he is known to be working vigorously toward a result at Madrid which might be highly beneficial not only to the American radio public but to radio manufacturers.

▲

CLASS B AMPLIFICATION

THE inclusion of class B amplification in certain of the 1932 radio receivers appears to be an experiment along the line of giving more for the money, or of finding out whether the extra manufacturing cost involved may agreeably be passed along to the ultimate purchaser.

The principle of operating two vacuum tubes in a quasi-push-pull output system close to plate current cutoff at no signal input, the incoming signal rendering the grids positive, sounds complex, and in fact is relatively expensive because special accessories are required.

Those who have not kept pace with the technical development of class B amplifiers are puzzled to distinguish class B from class A amplification by viewing a receiver diagram.

Where there are two tubes shown in the output stage, usually the presence of a by-pass condenser across the bias resistor denotes class B amplification. The absence of this condenser denotes class A. Of course measurement of the plate current when no signal is being received will disclose a much smaller current value in the case of class B than in class A.

In the matter of design for class B amplifiers a method is to plan using an input transformer with such stepdown ratio as to make the impedance the source of the driving power plus the transformer impedances appear as an impedance in the grid circuit (negligible in comparison with the internal grid resistance of the tube.)

The new 46 tube with its two grids is applicable either to the output or driver stages of class B amplifiers. The tube has five base pins—one for the extra grid. The two grids connected together serve for class B purposes.

HIGHER POWER FOR CLEAR CHANNELS

Broadcast stations now using the higher powers granted by the Federal Radio Commission are:

WBZ, Boston, 25 kw.
WHAS, Louisville, 25 kw.
WCAU, Philadelphia, 50 kw.
WSM, Nashville, 50 kw.
WBT, Charlotte, 25 kw.
WCCO, Minneapolis, 50 kw.

Stations granted powers higher than used at present, and which will have much new construction to do before they can employ the higher ratings are: WOR, Newark, N. J.; WSB, Atlanta; KVOO, Tulsa, Okla.; WAPI, Birmingham; WHO-WOC, Des Moines; KFAB, Lincoln, Neb.; KOA, Denver; KSL, Salt Lake City, and KPO, San Francisco.

▲

TO REDUCE NEW TUBE MODELS

COOPERATION between leading receiving set and tube manufacturers to reduce the number of new tubes brought into the market was effected at recent meetings, in New York, of the RMA set and tube divisions and at the meeting of the board of directors. President Fred D. Williams, of Indianapolis, presided over the directors' meeting which was largely attended and largely devoted to the serious tube situation.

Chairman S. W. Muldowny, of the tube division, held a perliminary meeting of prominent tube manufacturers to discuss the burdens not only on manufacturers, but on jobbers and dealers evolved from the promotion of new tubes. At the RMA directors' meeting, when a joint conference of set and tube manufacturers was held, it was decided that Chairman Murray, of the set division, should formally and in detail advise all receiving set manufacturers and their engineers of the serious difficulties, including loading up of dealers, involved in the promotion of numerous new, unnecessary and minor tubes. Set manufacturers will be urged to reduce their demands on tube makers for products embodying only minor or special developments.

▲

DR. CADY ADDRESSES COPENHAGEN CONVENTION BY RADIOPHONE

A RADIO exhibition was recently held at Copenhagen, Denmark, to celebrate the twenty-fifth anniversary of the invention of the Poulsen arc transmitter for radio telephony and also the tenth anniversary of the first Danish broadcasting. As a sample of the effectiveness of modern communications systems, it is interesting to note that Dr. W. G. Cady, President of the Institute of Radio Engineers transmitted via transatlantic radio telephone, a short address at this exhibition in honor of Messrs. Valdemar Poulsen and P. O. Pederson who played a large part in the development of Danish radio. Dr. Cady spoke into a line telephone at his home in Middletown, Conn., and his speech was heard by a large assembly in Copenhagen.

▲

CROSLEY PRODUCTION INCREASES

(*Concluded from page* 15)

drive and full floating moving-coil dynamic speaker.

"As we analyze the radio market today", Mr. Crosley said in discussing the new models, "we feel that a successful radio line must incorporate two features. First, of course, is the utmost in value at the lowest possible price and the second vitally important feature is novelty, newness and definite appeal to the eye. We are confident these two new models meet those requirements admirably.

"Both the new 'Jewel Case' and the 'Book Case' have virtually a ready-made market and for Christmas, birthdays, anniversaries and other occasions, these two models have an exceptional appeal. Art stores, gift shops, book stores, jewelry stores and a score of other retail outlets should find the 'Jewel Case' and the 'Book Case' leaders in their merchandise stock."

THE Group Subscription Plan for RADIO ENGINEERING enables a group of engineers or department heads to subscribe at one-half the usual yearly rate.

The regular individual rate is $2.00 a year. In groups of 4 or more, the subscription rate is $1.00 a year. (In Canada and foreign countries $2.00.)

The engineering departments of hundreds of manufacturers in the radio and allied industries have used this Group Plan for years, in renewing their subscriptions to RADIO ENGINEERING.

Each subscriber should print his name and address clearly and state his occupation—whether an executive, engineer, department head, plant superintendent, or foreman, etc.

Remember this Group Plan when *Your* Subscription Expires

(Radio Engineering)

Bryan Davis Publishing Co, Inc.
19 East 47th Street
New York, N. Y.

Los Angeles Chicago St. Louis

A chronological history of electrical communication —telegraph, telephone and radio

▲

This history was begun in the January, 1932, issue of RADIO ENGINEERING, and will be continued in successive monthly issues throughout the year. The history is authoritative and will record all important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific developments. The entries will be carried along to our times.

▼

Part XII

1874 (*Cont.*)

(442) Plans are made to build a telegraph line along the Canadian Pacific Railway, Canada. It is reported that a contract to build a western section of 750 miles has been awarded to F. J. Barnard for $750,000, and $50,000 per year for five years for maintenance.

(443) Moritz Herman Von Jacobi dies. (Born Germany, 1801.)

1875 (444) Thomas T. Eckert is elected president of the Atlantic and Pacific Telegraph Company, January 14.

(445) The offices of the Western Union Telegraph Company are moved from 147 Broadway to 145 Broadway, New York, February 1. On the sixth floor of the building 15,000 cells of primary battery are located.

(446) The number of telegrams handled daily in the main operating room of the Western Union Telegraph Company, New York, now amounts to 35,000.

(447) The Western Union's employees in the United States number 9,200 males and 750 females.

(448) A. G. Bell's patent number 161,739 is granted April 6, covering a system of double telegraph transmission over a single wire.

(449) Wallace and Sons, Ansonia, Conn., begin the manufacture of dynamos.

(450) The International Telegraph Convention is held at St. Petersburg, Russia.

(451) Sir Charles Wheatstone dies. (Born in England. 1802.)

(452) The first railroad interlocking signal plant in the United States is installed (February) at East Newark, N. J., on a line which subsequently became a part of the Pennsylvania System. Later in the year a plant was installed at Spuyten Duyvil, N. Y., on the New York Central Railroad.

(453) Ducretet employs an electrolytic rectifier to change alternating current into pulsating direct current.

(454) Clark standard cell brought out by Latimer Clark, in England.

(455) Montreal Telegraph Company, Canada, has 1,400 offices and 20,000 miles of line wire in service.

(456) Direct United States Cable Company lays a cable between Ireland and the United States.

(457) G. M. Phelps' printing telegraph system placed in service on a line between New York and Washington.

(458) Georges De Infreville is granted a patent (U. S. No. 157,469) for a system of duplex Morse telegraphy.

(459) Western Union Telegraph Company leases the lines of the Great Western Telegraph Company, Chicago.

(460) W. F. Channing, Providence, R. I., and Moses G. Farmer, procure several patents covering improvements in fire alarm telegraph apparatus.

(461) Professor Crookes, in England, produces X-rays. (These, however, were not identified accurately until twenty years later.)

(462) Dane Sinclair, of the North British Railway Telegraphs, England, is selected to proceed to Japan in the service of the Japanese government, as inspector of telegraphs. (Remained in Japan five years.)

(463) Dr. Stephan, head of the German post office department, takes provisional charge of German telegraph facilities, with a view to consolidating the two services.

(464) Dr. H. C. Nicholson, Cincinnati, Ohio, invents a Morse quadruplex system which is later given a tryout in service and found to work well.

(465) Sholes and Glidden typewriter introduced in American telegraph service by operators, for receiving from wire.

(466) Cable rate from New York City to points in Great Britain is reduced to fifty cents per word.

(467) I. D. Purkis retires as general manager of the Dominion Telegraph Company, Toronto, Canada, and is succeeded by Mr. Swinyard.

1876 (468) The Phelps telegraph printer is operated between New York and Chicago at a speed of fifty-five words per minute.

(469) Elisha Gray and A. G. Bell, on February 16, file respectively patent applications covering the invention of a system for transmitting sounds telegraphically.

(470) A. G. Bell transmits speech by telephone, March 10.

(471) The Phillips Code is introduced by Walter P. Phillips.

(472) Lines of the Franklin Telegraph Company taken over by the Atlantic and Pacific Telegraph Company, June 15.

(473) The phonograph is invented by T. A. Edison.

(474) The first practical ozonator is constructed, by Berthelot.

(475) Pneumatic despatch tubes are laid underground between the Western Union main office and the stock exchange building, New York.

1877 (476) Early in this year Charles F. Brush invents and constructs his first arc lamp, exhibiting it in connection with one of his new type dynamos at the Franklin Institute, Philadelphia.

(477) The Fuller bichromate of potash primary battery is introduced.

(478) Emile Berliner, of Boston, files a patent application (June 4) covering the invention of combined telegraph and telephone apparatus. (Patent No. 463,569 granted November 17, 1891.)

(479) Edison files a patent application (July 20) covering the use of carbon as an electrode contact in telephone transmitters.

(480) A. G. Bell delivers a lecture before the Society of Telegraph Engineers, London, October 31, giving an account of his telephone experiments in the United States.

(481) Professor Eli W. Blake, Dr. W. F. Channing, Professor John Pierce and Edson S. Jones, of Providence, R. I., construct a practical portable telephone. embodying the hand receiver.

(482) The first long-distance telephone line is constructed, between Boston and Salem, Mass., a distance of sixteen miles.

(483) Vacuum-gap lightning arresters are experimented with on European telegraph lines.

(484) Sir William Preece visits America, and on his return to England introduces "sound" reading on Morse lines, and the quadruplex system of operation.

(*To be continued*)

MATERIALS HAVING INSULATING AND MECHANICAL PROPERTIES

An engineering data book has been made available on the general subject of laminated phenolic materials. The information contained in its forty pages is of particular value to engineers and mechanics engaged in the manufacture of radio receivers, transmitters and accessories. Copies may be procured by writing the Continental Diamond Fibre Co., Attention Nelson W. Sieber, Newark, Delaware.

▲

C. R. C. EXPANDS

In line with its extension of service to jobbers and service dealers, Central Radio Corporation, Beloit, Wis., announces the appointment of the following new representatives:

Gerber Sales Company, 94 Portland Street, Boston, Mass., covering Maine, Vermont, New Hampshire, Rhode Island and Connecticut.

Samuel K. Macdonald, 217 Riggs Bank Building, Washington, D. C., covering Maryland, Virginia, Delaware, Pennsylvania, New Jersey and Washington, D. C.

William T. McGary, 3800 N. Grand Ave., St. Louis, Missouri, covering the St. Louis territory.

▲

NEW RESISTOR REPLACEMENT GUIDE

The service engineering department of Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio, has just completed a new book of resistor replacement data for over 900 popular receivers. Much valuable general resistor servicing data are also included. An entirely new method of listing resistor data has been developed that greatly simplifies selection of the proper replacement value. Both resistance and wattage ratings are given for each unit.

Servicemen who have used this new system in tests before its adoption by the service engineering department, report that it speeds their work and eliminates the uncertainties frequently causing mistakes.

The Continental replacement resistor guide may be secured for $0.50 from any Continental jobber or from the factory. It is supplied at no extra cost with every Continental resistor kit.

▲

CHICAGO STUDIO OPENED BY WORLD BROADCASTING SYSTEM

The World Broadcasting System announces the opening of a production studio at 400 West Madison Street, Chicago. This studio is located on the 25th floor of the Daily News Building—well known in radio circles as Station WMAQ. This is the third in a coast-to-coast series opened by World Broadcasting System. The others are at New York and Hollywood. Equipment has been installed for recording transcriptions under Western Electric license. This method, known as Western Electric wide range noiseless recording is a recent development in the production of transcriptions. Over 170 broadcasting stations throughout the country have been equipped through Electric Research Products, Inc., with installations specially designed to broadcast the new discs. The field organization which services sound reproduction in moving picture theaters will service the radio stations.

A. J. Kendrick, president of Sound Studios, is directing the opening of the new Chicago plant. Mr. Kendrick will welcome visitors who are interested in the new facilities of radio as an advertising medium. He will be glad to show the new recording equipment in operation and to accord visitors an opportunity to listen to transcriptions of the new vertical wide range type.

▲

PACKING, GASKETS AND WASHERS

The Felt Products Manufacturing Company, 1508 Carroll Avenue, Chicago, has recently issued a very complete handbook on industrial packing materials. This interesting book not only contains descriptions and lists of uses for which each material is suited, but also actual samples of thirty-six different materials, for gaskets, washers, strips, etc.

▲

RESISTOR DATA

The series of loose-leaf data sheets issued by the Erie Resistor Corporation, Erie, Penna., are becoming deservedly popular among radio engineers. These data sheets contain dependable and useful technical information of permanent value.

▲

TUBE PARTS

Goat Radio Tube Parts, Inc., 33 Thirty-fifth St., Brooklyn, N. Y., announces a complete line of parts for modern tubes, including plates, collars, caps, getters, eyelets, discs, screens, shields, rivets, etc.

▲

MULTI-ELEMENT TUBES INCREASE SET EFFICIENCY

Modern radio tube construction, according to W. L. Krahl, chief engineer of the Arcturus Radio Tube Company, Newark, N. J., reverses the old adage that the simpler a device the more efficient it is.

Inversely, the more complex tubes have been made by the addition of an extra grid or cathode or other element, the more efficient they have become. And their improved effectiveness has been reflected in the increased efficiency of radio receivers.

"The early three-element filament tubes," continued Mr. Krahl, "were efficient as far as they went. But when a screen, grid or cathode was added, either individually or in combination, tube operation and resultant set performance were considerably improved.

"Now comes a new seven-prong tube which we have developed, embodying a filament, cathode, control grid, suppressor grid, screen grid and plate. All of these elements within one bulb result in one of the most versatile tubes ever made. By various connections, this new Arcturus tube can be used as a class A amplifier, triode driver-output tube, class B triode or a pentode output tube.

"Here is a definite example where a multielement tube, involving difficult manufacturing processes, results in improved performance of a radio receiver."

▲

ENLARGED QUARTERS FOR HYGRADE SYLVANIA

Announcement has been made by the Hygrade Sylvania Corporation that larger offices will be opened at 500 Fifth Avenue, New York, on January 1. The entire fiftieth floor has been leased and the work of laying out and furnishing the offices is going ahead.

For the present the following will make their offices in New York as of January 1: E. J. Poor, chairman of the board; B. G. Erskine, president; Walter E. Poor, vice-president; Stanley N. Abbott, Charles G. Pyle, H. P. Gilpin and P. S. Ellison. The main lamp sales offices will be at Salem, Mass., and the main tube sales offices at Emporium, Penn., as heretofore.

The Hygrade Sylvania Corporation is a result of a consolidation which took place in the spring of 1931 when the Hygrade Lamp Company, the Sylvania Products Company and the Nilco Lamps Works were brought together in one corporation. All of these individual companies had a history of highly successful and profitable operation over a period of from fifteen to thirty years. Since the consolidation, the company has been among the leaders in the radio tube industry.

▲

RADIO NOISE ELIMINATOR

The filterizer kit has been developed for radio set owners who have serious reception difficulties that are due to radio noises of unknown origin or to man-made static created by apparatus beyond the control of the individual broadcast listener. When the filterizer kit is correctly installed, it should enable anyone to obtain clear, interference-free radio reception.

The filterizer kit includes one antenna filterette RF-1; one a-c. line filter RF-2 and 75 feet of special filterized shielded leadin wire.

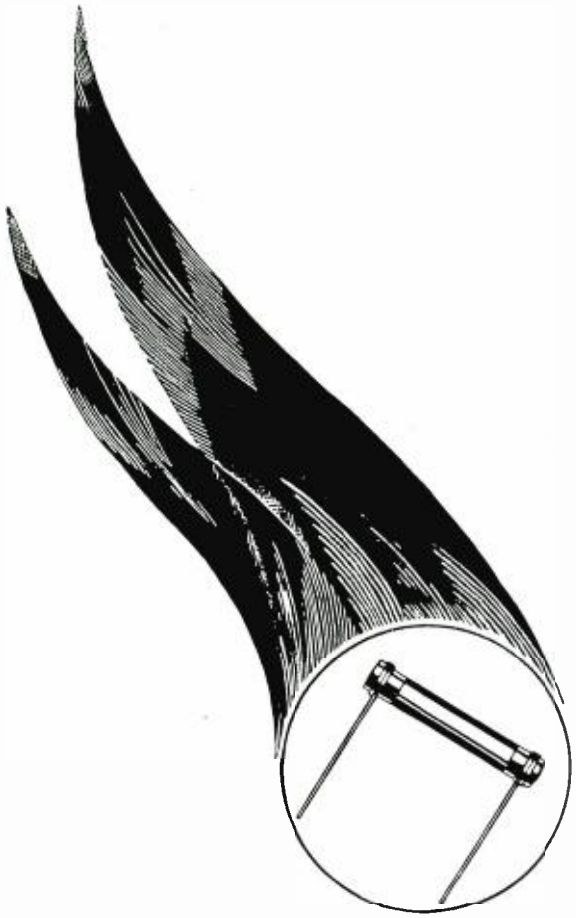
It is being marketed by the Newark Electric Co., 226 West Madison St., Chicago, Ill.

▲

WORLD'S FAIR AMATEUR RADIO COUNCIL

The Amateur Radio Exhibit Co., Not Inc., has been formed to negotiate all commercial arrangements for the World's Fair Radio Amateur Council, Not Inc., and has the whole-hearted cooperation of this body. Mr. Paul H. Davis, president of the Chicago Stock Exchange, is trustee of all funds collected for the radio amateur exhibits.

STRENGTHENED IN THE CRUCIBLE OF FLAME



STRENGTH: the secret of their popularity with manufacturers; experimenters and with service-men. No wonder they are strong . . for they are baked in a terrific heat . . . 2700 degrees. *Baptized with Fire!* As a result CENTRALAB Resistors will withstand many times the overload of the ordinary "composition" resistor.

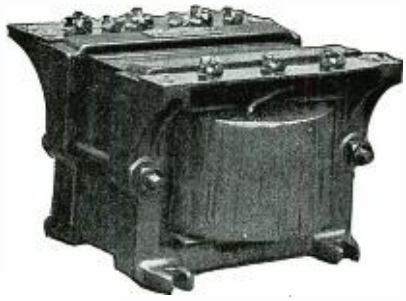
True to CENTRALAB tradition they are built for service and not for price alone.

CENTRAL RADIO LABORATORIES, MILWAUKEE

Centralab *RESISTORS*

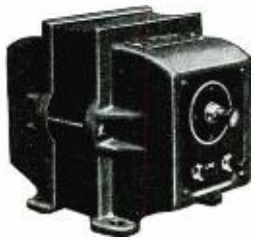
Plate-Supply Transformers

—Built to Meet Every Radio and Amplifier Application



ABOVE—*AmerTran Air-Cooled Plate Transformers are available for all requirements in amplifiers and small radio transmitters; sizes up to 5 kva; voltages up to 2000.*

LEFT—*AmerTran Oil-Immersed Plate Transformers for use in large broadcast transmitters are made in sizes from 5 to 500 kva., and for potentials up to 100,000 volts.*



RIGHT—*AmerTran Power Transformers for radio sets and amplifiers supply plate and filament voltages. Stock sizes for all standard tubes.*

With a background of thirty years' experience in supplying apparatus to meet the special requirements of the radio industry, AmerTran offers more than high quality transformers—we provide an experienced engineering staff to assist in solving your transformer problems.

Take Plate Transformers as an example: We have built hundreds of different types for every conceivable application, and we are developing new designs daily. Whether it be for use in a radio set, amplifier, amateur transmitter or 50 kw broadcasting station, we would welcome the opportunity of recommending equipment for your needs.

AMERICAN TRANSFORMER COMPANY

Transformer builders for over 31 years

178 EMMET ST. NEWARK, N. J.

AMERTRAN TRANSFORMERS

NEW DEVELOPMENTS OF THE MONTH

VACUUM PUMPS

A line of vacuum pumps, including a hand-driven duo-cycle pump for pressure and vacuum, a new Deka-micro-pump with pressure to twenty pounds per square inch and a vacuum to .005 atmosphere, and a new two-stage Wegner movement vacuum pump, is announced by the M. W. Welch Manufacturing Company, 1515 Sedgwick Avenue, Chicago, Ill. Descriptive literature will be mailed upon request to the company.

▲

ROTARY SNAP SWITCH

The Wirt Company, Germantown, Pa., announces a new rotary snap switch, single pole, single throw, No. 711. It is rated at 3 amperes, 125 volts. Simplicity of working parts and ease of mounting make

this switch especially applicable in radio receiver design and assembly.

▲

A GENERAL PURPOSE METER

A wide range of electrical measurements may be made with the general purpose meter No. 610, recently announced by the Shallcross Manufacturing Co., Collingdale, Penna. Uses and measurements cover the following ranges:

D-C. voltage ranges—5-50-250-1000 volts.
D-C. current ranges—1-10-100-1000 ma.
A-C. voltage ranges—5-50-250-1000 volts.

Resistance (d-c.) ranges—100-1000-10,000 ohms.

Resistance (a-c.-IMP) ranges—10,000-100,000-3,000,000 ohms.

Inductance (a-c.-IMP) ranges—1 to 100-1000-10,000 henrys.

Capacitance (a-c.-IMP) ranges—.001 to 0.1-1.0-10 μfd.

Output meter (Approx. 5,000 ohms)—5-50-250 volts a-c.

NEW ECONOMICAL PHOTOELECTRIC CELLS

Longer life and more uniform operation of a photoelectric cell are made possible by patented processes developed by the

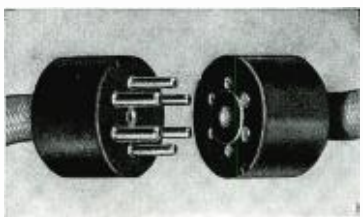
Continental Electric Company, of St. Charles, Illinois.

The Cetron photoelectric cell is available in types to operate in any sound head. New descriptive literature has just been prepared.

▲

NEW CINCH RADIO PLUG

Another addition to the line of Cinch radio products has been announced. It is a new radio plug which provides positive, dependable contact in both male and female types. The plugs are available in 4, 5 and 6-prong types. Easy assembling is provided by a neat, positive locking cap of moulded bakelite. Ample room for soldering is likewise provided. The female plugs are equipped with standard "floating



contacts." Prices are economical in keeping with present-day requirements. For samples and prices address the Cinch Manufacturing Corp., 2335 W. Van Buren St., Chicago, Illinois.

▲

A NEW CRYSTAL HOLDER

General Radio Company has recently introduced a new crystal holder, Type 580-A. The holder will accommodate crystals up to 1⅛ inches in diameter, and of thickness to 4 millimeters. Three blank retention plates of fabricated Bakelite laminated are provided so that the user may readily cut out the blanks to accommodate crystals of various shapes. Pressure on the top plate is provided by a flat spring, the tension of which is adjustable. Both electrodes are chromium plated. The case of the holder is of Bakelite molded.

ELECTROLYTIC CONDENSERS

A. M. Flechtheim & Co., Inc., 136 Liberty St., New York City, announce the addition of a complete line of dry electrolytic condensers rated at 500 volts d-c. peak in the inverted, upright and cardboard containers. Their new catalogue No. 25A listing a wide range of capacities will be sent to anyone requesting same. Two types

of tubular dry electrolytic condensers rated at 30 and 55 volts d-c. peak are also included in this catalogue.

▲

WIRE WOUND CONTROL

A new wire wound control herewith illustrated has been announced by Clarostat Manufacturing Company, Inc., 285-N. 6th St., Brooklyn, N. Y.

The resistance range is from 0 to 100,000 ohms. The body diameter is 1⅝ inches. the depth 1 inch. The shaft is insulated.

▲

FULL WAVE "B" ELIMINATOR

The Electronic Laboratories, Inc., Indianapolis, Ind., are marketing a "B" battery eliminator for use with automobile, police car, marine and other radio receivers.

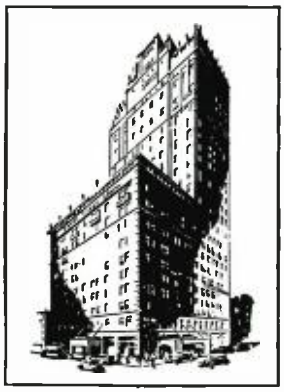
The features of the eliminator are: automatic load delay circuit which delays the application of the high voltage to the rectifier tube and to the radio set until all of the tubes in the radio set and the rectifier tube have reached normal temperature. Also, available for manufacturers or distributors, both types of rectifier tubes, the mercury vapor type and the high vacuum type.

The eliminator has an efficiency of 55 per cent or over and a regulation of approximately 85 per cent.

"AGLOW *with* FRIENDLINESS"

. . . succinctly expresses the atmosphere Hotel Fort Shelby has created and maintained through its vigorous and untiring devotion to the guests' welfare and comfort. ¶ The major percentage of Hotel Fort Shelby patronage embraces people who stop there every time they visit Detroit. They are genuinely appreciative of Fort Shelby's ability to administer to their needs courteously and efficiently. ¶ Hotel Fort Shelby's location in the heart of Detroit's shopping, theatre, financial, insurance and wholesale districts is a happy one; no other large hotel is so near the principal railway terminals, airports and steamship piers. 900 units . . . all equipped with servidor, private bath and circulating ice water. Rooms as low as $3.00 per day . . . suites $10.00 and upwards.

Motorists are relieved of their automobiles at the door without service charge. Write for free road map, and your copy of "Aglow with Friendliness," our unique and fascinating magazine.



HOTEL Fort Shelby

"AGLOW WITH FRIENDLINESS"

E. J. BRADWELL, Manager

DETROIT

. . . . . STRIDES

made by **AUTO-RADIO**

are matched by

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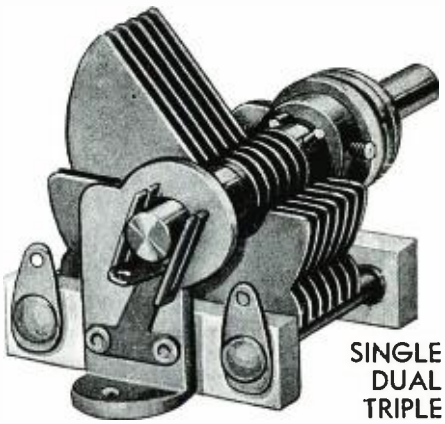

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MIDGET CONDENSERS

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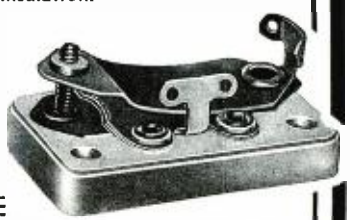
Over 3,000,000 used last year



ADJUSTABLE PADDING CONDENSERS

THE finest imported mica is used. In design and quality of raw materials—there is no equal to these efficient, trouble proof Hammarlund condensers. Seven years of experience, specializing in this type of equipment, permits us to offer this substantially improved line. Learn more about their technical advantages,—get our catalog!

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INDEX OF ADVERTISERS

Service!

In order to better serve manufacturers, and to provide for the growing jobbing demand for CRC sockets, additional CRC representatives have been appointed. Below is a complete list of present representatives and their territories:

Lew Bonn Company, 2504 University Ave., St. Paul, Minnesota.
Territory served: Minnesota, North Dakota, South Dakota.

George R. Clarke, 5551 Vancouver Ave., Detroit, Michigan.
Territory served: Michigan, Northwestern Ohio, Northern Indiana.

L. A. Dernier, 408 F. P. Fay Building, Los Angeles, California.
Territory served: California.

Gerber Sales Co., 94 Portland St., Boston, Massachusetts.
Territory served: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont.

L. H. Jackman, 2043 E. 77th St., Cleveland, Ohio.
Territory served: Cleveland.

R. C. James Co., 2319 Second Ave., Seattle, Washington.
Territory served: Oregon and Washington.

Samuel K. Macdonald, 217 Riggs Bank Building, Washington, D. C.
Territory served: Delaware, Maryland, New Jersey, Pennsylvania, Virginia, Washington, D. C.

William T. McGary, 3800 N. Grand Ave., St. Louis, Missouri.
Territory served: St. Louis, Missouri.

Murphy & Cota, 70 Spring St., N. W., Atlanta, Georgia.
Territory served: Alabama, Florida, Georgia, Louisiana, Mississippi, Tennessee, North Carolina, South Carolina.

Additional representatives are now in process of appointment.

CRC SOCKETS ARE MECHANICALLY AND ELECTRICALLY CORRECT!

CENTRAL RADIO CORPORATION
Beloit, Wisconsin

Unusual beauty at moderate cost
in this Bakelite Molded receiver case

Radio Receiver with Bakelite Molded case, made by International Radio Corp., Ann Arbor, Mich.

THIS midget portable radio receiver, completely housed in a duo-tone Bakelite Molded case, strikes a new note in set design. Provided in a range of lustrous colors it is exceedingly attractive.

The box-like compartment for receiver and speaker, with panel decoration on the front, is produced in a single molding operation, and the back panel in another. These parts with handsome Bakelite Molded control knobs to match, complete the entire case. Accurately formed and ready for assembly, they require no further finishing operations. The receiver ready for use weighs but five and one half pounds.

For the insulation parts of radio receivers Bakelite Materials are standard practice, and for exterior parts, where attractive appearance is so important, they possess many advantages. Bakelite engineers and laboratories always welcome opportunities to cooperate with manufacturers in advantageously adapting Bakelite Materials to their individual needs. We will also be glad to mail a copy of our illustrated Booklet 12M, "Bakelite Molded" to anyone interested.

BAKELITE CORPORATION, 247 Park Avenue, New York, N.Y. . . . . 43 East Ohio Street, Chicago, Ill.
BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Ontario, Canada

BAKELITE

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