JUNE, 1935

Radio Engineering

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
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- Testing and Measuring Equipment
- Television Apparatus
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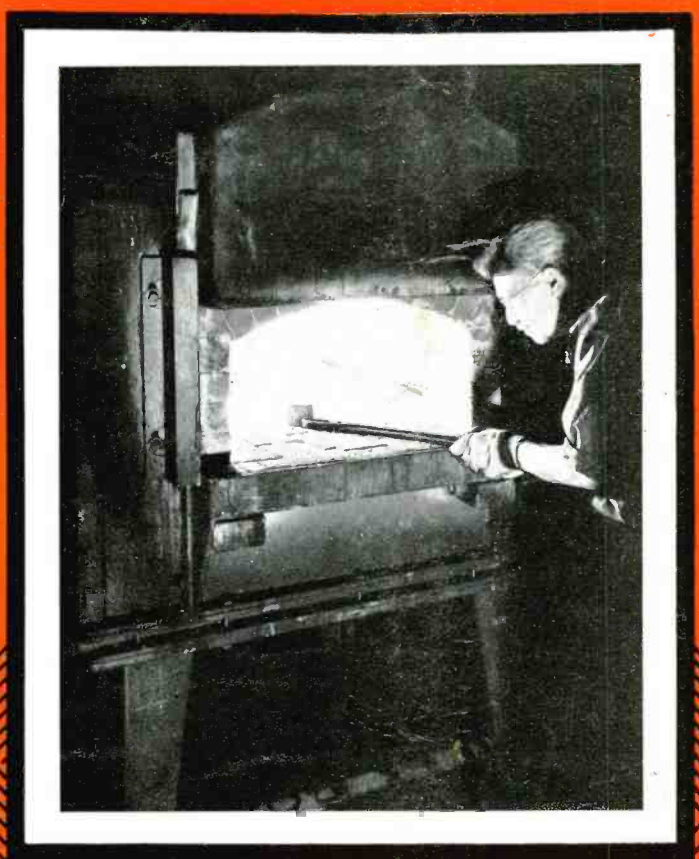
- Components
- Tubes
- Photocells



VOL. XV NO. 6

The Journal of the Radio and Allied Industries

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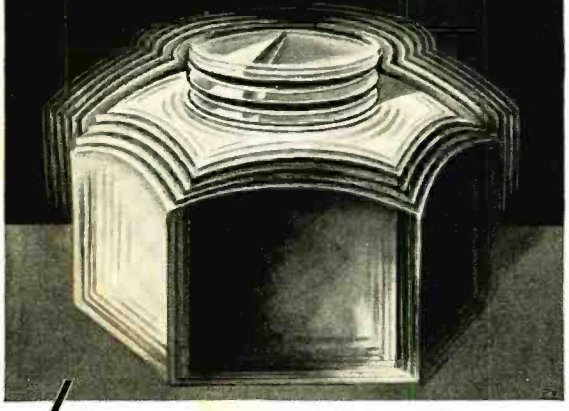

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VOL. XV NO. 6

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EDITORIAL

1936 RECEIVERS

THERE IS CONTAINED in this issue, in the "Notes and Comment" section, a number of recommendations with regard to the design of receivers for the coming year. Some of the recommendations may seem a bit far-fetched, since they refer more to engineering conjectures than to actual laboratory attainments. Besides, a few of the recommendations have bearing upon the transmitter, but these may be excused on the grounds that the problems of the transmission and reception of broadcast signals are interdependent.

Receiver design is not altogether a problem in engineering; it is also a problem in human relations and in economy. There are a number of really valuable features that could be put into effect immediately providing, first, there was the proper co-operation to carry through the efforts and, second, providing the additional features added to both transmitter and receiver were worth the candle from the viewpoint of cost in relation to subsequent gain.

The matter quite often boils down to a simple question: Should the field await the demand or create it? Possibly such features as increased volume range of broadcast transmitters and receivers can afford to await a more desirable time for introduction, yet our personal opinion is that this has been on ice much too long as it is. Will we await its practical, everyday use in Europe before bestirring ourselves over here, or will some enterprising group contrive to work it into the broadcasting structure before the year is out? Certainly, this feature harbors a very definite sales stimilus and it may prove to be the lever for raising the standard broadcast receiver back into the channel of popular demand.

Of more immediacy are the problems of: (1) Control action of broadcast and all-wave receivers; (2) selective characteristics; (3) sensitivity with relation to noise; and (4) convenience of operation.

The matter of control action is of special importance, just as it has been and still is in the automobile. To be of maximum value to the listener, the control action of circuits must be automatic, as the listener cannot be relied upon to properly handle manual controls other than those for tuning and volume. As matters stand, there is room for considerable improvement in avc, squelch circuits, and in the addition of automatic tuning correction, automatic frequency correction and automatic bass compensation. A very interesting and practical system of abc is featured in this issue.

Sooner or later, the selective characteristics of a good broadcast receiver may have to be flexible in nature and likewise automatically controlled. Heroic attempts have been made in this respect, but for some unaccountable reason, the advantages have either been lost sight of or it has been decided that the system was introduced prematurely. Yet it should be of distinct value in any receiver boasting high sensitivity and fidelity.

Improved signal-to-noise ratio is urgently needed. Although considerable progress has been made, through the use of well-designed pre-amplifiers, improved mixer-oscillator tubes, etc., little thought has been given to tuned antenna circuits. It has been maintained that this arrangement is impossible from a practical point of view, unless a secondary control is added to the receiver. A tuned antenna circuit is a feature of one of the more recent auto-radio receivers. In this instance, of course, the antenna characteristics were predictable, so the problem was not a particularly difficult one. In the case of home receivers, where the characteristics of the antenna cannot be predicted, the problem is more acute. Nevertheless, the solution may be found through some other channel. The advantages to be derived are certainly worth the effort.

KEEPING PACE

Already finding many useful applications in industry, "dag"★ Brand colloidal graphite is keeping abreast of modern development. ❖ Having played a part in the field of radio, this unique material is now being employed as an important constituent of certain cathode ray tubes. When coated on the interior of the glass envelopes, it serves as an efficient ray focusing anode material. ❖ In many instances silver is being replaced by colloidal graphite because it (1) is easier to apply; (2) is less expensive; (3) adheres equally well to all types of glass; (4) reduces light reflection, due to the black, matte surface formed. Technical Bulletin No. 191A, giving details concerning this application will be forwarded gratis on request.

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RADIO ENGINEERING

FOR JUNE, 1935

Automatic Bass Compensation

A Development of the Hazeltine Service Corporation

IT HAS LONG been known that the human ear becomes relatively insensitive to sounds of very low frequency when the sound intensity falls to low values.

FREQUENCY CHARACTERISTICS

When a musical program is being reproduced at an acoustic level nearly the same as that at the microphone, the reproduction is most natural if the characteristic of the electro-acoustic system is flat; i. e., if all the component frequencies are present in the reproduction in the same relative amplitude as in the original rendition. However, it is not normally desirable to have the reproduced sound as loud as the original; this is especially true when the reproduction is in a small living room as in the ordinary home reception of broadcast signals. When the volume level is reduced to a satisfactorily low value without altering the relative amplitudes of the various frequency components, it is found that the music sounds thin, as though there were a serious deficiency in the reproduction of the bass notes. Therefore, in order to produce the psychological effect of true tone balance at low levels, it is necessary to introduce frequency discrimination in the amplifier so that the actual bass response is much greater than that for higher frequencies.

Attempts have been made to achieve the desired result by connecting appropriate circuit elements so that the frequency characteristic of the amplifier varies in shape according to the setting of the audio-frequency volume-level control. While these methods result in an appreciable improvement over the performance of an uncompensated amplifier they are not entirely satisfactory because they do not normally introduce enough compensation and because the actual output of the amplifier may vary over a wide range with the fixed setting of the volume control, because of the normal variation of musical amplitude between pianissimo and fortissimo, lack of sufficiently flat avc, and variation from station to station in the average percentage of modulation.

The automatic bass compensation (abc) arrangement described in this article is intended to augment the low-frequency response relative to the response at higher frequencies whenever the volume level is low, regardless of whether the level is low because of low percentage modulation or because the volume-level control is set at a low value.

THE CIRCUIT

In Fig. 1 is shown an automatic bass compensation circuit which is capable of more compensation than will usually be required and which is not critical for any of the voltage or circuit constants involved.

Compensation is accomplished by having a supplementary amplifier which amplifies only the low frequencies, but which gives a gain several times that of the original amplifier. The gain of the supplementary amplifier is controlled by a separate avc system which is actuated by the signal level at the output of the main amplifier. Accordingly for loud signals the supplementary amplifier is biased beyond cut-off and the characteristic is that of the main amplifier alone; as the signal level is reduced, the bias on the supplementary amplifier is likewise reduced, allowing it to intro-

● DETAILS OF A RECENTLY DEVISED ABC CIRCUIT PROVIDING ADEQUATE LOW-FREQUENCY COMPENSATION ENTIRELY INDEPENDENT OF THE EFFECT OF VOLUME-CONTROL SETTINGS AND ALTERATIONS IN PERCENTAGE OF MODULATION OF RECEIVED SIGNALS

duce a greater amplification of the low frequencies than would be had with the main amplifier alone.

Referring again to Fig. 1, the main amplifier consists of the 55 tube triode section fed from the volume control through a .01-mfd condenser, resistance-capacity coupled to the input transformer which feeds the push-pull 56's, the latter in turn being transformer coupled to the push-pull output stage, which uses a pair of 2A3 tubes. The input transformer is resonant at about 55 cycles with the .06-mfd coupling condenser.

Two additional tubes, a 57 and a 55, supply the automatic bass compensation. The grid of the 57 is connected effectively in parallel with the grid of the 55 tube in the main amplifier. The plate circuit of the 57 is coupled by means of a tuned impedance, rather sharply resonant at 75 cycles, to the grid of the added 55 tube. This latter tube is used primarily as an impedance-matching device to enable the abc amplifier to feed effectively into the input transformer. The grid of the 55 tube is connected to a slider on the grid leak, called the "Bass Control" the adjustment of which controls the amount of compensation introduced at low output levels. The diodes of the 55 are connected to the plate of one of the 2A3's, thus securing the automatically varying bias to control the amount of compensation as the audio output of the amplifier varies. A switch is provided to short the grid of the extra 55 to ground when it is desired to cut out the abc system without disturbing the setting of the bass control.

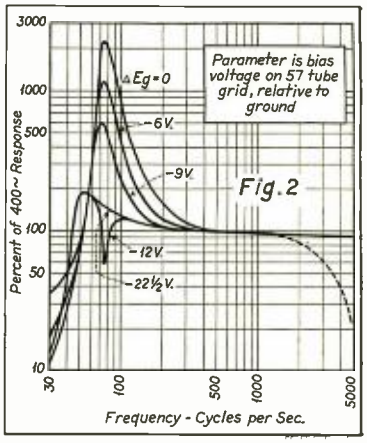
The diode leak resistance must be high enough so that it produces a negligible loading effect on the output circuit. The value of .005 mfd is used for the condenser which feeds the diode circuit. If this condenser is too small, the low notes will be accentuated too much when the output level is high, providing the musical passage contains few high notes. On the other hand, if this condenser is too large, the desired accentuation of the bass at low levels cannot be achieved because the bass notes themselves will excite the diode circuit too much.

At high outputs, a large negative bias voltage is built up at the diode plates of the second 55, and this voltage is transmitted through the filter network to the grid of the 57, rendering it inoperative. Under this condition the amplifier has a normal flat-frequency characteristic.

As the output decreases the negative voltage at the diodes decreases, until at a certain output level the bias on the 57 permits it to become operative. A further decrease in the output decreases the negative voltage at the diodes still further, until finally the point is reached where the supplementary amplifier is delivering maximum gain.

PERFORMANCE

The curves of Fig. 2 show the performance attainable when the bass control is set at maximum. This probably represents more compensation than is normally desirable, but of course this can be reduced to any desired amount by reducing the setting of the bass control.



Bass control at maximum resistance load. The dotted curve is the overall response with resistance load; solid curves are of a-f amplifier only.

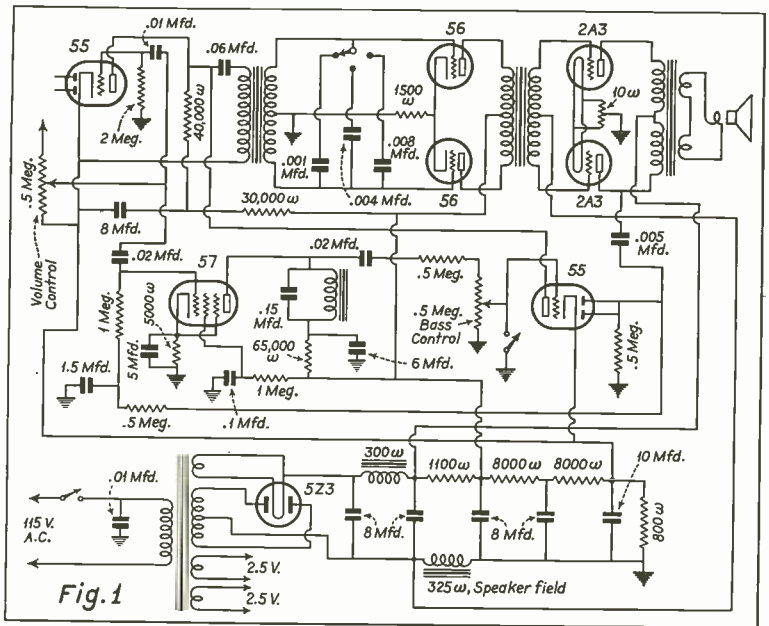
The sharp dip at 75 cycles which occurs with a bias of —12 volts is due to the fact that at this particular bias and frequency the output of the abc amplifier is opposite in phase and nearly equal in amplitude to the output of the original 55 tube. This effect is not perceptible during reception because the dip is so narrow in frequency coverage, and because the bias is constantly shifting up and down with the rapid changes in output level and hence does not linger at the critical value for an appreciable length of time. The effect can be eliminated, if desired, by using a tuned transformer instead of a choke in the abc amplifier and connecting the winding to get phase reversal. However, this is not believed to be of sufficient advantage to warrant the cost.

It is necessary that the tuned choke be mounted in such a position that its pickup of 60-cycle flux from the power transformer be a minimum.

If the "Bass Control" potentiometer is made available for the user to operate, the audio avc system must be so designed that for the maximum bass setting the rise of the low frequencies will be removed before the output system is overloaded.

In order to retain naturalness in speech reproduction, it is necessary that the low-frequency resonant circuit be quite sharp. With full compensation the output at 200 cycles should be less than twice the 400-cycle output voltage.

It is important that the natural frequency of the loudspeaker cone be different from the resonant frequency of the tuned coupling circuit in order to avoid "hanging on" to low notes. The cabinet must be very rigidly constructed to minimize rattles with intense low-frequency acoustic excitation.



Circuit diagram of audio-frequency amplifier for a broadcast receiver, containing an automatic bass compensation system. The functions of the 57 and 55 abc tubes may be performed by a single 6F7 with slight circuit revisions.

MODERN PRODUCTION

By J. B. NEALEY
AMERICAN GAS ASSOCIATION

THE CHASSIS for Philco radio receivers are made in an immense division with rows of giant mechanical presses fitted with heavy steel dies and are fed heavy steel sheets from which the chassis are stamped. This requires three presses and four operations for one model as follows: (1) Blank and Perforate; (2) Perforate; (3) Fold; (4) Spot weld corners. For one model there are two sets of dies in one press for perforating and folding respectively.

SAFETY MEASURES

None of these presses can be set in motion unless both the operator's hands are engaged with two separate control buttons. If he releases one or the other of these, while the press is in motion, a hydraulically-operated brake immediately stops the press, assuring absolute safety to the operator. Other parts, such as, condensers, loudspeaker frames, etc., are made here while long rows of screw automatics turn out many different items, almost with the speed of a machine gun. All tools, dies, fixtures, etc., used here are made in a separate department and these are heat treated in a battery of gas-fired furnaces. Most of the parts from the press division are finished by plating, lacquering or japanning and therefore must be thoroughly washed. This is accomplished in a gas-heated washing machine 30 feet long with a continuous conveyor which carries the parts successively through sprays of hot cleaning solution and a drying compartment. The solution is heated with gas burners and sprayed with pumps and nozzles and gas burners supply heat to the drying compartment.

Spraying lacquer on speaker grilles.

Washing parts in automatic and continuous washing machine.

LACQUERING

Lacquer is sprayed onto various parts such as transformer and other housings, control units, etc., in a long line of spray booths and these are then placed on trays, suspended from a double-chain loop conveyor in a gas oven for drying. This oven is of sheet steel, insulated and is 8 x 10 x 25 ft long. Heat is supplied by six atmospheric gas burners with venturi tube mixers and a temerature of 275° F is maintained with an automatic temperature control actuating an on and off valve in the gas supply line to the burners. While lacquer air dries very nicely, heating speeds this process as the parts are in the oven only 55 minutes.

WINDING OPERATIONS

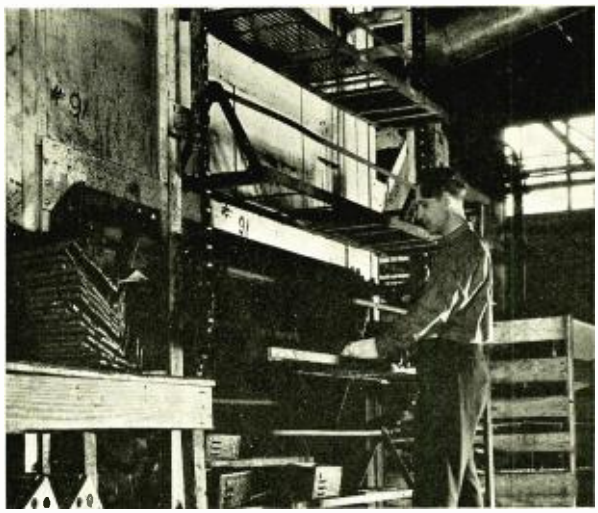
Another division presents to the eye unbelievably long vistas of benches covered with many types of small machines manned by hundreds and hundreds of workers; and yet quietness, speed of production, the best of sanitary conditions and a maximum of light, reveal an organization control unsurpassed. One great section is devoted to coil, transformer, and condenser winding. Small motor-driven coilers, that can be set to stop automatically at any number of turns, and equipped with tension devices, are employed. The i-f transformer coils are wound simultaneously on one bobbin—when wound, stickers are pasted on to keep them from unwinding. Roll gummed paper 1¼ in. wide is fed to a little machine that slits, wets and cuts it up into stickers at the rate of 24,000 per hour. The paper is pulled by a pair of rollers and the proper tension is applied by another pair, the upper being of rubber and the lower of steel.

CONVEYOR SYSTEM

In one big assembly division there are three parallel conveyors 200 feet long

(*Continued on page* 18)

Mass drying of lacquered parts in a mechanical oven.



THE CATHODE-RAY

PART I

SUMMARY: Advantages and general applications of the cathode-ray type of oscillograph are stated. A brief historical sketch of the cathode-ray tube is included. The latest three-inch and five-inch tubes, types 906-908 and 905-907, respectively, are discussed. A portable instrument utilizing a three-inch 906 type tube is described and used as a basis for discussing power supply, tube mounting, vertical and horizontal amplifiers and linear timing axis oscillator. Three series of photographs are shown which illustrate the use of the instrument for: Adjusting auto vibrators correctly, studying coupled-circuit theory, aligning radio receivers and analyzing a modulated carrier. Subsequent articles will deal with the application of the instrument in various fields.

INTRODUCTION

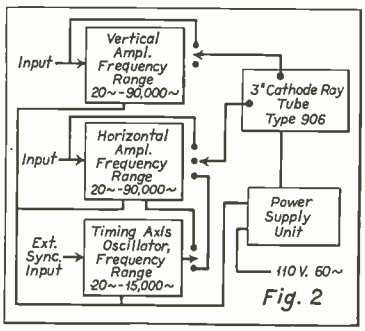
The cathode-ray oscillograph is a device for accurately observing, measuring, or recording the instantaneous effects of changes in electrical circuit parameters. One or more effects, which may occur in only a few micro-seconds or after several seconds, as a result of varying such parameters as current, voltage, inductance, capacity, resistance, impedance, etc., is indicated as an image on the screen of a cathode-ray tube. The tube is essentially an inertialess electron beam which may be deflected either vertically or horizontally, its motion

Fig. 1. The 905 and 906 cathode-ray tubes, showing comparative sizes.

being traced on a fluorescent screen which converts the electron energy into visible light. Its freedom from inertia, allowing the observation or recording of very rapid changes of current or voltage without appreciable distortion, and its high input impedance, which permits measurements to be made without disturbing circuit conditions, give this type of oscillograph two decided advantages over all other types of electrical instruments. Furthermore, it is not limited primarily to electrical measurements but may also be used to analyze the relation between a number of other physical effects by supplying externally adequate conversion equipment. It may be applied, therefore, economically and advantageously in many fields.

GENERAL APPLICATIONS

In the educational field the instrument will find increasing use for demonstrating the theory of coupled circuits, filter networks and ac meshes at both low and high frequencies. In the communications field it may be used to record and analyze static pulses, telegraph signals, modulated carriers and entire transmitting and receiving networks, including wave propagation. It provides the service engineer with the only satisfactory means of analyzing certain modern receivers and other equipment. In manufacturing plants it may be applied to reduce the cost of test and reject analysis operations and in many cases will permit higher standards to be maintained. It may be used to excellent advantage in development laboratories for obtaining valuable information which, hitherto has remained hidden or has been only partly disclosed by means of elaborate, costly equipment requiring considerable time to operate. It will



Block diagram of the five essential units comprising the portable oscillograph.

Fig. 2

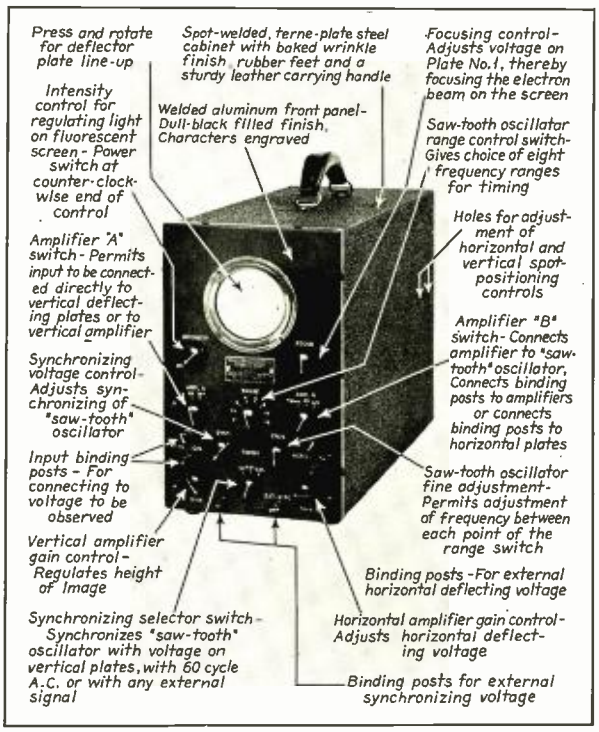


Fig. 3. External view of the portable cathode-ray oscillograph described in the text.

OSCILLOGRAPH

By WILLIAM F. DIEHL
Engineering Department
RCA MANUFACTURING CO., Inc.

enable the amateur to monitor modulation, to check his transmitter for distortion and to examine phase shift and other undesirable conditions in speech-input equipment. Through its use, the experimenter will enjoy many delightful and profitable hours and save considerable time in the solution of his more difficult problems. In the medical field it may be used in connection with the study of the heart and nerves. The automobile, aviation and associated industries will profit by applying it to studies of vibration, noise, engine pressure and ignition. Public service companies will find it invaluable in connection with waveform studies of alternating-current machinery, rectifiers, circuit breakers, relays, fuses, etc. Applications of this type oscillograph would fill a good size volume. Some of the more important ones will be treated in detail in subsequent articles.

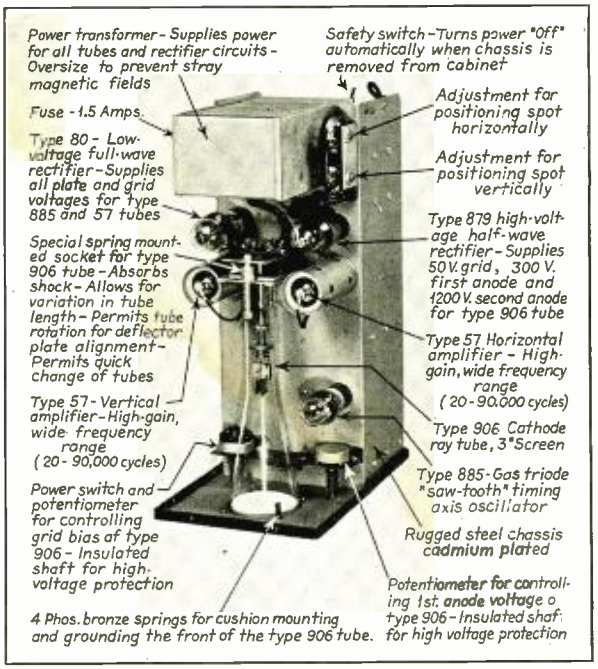


Fig. 4. Top view of the portable oscillograph chassis.

HISTORICAL[1]

While Hess in France first suggested the cathode ray for tracing curves of electrical phenomena in 1894, it was not until three years later, 1897, that Professor Ferdinand Braun in Germany designed and applied the first cathode-ray oscillograph to electrical measurements, and Sir J. J. Thompson in England proved that cathode rays were negatively-charged particles and used a Braun tube to measure their velocity and to determine the ratio of the charge to the mass (e/m). The Braun tube and also designs of many other investigators which followed used a cold cathode, a gas for focusing, required a high anode potential (10,000 to 100,000 volts) and complicated associated equipment. Initial and operation costs were great and voltage supplies were cumbersome so that the use of this device was limited to special physical and research laboratories. In 1905 Wehnelt incorporated a hot cathode (for supplying a copious stream of electrons) thereby reducing the required anode voltage to as low as 220 volts dc. The Wehnelt tube, however, also used a gas for focusing which limited its filament life to a few hours. Experimental type Wehnelt tubes were used where simplicity of equipment compensated to a certain degree short filament life.

In 1922 considerable new interest was stimulated in the cathode-ray type of oscillograph due to the appearance on the market of the first commercial hot-cathode, low-voltage, gas-focusing tube. This tube, the Western Electric type 224, incorporated a metal disc between the cathode and anode which reduced the bombardment of the cathode by the positive ions and increased the filament life to a few hundred hours. The type 224 tube, therefore expanded the field for cathode-ray devices and in the years following this tube was used in many laboratories.

It was not until recently, however, that major advancements in tube engineering and manufacturing processes have made possible several new types of cathode-ray tubes, two of which are

[1]Journal I.E.E., British: A. B. Wood, Nov., 1925.

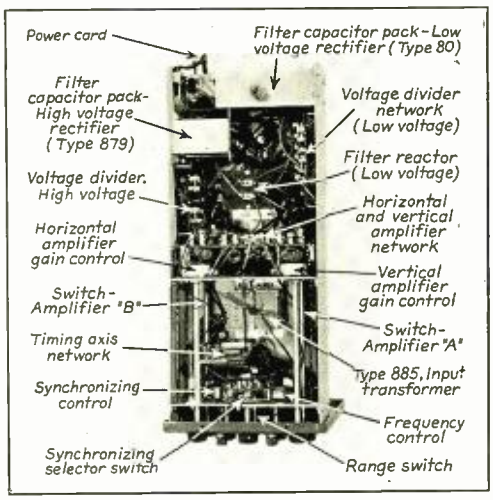
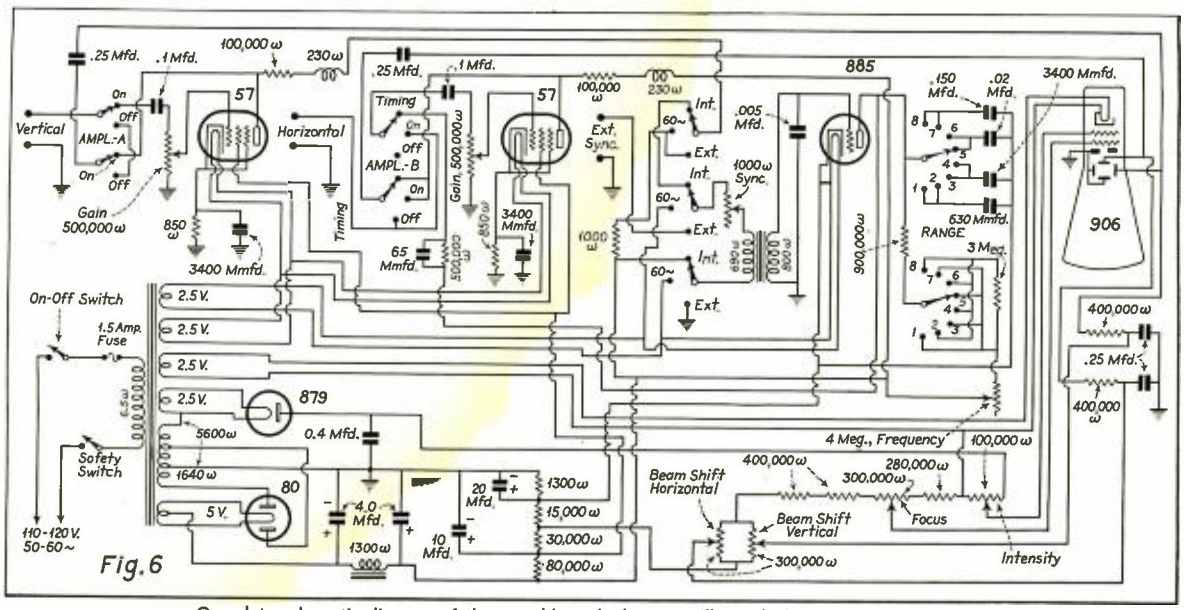


Fig. 5. Bottom view of the portable oscillograph chassis.



Complete schematic diagram of the portable cathode-ray oscillograph shown in Figs. 3, 4 and 5.

illustrated in Fig. 1. These tubes have been described in detail in past issues of RADIO ENGINEERING and are the high-vacuum electrostatic-focusing type. They are available with both standard screen and short-persistence screen. The spot size is extremely small, resulting in good definition and the absence of gas has made possible a long life approximating that of ordinary receiver tubes. This excellent performance, coupled with the exceedingly low price of some of the types, has further expanded the field for cathode-ray devices and has placed this type of oscillograph within the means of the experimenter, the student, the amateur and the radio service engineer.

FACTORS EFFECTING THE CHOICE OF A TUBE

Either the standard type 906 (three-inch tube) or type 905 (five-inch tube) should be selected for general oscillographic use. With either tube a brilliant luminous spot, having a greenish hue, is obtained which is suitable for the observation and photography of recurrent and transient electrical phenomena.

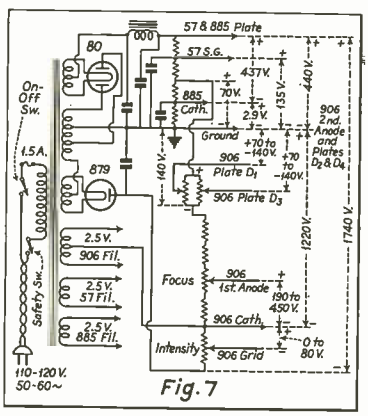
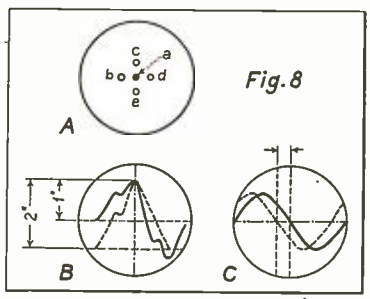


Diagram of the complete power-supply network.

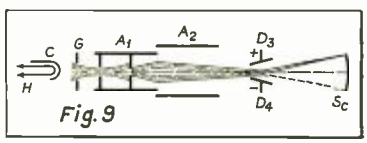


(A) Position of spot indicated by b, c, d or e would be normal (without controls) due to commercial tolerance or effect of earth's magnetic field, while a shows spot adjusted to exact center by means of the controls.

(B) Heavy line shows a full cycle, while the dotted line shows the horizontal axis moved down (by means of vertical spot control) to gain twice the effective height of image.

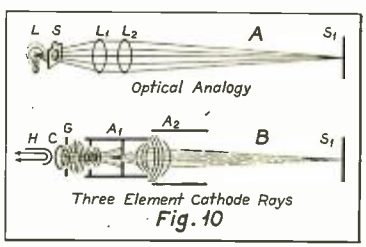
(C) Heavy line shows complete cycle covering full screen when horizontal spot control is adjusted for spot in center of screen. Dotted curve shows incomplete image if no spot control was used.

For oscillograph applications with external mechanical timing, the companion tubes, type 908 (three-inch) and type 907 (five-inch) should be used. With the exception of screen persistence and color of spot, the characteristics of these tubes are approximately the same as those of their equivalent types with the same screen size. With either of these tubes, a brilliant luminous spot having a bluish hue, with a duration of less than 25 micro-seconds, is obtained. The extremely short persistence of the actinic image makes them especially suited for applications where it is desirable to supply timing by mechanical means external to the tube. Such means may be a recording film moving at constant speed or a system of mirrors rotated at a uniform speed.

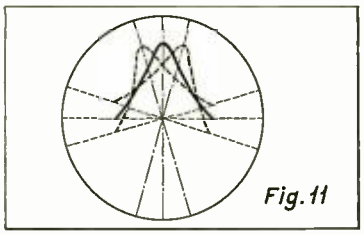


Deflection in one direction.

While the five-inch tube (types 905 and 907) has a larger screen and separate terminals for each deflecting plate, these advantages are in many instances compensated for in the three-inch tube (types 906 and 908) by the much lower cost of not only the tube but also of the associated equipment required. In general, therefore, the five-inch tube finds wider application in fixed laboratory set-ups where specific needs dictate its use and where its advantages are worth



Focusing cathode rays.

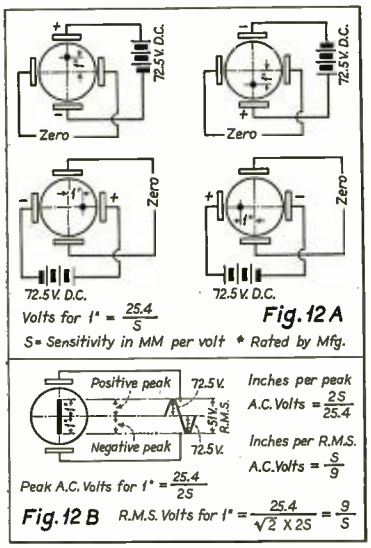


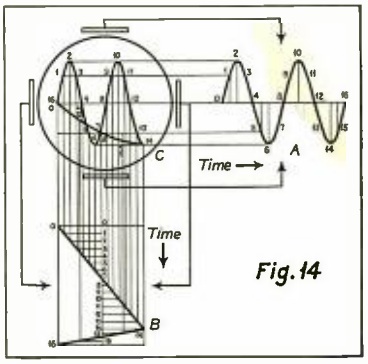
Heavy line indicates image when tube is adjusted correctly in socket. Dotted lines indicate possibilities if adjustable socket is not used.

the extra cost. On the other hand, the three-inch tube offers many advantages in portable equipment where space, weight, and cost are important factors.

Based on equivalent performance, spot size, sensitivity, frequency range, etc., a complete oscillograph employing a five-inch tube will be much more costly than one using a three-inch tube. The power supply for the five-inch tube, will require a larger power transformer, with added shielding problems; the filters require higher voltage capacitors; the size of the components and the additional tube length require a larger chassis, necessitating extra material. Multi-tube amplifiers will have to be resorted to instead of a single-stage unit for equivalent sensitivity.

With these considerations in mind the standard three-inch 906 tube was selected as a basis of design for a portable oscillograph. This instrument incorporates many new features required for universal application and is designated as type TMV-122-B.



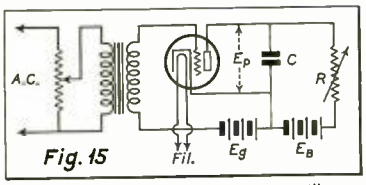


Frequency ratio 1:2 voltages A and B in phase: This shows a sine-wave voltage A applied to the vertical deflecting plates and a saw-tooth wave B applied to the horizontal deflecting plates. Wave B is linear from 0 to 14; hence, on the pattern C, the sine wave A appears undistorted. During the interval 14 to 16, the trace returns to the starting point 16.

Illustrating deflection in the cathode-ray tube.

THE PORTABLE OSCILLOGRAPH

The 122-B, a complete portable instrument, operates entirely from an ac source of 110-120 volts, 50-60 cycle current, consumes 50 watts, and weighs approximately thirty-eight pounds. It incorporates the five essential units illustrated in Fig. 2. These units are all mounted on a single rugged steel chassis which is readily removable from, and protected by, a steel cabinet 7¼ inches wide by 14 inches high by 17¾ inches deep. A front panel, on which are located ten of the twelve operating controls, the cathode-ray screen bezel, and the three sets of input terminals, is secured to this chassis. Fig. 3 illustrates the external appearance of the instrument, describes the functions of the operating controls, and explains certain other details. Fig. 4 illustrates the top of the chassis and describes the functions



Circuit of the linear timing axis oscillator.

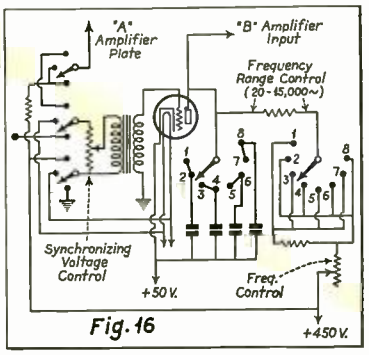
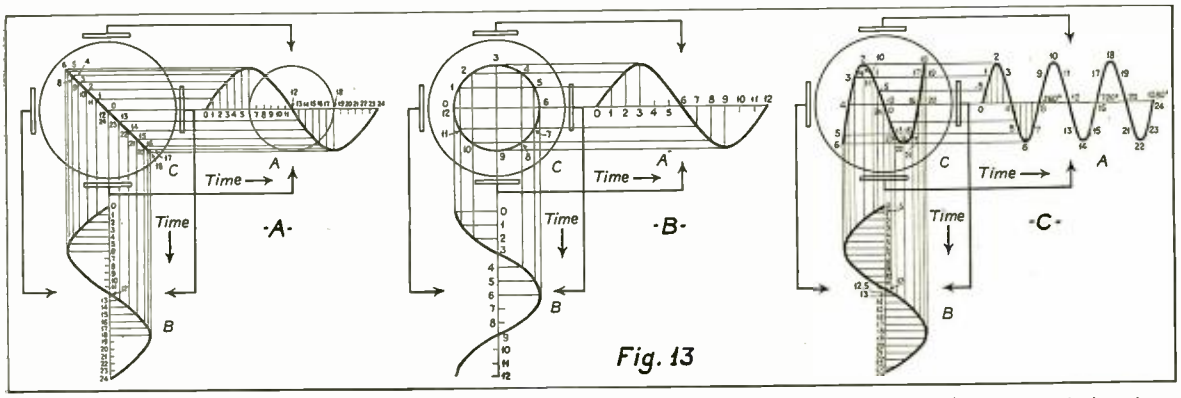


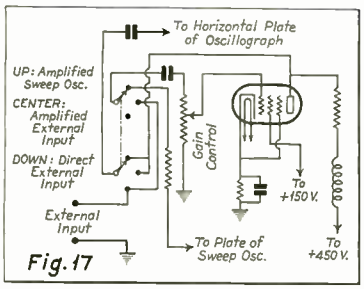
Diagram of the timing circuit. With synchronizing switch at left in upper position, synchronization from "A" amplifier; center position, synchronization from 60 cycles; lower position, synchronization externally.



(A) Frequency ratio 1:1 voltages A and B in phase: C is the figure obtained on the screen when sine-wave voltage B is applied to the horizontal deflecting plates, and an identical voltage A is applied to the vertical deflecting plates.

(B) Frequency ratio 1:1 voltages A and B 90° out of phase: Circle C is the resultant figure obtained on the screen when a sine-wave voltage A is applied to the vertical deflecting plates and an identical voltage B is applied to the horizontal deflecting plates. This figure differs from (A) only in that the voltage B leads the voltage A by 90°.

(C) Frequency ratio 1:3 voltages A and B in phase: Pattern C is the resultant figure when a voltage B is applied to the horizontal deflecting plates and a voltage A whose frequency is three times that of B, is applied to the vertical deflecting plates. In the pattern C, peak 10 is directly behind peak 2 and peak 18 is at the right.



Circuit of the horizontal amplifier. Voltage gain, 75; frequency range, 20 to 90,000 cycles.

of the various components which are symmetrically mounted thereon. Fig. 5 illustrates those components which are mounted on the bottom of the chassis and describes their function. Fig. 6 is the schematic wiring diagram which includes the circuit constants.

POWER SUPPLY

Fig. 7 shows the equivalent network of the power-supply unit, indicates the various voltage relations, and explains the means of obtaining a positive or negative deflector plate polarization voltage for positioning the spot on the screen. Fig. 8 clearly indicates the advantages of spot-locating controls.

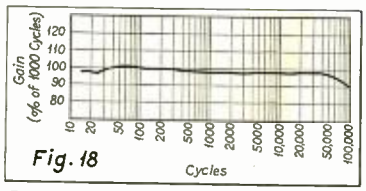
CATHODE-RAY TUBE AND MOUNTING

The 906, illustrated in Fig. 9, consists of an "electron-gun," for producing an electron beam, a pair of plates for deflecting the beam vertically, a second pair of plates for deflecting it horizontally and a fluorescent screen for converting the energy of the electrons into a spot of visible light. These elements are enclosed, by a glass bulb of special form, in a gas-tight space which represents the highest vacuum that is practical to obtain. The electron-gun comprises an indirectly-heated cathode for supplying electrons, a grid for controlling the quantity of electrons and two anodes for accelerating and focusing them. Fig. 10 illustrates the action of the electron-gun, the theory of which has been published by I. Maloff, and D. W. Epstein, while Fig. 11 indicates the advantages of an adustable socket in correctly aligning images.

DEFLECTION

A dc potential applied directly to either pair of deflecting plates will cause the beam to move either vertically or horizontally, as the case may be, and the position of the spot on the screen will depend on both the magnitude and polarity of the dc as illustrated in Fig. 12-A.

When ac is applied to the deflecting plates, the spot, instead of being stationary, moves at a non-uniform rate in accordance with the frequency and waveform of the ac. If the frequency



Frequency characteristic of the horizontal amplifier used in the portable cathode-ray oscillograph.

is greater than 10 cycles per second, due to the persistence of vision, a solid line appears on the screen, as illustrated in Fig. 12-B.

When ac is applied to both sets of deflecting plates simultaneously, a Lissajous figure appears on the screen, the form of which is a function of the frequency, amplitude, phase and waveform of inputs, as illustrated in Fig. 13. A thorough knowledge of Lissajous figures is important in connection with certain applications of the oscillograph and such figures will be treated in detail in a subsequent article. For most applications we are interested in obtaining an image of the true ac waveform applied to the vertical plates. This can only be obtained when the voltage applied to the horizontal plates is of such waveform as to cause the spot to move at a uniform rate across the screen and then to snap instantly back to the starting point. A saw-tooth wave, as illustrated in Fig. 14, which may be obtained from a linear timing axis oscillator, will meet these requirements.

LINEAR TIMING AXIS OSCILLATOR

While there are several methods of generating the required saw-tooth, the method illustrated in Fig. 15 seems to offer certain advantages and has been resorted to in the case of the 122-B instrument. In this case a condenser "C" is charged to a potential E_p through a resistor "R" from a voltage source E_b. The potential E_p is applied to the plate of an 885 gas triode, the value of this potential E_p being a substan-

Fig. 19. Waveform of properly adjusted auto vibrator.

Fig. 20. Waveform of auto vibrator with unequal air gaps.

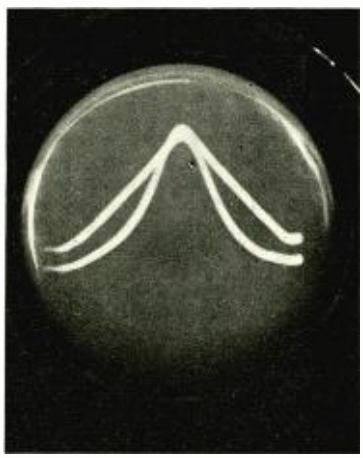


Fig. 21. The i-f curves of receiver misaligned but on frequency.

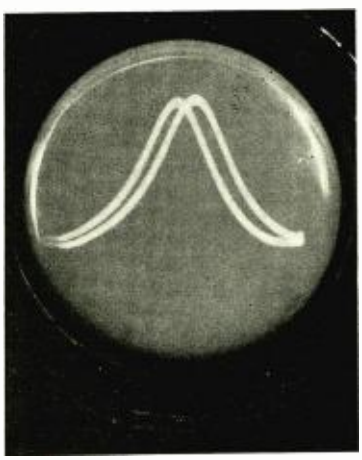


Fig. 22. The i-f curves of receiver properly aligned but off frequency.

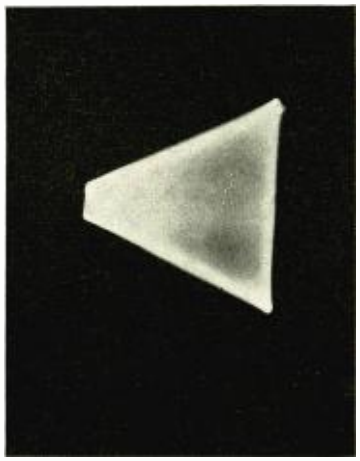


Fig. 23. Trapezoid of carrier with 75% modulation.

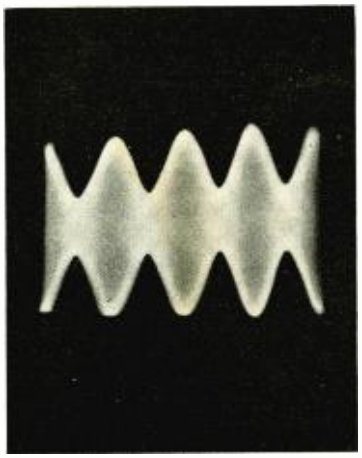


Fig. 24. A 60,000-cycle carrier modulated at 400 cycles, 50% modulation.

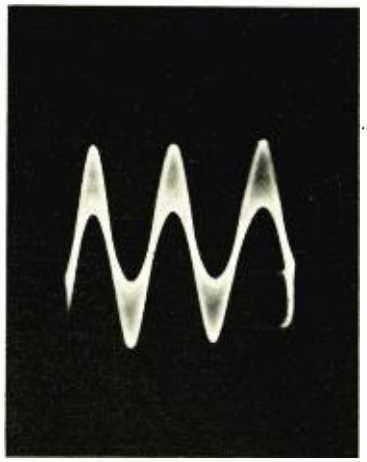


Fig. 25. A 50,000-cycle carrier modulated 50% at 400 cycles with timing axis oscillator set to 16,600 cycles.

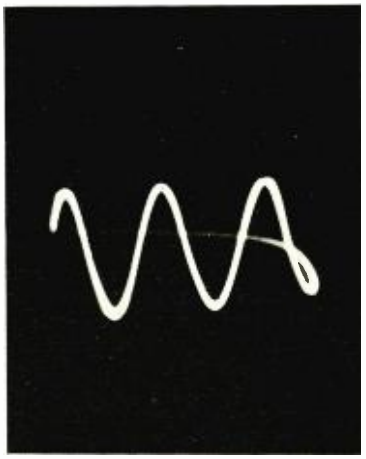


Fig. 26. A 50,000-cycle unmodulated carrier, illustrating the range of the timing axis oscillator.

tially linear function of time when the ratio E_b/E_p is very large. The 885 has a fixed dc bias on the grid which causes the gas in the tube to ionize the instant the plate voltage reaches the value E_p. The condenser is then discharged so that E_p instantly drops to zero. After the condenser has discharged, the grid loses control and a new charging period starts. The number of periods or frequency being equal to 1/t where t is the time required to charge the condenser to the value E_p. Since the time t is a function of E_b, R, E_p and C, a wide continuously variable frequency range can be obtained by selecting suitable values of C and R, since E_b is a constant and E_p has been fixed constant by the proper dc bias on the grid of the 885. It is to be noted that if the dc bias on the 885 is changed, the value of the plate potential E_p, at which condenser discharge occurs, will also be changed and as a result the frequency will be modified to a new value. When an ac potential is applied to the grid of the 885, the plate potential E_p is changed to a value which makes the timing axis oscillator frequency equal to the frequency of the wave applied to the grid of the 885 and the two are then synchronized. When the frequency of the timing axis oscillator is equal to or a sub-multiple of the frequency of the wave under observation, the image will remain stationary on the screen. The grid action outlined above provides a suitable method of synchronizing two waves when one or both are drifting. In this case, a small portion of the voltage of the wave under observation is applied to the grid of the 885. In like manner, synchronization can be obtained from 60 cycles or from an external source through the agency of a switch, as shown in Fig. 16.

In the circuit described above, the linearity is obtained at a sacrifice of output and the required output is regained by using an amplifier with sufficient frequency range to be linear, not only with respect to the fundamental frequency of the timing axis oscillator but also to the higher harmonics of the saw-tooth wave. In this instrument, the horizontal amplifier is linear from 20 cycles to 90,000 cycles, which takes care of the sixth harmonic of the highest frequency (15,000 cycles) of the timing axis oscillator.

HORIZONTAL AMPLIFIER

The circuit of the horizontal amplifier is illustrated in Fig. 17, while the frequency characteristic is shown in Fig. 18. The switch "S" permits the amplifier to be connected to the timing axis oscillator output, to the horizontal input terminals, or to be disconnected so as to permit observation of the phenomena at frequencies above 90 kc.

The horizontal amplifier increases the sensitivity so that only 0.50 volt rms is required for one-inch deflection in the frequency range of 20,000 cycles to 90,000 cycles, instead of 25.0 volts rms which is required for frequencies above 90,000 cycles and for low frequencies when the amplifier is disconnected. The gain control allows the wave to be spread out which is a desirable advantage in analysis work.

PHOTOGRAPHY

While the 908 tube will give better results for photographing screen images with moving film, for ordinary still photography the standard 906 tube should be used. The photographs of various 906 screen images, as illustrated in Figs. 19 to 26, inclusive, were taken in daylight with an ordinary camera, f/4.5 lens, extension bellows, verichrome film and a one-second exposure. Excellent definition of extremely fine line waveform pictures can be obtained by using an f/3.5 lens and approximately 1/25 of a second exposure.

Fig. 19 illustrates the waveform of an auto vibrator properly adjusted, while Fig. 20 is the same vibrator showing unequal air gaps. Fig. 21 is the i-f curves showing receiver unsymmetrically aligned but on frequency. The usual output meter would not indicate this asymmetry. Fig. 22 was taken with the same receiver symmetrically aligned but off frequency. Fig. 23 shows the familiar trapezoid of a modulated carrier with 75 percent modulation. Fig. 24 shows a 60,000-cycle carrier modulated at 400 cycles, the percentage modulation being 50. The equal distance between peaks indicates the linearity of the timing axis. Fig. 25 shows a 50,000-cycle carrier modulated 50 percent at 400 cycles, the timing axis oscillator being set to 16,600 cycles. Fig. 26 shows a 50,000-cycle unmodulated carrier and illustrates the range of the timing axis oscillator.

(*To be continued*)

Radio Industry Review

CONTINUED GAINS RECORDED FOR SALES OF RADIO SETS

NEW DESIGNS and improvements, augmented by the most entertaining programs that broadcasting companies ever have devised, are the leading factors which have caused an extension of the gains made by the radio industry last year. Perfection of the short-wave sets and progress made in the development of radios for motor-cars forced some manufacturers to increase their output from 75 to 300 percent above that for the first quarter of 1934. Sales in nearly all parts of the country have expanded, the increases running all the way from 15 to 70 percent, in spite of the fact that demand generally during the opening months of the year usually is nearly one-third less than that experienced during the third and fourth quarters.

A particularly encouraging phase of this year's sales has been the higher profit margin obtained on household sets, because of the trend toward the larger and more expensive models. Interest in the single-wavelength radio is waning, and many distributors are stocking only the long- and short-wave combination sets, and are increasing the proportion of their inventories represented by units ranging from $300 to $1,000. New all-time peaks for net work advertising sales have been touched this year, and profits of some of the leading concerns for the first quarter were the largest since 1930, with the exception of the final quarter of 1934. While no early developments are expected, much interest is being taken in the experimental work on commercial television, according to a survey of the radio industry which has just been completed by Dun & Bradstreet, Inc.

SALES ABOVE LAST YEAR'S

Following increases of 50 to 100 percent in sales of radios in 1934, when compared with the 1933 figures, the expansion of demand has been extended thus far in the current year. Dollar sales in most parts of the country averaged 15 to 50 percent larger than during the first four months of 1934. In fact, distribution has gained steadily since last fall, with much of the increased volume attributed largely to the urge to replace old and obsolete models with modern short-wave sets and to equip automobiles. The introduction of all-wave sets, designed for use with batteries in sections not electrified, has created considerable interest among farmers, and sales in rural districts during the first two months of this year nearly equalled the total for the entire twelve months of 1934.

The medium-priced models constitute the bulk of the sales, but there has been a decided shift since last summer to the more elaborate console units. In fact, now that earning power has improved, the desire is more marked to own a real article of furniture rather than just a midget set. This year the radio is playing two rôles, one being entertainment and the other decoration. In many instances, the latter has assumed paramount importance with the former, after the years of rigid economy, which forced buyers into the lowest price ranges.

SHORT-WAVE SETS LEADING

The phenomenal increase in radio sales this year is attributed to the greater demand for foreign reception, which has made every owner of the long-wave set a prospect for either the short-wave unit or a combination of the two. As manufacturers have succeeded in combining short-wave reception with standard broadcasting, at only a slight additional cost, fully 80 to 90 percent of the radio purchases are of this type. In the nationally-advertised sets, the best-selling items are the console models with foreign bands, and in this field approximately 60 to 85 percent of the total is accounted for by short-wave sets. In the popular-priced grades, the short-wave models make up 75 to 95 percent of the total.

Although sales of automobile radios in 1934 established an all-time high, the increase over that record thus far this year has ranged from 20 to 40 percent, with the gain in some districts as high as 75 percent. During the first four months of the current year, sales of automobile sets made up 10 to 30 percent of the total radios sold, but this ratio is expected to be lifted rapidly during the summer.

ADVANCE IN PRICES EXPECTED

After strengthening during the fall and early winter months, the price level has been comparatively firm since the first of the year at a level 5 to 10 percent higher than that of a year ago, with the current trend upward. While prices have been subject to considerable fluctuations, due to competition of chain units and the tendency to offer substantial concessions from quotations listed, mark-downs have been confined almost entirely to the less expensive models and midget sets.

On the other hand, prices of the better grade sets are as much as 20 percent higher than a year ago. Since April 1 price-cutting has appeared in some cities, but this has failed to disturb the general market level. It is expected that the new models to be brought out next fall will carry higher prices due to the introduction of metal tubes by some of the large producers. Recent developments in the tube industry indicate that further recessions may be expected.

Wholesalers report collections as more prompt than during the comparative period of 1934, and a number of old accounts, which had been outstanding more than a year, have been liquidated. Retail collections in many centers are making the best showing in several years, due to the steady increase in cash sales. Collections on deferred-payment sales are satisfactory, with few repossessions necessary thus far this year.

BANKRUPTCIES NEARLY CEASE

The total of failures for manufacturers and wholesalers and retailers of radios in 1934 was reduced to 46, the fewest recorded for any year in the industry's history. The number was lower by 65.7 percent than the 134 set down for 1933, and represented a decline of 82.1 percent from the all-time high which was reached in 1930 at 257. Durthe first four months of the current year only 2 failures were listed for manufacturers and 19 for wholesalers and retailers.

For the money lost because of bankruptcies, the reduction was not pronounced in the manufacturing division in 1934, as the defaulted indebtedness dropped to $941,338, which was the first year that it has been held under a million dollars, and was 74.7 percent under the 1933 total of $3,719,519. While the number of wholesalers and retailers that failed in 1934 was nearly two-thirds fewer than in 1933, the involved liabilities rose to $2,207,408, or an increase of 21.7 percent over the $1,813,980 in 1933, due to the bankruptcy of one large wholesaler during the early part of the year for more than $1,000,000.

The industry's total defaulted in-

(*Continued on page* 20)

Fundamental Tube-Tester Design

By L. D. SMITH
Radio Engineering Division
WESTON ELECTRICAL INSTRUMENT CORP.

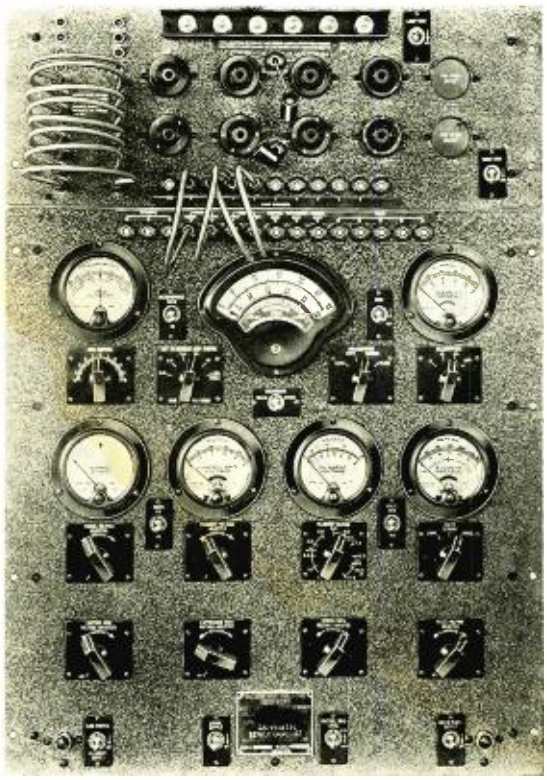


Fig. 1. Illustration of the vacuum-tube analyzing equipment.

THERE IS PROBABLY no more striking indication of the wide field of usefulness for electron tubes, or of the problems involved in assuring their efficient operation, than the present number and variety of tubes themselves. A chart recently issued includes more than 250 types which are "standard" in the sense that replacement demands must be met by tubes of similar construction and operating characteristics if specifications of the designer of the equipment are to be exactly maintained. Moreover, this list does not even enter the field of high-power transmitter tubes or others requiring a plate voltage in excess of 300 volts. In other words, all of these hundreds of types are likely to be encountered in commercial service operating radio receivers, public-address systems, motion-picture sound equipment, remote-control devices, or other apparatus which competent radio engineers may be expected to service.

TRANSCONDUCTANCE—THE BASIC

If determination of the operating efficiency of all such tubes involved as many variables as the uses to which they are put, the design of fundamental tube-testing equipment would be a well-nigh hopeless task. Luckily, however, once the mechanical constants inherent in the tube design itself have been established, operating efficiency may be determined by a single basic electrical measurement—that of transconductance as related to the rated transconductance value. After all, the common purpose of the vacuum tube is to take a voltage change on its grid and transform this impulse to an amplified change in plate current. Since transconductance is the ratio of the change in plate current to the change in grid voltage which produced it (expressed in "micromhos," or microamperes per volt), it is a direct measure of the ability of the tube to function in service. Standard ratings of transconductance are available for practically every type of tube, as well as minimum ratings for satisfactory operation. Moreover, the decrease in transconductance of any tube over a period of time generally bears a direct relationship to its length of service, so that the measurement is a check on depreciation as well as on efficiency. Design of fundamental tube-testing equipment, therefore, is not so much an analytical problem as it is one of assuring accurate electrical measurement under the specific electrical constants and load conditions that apply.

Although legitimate tube manufacturers have found it necessary to install basic standards for determining the operating efficiency of tubes by means of dynamic electrical measurements, few other organizations have had economic justification for such equipment. Most commercial tube-testing equipment, in fact, has been designed to serve the ordinary radio dealer. In such design, simplicity and economy have been paramount factors. Such equipment, generally provided with scales reading "good—bad," range from the better grade devices, which give an indication closely proportional to transconductance, to the simple and less expensive devices which give an approximate test of worth based on total emission.

Gradually, however, there has grown up a median class of those who use or service a wide range of electron-tube installations—organizations who find the ordinary commercial tube checker too limited in its mechanical and electrical characteristics to meet their requirements. In marine and aviation service, particularly, there has been a real need for a flexible, self-contained unit, powered from a single source, in which all common types of tubes could be tested under load conditions with an accuracy approaching that of basic standards. Development of an instrument of this kind, providing direct transconductance measurement in micromhos, has involved a number of electrical and mechanical factors which are unique in tube-testing equipment.

SPECIAL UNIT

The unit as finally developed (see Figs. 1 and 2) is essentially a highly flexible power supply, furnishing a full range of controlled voltages in five separate circuits (filament, plate, screen-grid, suppressor-grid, control-grid) to meet the operating constants for any element in almost every type of tube. In addition, a sixth circuit furnishes a 1-volt test signal, and a seventh is utilized in a preliminary short test.

In the case of filament-voltage supply, eleven separate ranges, from 0-1.1 to 0-27.5, were considered necessary to meet the requirements of the wide variety of tubes which might be encountered.

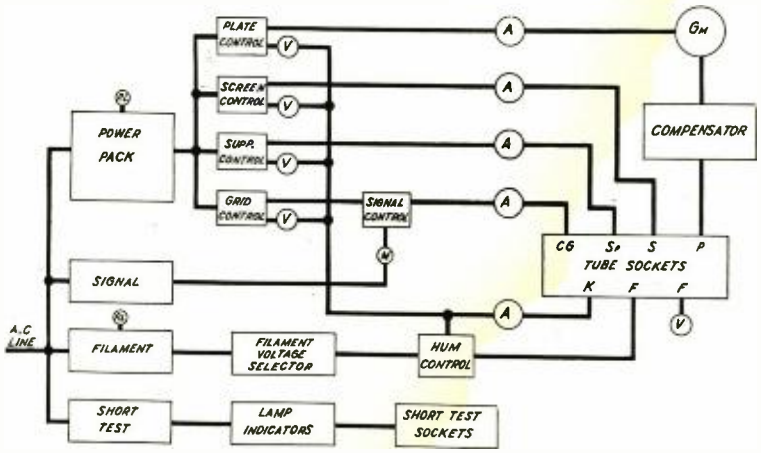


Fig. 2. Block diagram of the vacuum-tube analyzing equipment.

Individual controls and resistors, coupled to a direct-reading meter having 150- and 300-volt scales, are used to set the plate, screen-grid, and suppressor-grid voltages. Control-grid voltage is set by means of another control and independent meter with ranges of 0-10 and 0-50 volts. In addition, direct-reading meters are provided for plate- and grid-current indication.

AC GRID SIGNAL

Once the proper constants have been applied to the particular type of tube being tested by means of the voltage controls, it is then necessary to apply a suitable grid signal so that the resulting change in plate current will provide the transconductance measurement. For this purpose an alternating current of 0.1 ampere is applied through a 10-ohm resistance in series with the dc grid supply, thus impressing an ac signal of exactly one volt upon the grid.

The remainder of the fundamental measurement problem consists in determining the ac signal output set up in the plate circuit. This is done by placing a resistance in the plate circuit, and an ac rectifier-type milliammeter in series with a condenser across this resistance. The ac milliammeter is calibrated to read directly in micromhos, two ranges (0-3000 and 0-6000) providing additional accuracy. A compensating switch in the transconductance meter circuit is set at the nearest amplification factor rating for the particular tube under test. This brings into play various resistances and compensates for the resistance of the measuring circuit as the formula

$$G_m = \frac{u}{R_a + r}$$

where r is the meter resistance.

PATCH CORDS

In order to assure complete flexibility of operation, no wiring is made from the electrical controls direct to the tube rack. The panel is divided into two sections, and all leads from the metering and supply panel are brought out to separate pin jacks at the top of this section. Directly above, each socket terminal is brought down to a separate pin jack marked with the RMA tube-base prong number. Patch cords thus permit the proper circuits to be brought to any element in any tube, whatever the arrangement of the tube base.

In the case of the filament-voltage control, four separate jacks are brought to the upper panel, the heater supply and voltage meter being brought to the tube terminals in independent circuits. Thus the potential measured is that existing at the tube socket itself, unaffected by the drop in the heater supply leads.

SHORT INDICATOR

The only complete circuit on the upper panel is the preliminary short test, operating on a separate group of sockets. Secondary windings from a transformer are connected in series with an individual neon lamp between each pair of pins on these sockets. Before a tube is inserted for the short test, provision is made to test the neon lamps themselves by means of a special lamp test switch which places a short on these circuits. Then, when the tube is inserted and the lamp test switch is on, a glow in any test lamp provides a direct indication of shorting, with no possibility of an overlooked short due to lamp failure. This possibility may seem remote, but indicates the lengths to which it is necessary to go when thinking in terms of testing fundamentals.

Despite the apparent complications involved in making fundamental tube tests with this equipment, it is obviously more simple to use than any laboratory assembly of individual devices necessary to make the same determinations. The chief significance of the design and construction of a unit of this kind, however, goes beyond its specific usefulness to the limited group who now require such equipment; it is another indication of the fact that the use of the electron tube has now "come of age" in its commercial, as well as its scientific, applications.

MODERN PRODUCTION

(*Continued from page 9*)

and each conveyor consists of a series of steel frames about three feet wide linked together. These frames or fixtures will hold two radio chassis, one on each side, and at an angle of about 300 degrees. Operators sitting close together, on both sides, perform the individual assembly jobs as the chassis pass by, and all of these operations are nicely synchronized to the speed of the conveyor. Tests are given at progressive stages of assembly. An overhead chain conveyor with cabinets suspended from them, pass through this division and the completed radios are transferred to them direct from the lines. As they pass through another room each unit is placed on test, wrapped and packed, and are finally delivered to temporary storage or dropped through chutes direct to the shipping platform.

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COLOMBIA IMPORTS IMPROVE

WHEN COMPLETE DATA on radio-equipment imports into Colombia in 1934 are compiled and published they will reveal that the volume of business done in radio-receiving sets in that year reached a new high record. The sharp upturn which took place was the product of a group of factors of which the more important were an improvement in the general economic situation, the installation of new radio-broadcasting stations, improvements made on the transmitting side of several existing stations, better local programs, and the introduction of all-wave receiving sets enabling "listeners-in" to intercept at all times not only the programs of local broadcasters but also those of the principal American and European short-wave broadcasting stations.

A larger number of importers and dealers in the field, and more intensive sales campaigns also contributed to a greater number of units being placed with the public. (*Electrical Division, Department of Commerce.*)

A-F Band Response OSCILLOSCOPE

By SAMUEL BAGNO and MARTIN POSNER

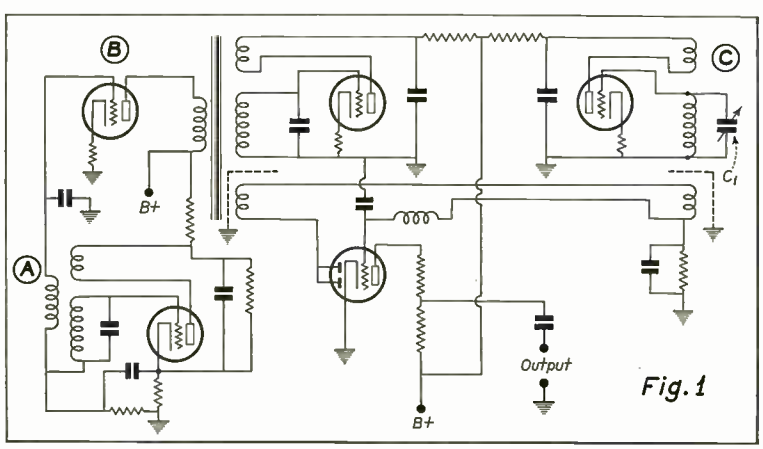
RADIO INSTRUMENTS COMPANY

PRESENT-DAY oscilloscopes perform a variety of functions, but they can all fall into one of two broad classifications, based on a fundamental functional distinction. An oscilloscope of the first type, to which the majority of the instruments belong, is used to observe a cycle or several cycles of one frequency, and so might be called a "Unit Cycle" Oscilloscope. The second type of oscilloscope is relatively new and is distinguished from the first by the fact that, in addition to the standard oscilloscope functions, it can project a picture of the response of an electric circuit to a *band* of frequencies (a band of any width) anywhere in the spectrum. It might therefore be named the "Band Response" Oscilloscope (BRO).

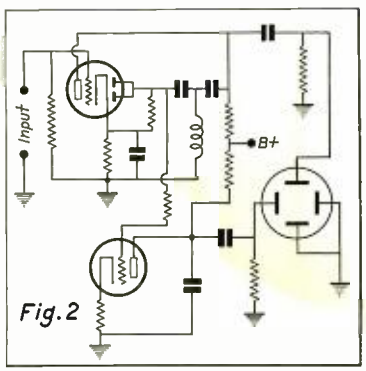
The first entirely electrical instrument of this latter type was developed and described by the present authors in 1934. This was a BRO whose chief function was to show response curves, such as resonance curves, of any width at high frequencies, e. g., 100 kc to 25 mc. It was called a Visual Resonance Oscilloscope, and is used for aligning receivers, measuring Q, L, and C of coils and condensers, etc.

APERIODIC BRO

The present article describes a new unit, an aperiodic BRO for *low* frequencies, in particular the audio-frequency range. Such a unit would generate a continuous spectrum of frequencies continually varying from perhaps the lowest audible frequency, which is about 16 cycles per second, through the upper range of audibility and slightly beyond, reaching about 16,000 cycles per second. An audio-frequency amplifier is essentially aperiodic, that is, over the audible spectrum, which covers a thousand-to-one range in frequencies. The ratio of input to output of any good amplifier or transmission medium must be essentially constant. In order to do this the frequency generated by the oscilloscope unit must have a constant output over the entire range. The output frequency must automatically vary over the required limits periodically, and, if the output is read on the vertical plane of the cathode-ray tube, the horizontal plane must correspond to the frequency, or to some function of the frequency that will permit interpretation of the image in terms best suited to the human ear.



Abbreviated diagram of the oscillator unit.



Circuit of high-pass filter, rectifier and amplifier.

ELECTRICAL REQUIREMENTS

The function of frequency best suited to the ear is logarithmic, that is, when the frequencies increase logarithmically, the ear hears it as a chromatic change in tone. To the ear every octave on a musical scale seems to give a change in sensation equal to every other octave. In other words, every time the frequency is doubled the ear perceives the same difference in pitch in spite of the fact that when the frequency changes from 64 to 128 cycles, the absolute frequency change is 64 cycles a second, whereas when the frequency changes from 4,096 to 8,192 cycles per second, the absolute frequency change is 4,096 cycles per second. This is 64 times the absolute frequency change of the first octave mentioned, yet the ear receives a similar sensation.

To sum up, the characteristics of an instrument to test audio response curves should be such that the frequency of the oscillator increases as a logarithmic function of time from 16 to 16,000 cycles per second. The horizontal deflection across the cathode-ray tube must be linear in respect to time so that the frequency scale, if spotted on the face of the cathode-ray tube, will assume chromatic proportions. The output of the

generator must be constant for all these frequencies and the output level must be such that convenient tests can be made with this instrument.

TIME ELEMENT

Another important consideration affecting the design of this unit is the time required for a complete cycle of frequency change. This depends on the lowest frequency put out by the generator and the number of octaves that the frequency sweeps through in going from the lowest to the highest. This follows because every octave must take the same increment of time.

If we take the lowest frequency of 16 cycles per second and assume that over the first octave the response is not exactly a pure frequency response (but a compromise between a transient and a pure frequency) so that the first octave covers an eighth of a second, the time required for a complete sweep from the lowest frequency to the highest will be nine times one eighth, or one and one-eighth seconds. On an ordinary cathode-ray tube it would be impossible to obtain any clear image of the resulting curve. However, there are persistent-screen cathode-ray tubes now available on the market which make such a slow moving curve readily visible from the beginning to end.

CIRCUIT CONSIDERATIONS

Now we come to the circuit considerations involved in the design of such an apparatus. In order to check broadcast telephone lines, as well as amplifiers, the instrument must be made in several different units. The oscillator, which varies its frequency periodically over the audio spectrum, must be a separate unit. This oscillator is placed at the input of the line or amplifier under test. The output of the line is fed to an amplifier unit which in turn supplies the cathode-ray tube. In order to provide for the changing frequencies, the electrical components of the oscillator shown diagrammatically in Fig. 1 are arranged as follows:

(A) is a blocked oscillator; that is, oscillations within the tube build up to a point where the charge across the grid leak and condenser is sufficient to block all oscillations, thus paralyzing the tube. The charge across the condenser then becomes dissipated through the resistor, and the voltage across the condenser decays logarithmically with time. This decay voltage is fed to another tube (B) which amplifies the logarithmic voltage change and feeds a saturating winding on an iron-core oscillator coil similar to the one described by the same authors last year.

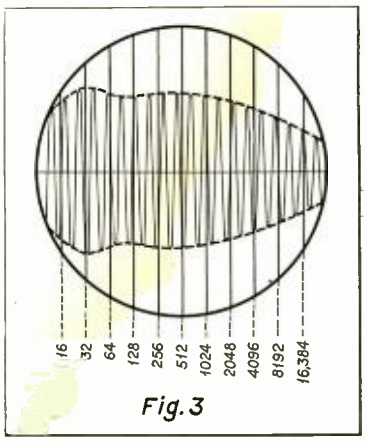


Fig. 3

race on oscilloscope screen for an amplifier passing full a-f range.

This iron-core coil is part of a beat-frequency oscillator which generates the audio voltages. The output of this beat-frequency oscillator is fed to the line or element under test, the output of which is fed through an amplifier to the vertical deflector plates of the cathode-ray tube as previously mentioned. The output is also fed to a high-pass filter, rectifier, and amplifier, to tie in a saw-tooth oscillator which determines the horizontal motion of the cathode-ray beam. This is shown schematically in Fig. 2.

RESPONSE CURVE PROJECTIONS

Modifications in the cyclic time constant of the frequency-determining circuits permit the projection of either transient or essentially steady-state response curves. In frequency tests on a piece of audio equipment, undesirable standing-wave effects can be made negligible by a rapid cyclic variation of the band of frequencies being supplied. By means of the calibrated controls, any desired portion of the band response curve can be picked out for observation; and the frequency range, the transit time, and the screen area alloted to that portion can be chosen. This is done by adjustment of the operating potentials (e. g., grid bias) of (B) in Fig. 1, by adjustment of C_1 in (C) of Fig. 1, and by adjustment of the amplitude of the horizontal timing oscillator.

APPLICATIONS

The resulting trace on an oscilloscope screen for an amplifier passing the full audio-frequency range, is illustrated in Fig. 3. An instrument of this type enables a quick check of a line and should also be essentially useful in the production testing of speakers, microphones, amplifiers, and similar equipment.

MEASUREMENT OF SOUND TRANSMISSION

RP800 in the June number of the Journal of Research gives a description of the equipment and method now used in making sound-transmission measurements at the Bureau of Standards. The method of measurement is essentially the same as that described in an earlier paper, but the equipment has been improved in line with developments in amplifier circuits, loudspeakers, and microphones.

To determine the transmission of sound through the test panel it is necessary to know the average sound pressure in the immediate vicinity of the panel. To make the sound pressure as uniform as possible a revolving loudspeaker is used as a moving source, and the frequency is varied through a certain range to give a "warble note" and hence a continuously shifting interference pattern. A thermoelement is used as an integrating device to give the average sound pressure. Measurements are taken at a number of points on each side of the panel at nine frequency bands covering a range from 128 to 4,096 cycles per second.

The results of sound transmission measurements on a number of floor and wall panels are given. Results on the transmission of impact noises are also given for the floor panels, and there is a brief discussion of methods of reducing this type of noise.

Specifications for the construction of the various panels are appended.

Technical News Bulletin.

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RADIO INDUSTRY REVIEW

(*Continued from page* 16)

debtedness for 1934 of $3,148,746 was lower by 43.1 percent than in 1933, when it amounted to $5,533,499, and marked a record low. Since 1931, when the peak was reached at $9,067,804, bankruptcy losses have been cut 65.3 percent.

The complete insolvency record of the radio industry since 1930, including January to April, 1935, inclusive, as compiled by Dun & Bradstreet, Inc., shows:

Manufacturers

Year	*Number*	*Liabilities*
1930	40	$3,522,400
1931	15	4,088,445
1932	23	1,826,995
1933	25	3,719,519
1934	9	941,338
1935*	2	45,000

Wholesalers and Retailers

Year	*Number*	*Liabilities*
1930	217	$2,071,392
1931	160	4,979,359
1932	170	1,978,678
1933	109	1,813,980
1934	37	2,207,408
1935*	19	152,432

*January to April, inclusive.

Tenth Annual I.R.E. Convention

HOTEL STATLER—DETROIT

JULY 1-2-3

STUART BALLANTINE,
President, I.R.E.

THE TENTH ANNUAL CONVENTION of the Institute of Radio Engineers will be held at the Hotel Statler in Detroit on the first, second and third of July. The following is the complete program:

SUNDAY, JUNE 30

Registration: 4:00 P.M.—6:00 P.M.

MONDAY, JULY 1

9:00 A.M.:
Registration and opening of exhibitions.

10:00 A.M.-12:30 P.M.:
Official welcome and technical session. Addresses of welcome by Stuart Ballantine, President of the Institute, and H. L. Byerlay, Chairman of the Convention Committee.

Technical Session, Large Meeting Room:

Electron Beams and Their Application in Low-Voltage Devices, by H. C. Thompson, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

Frequency Control by Low Power Factor Line Circuits, by C. W. Hansell, F. H. Kroger and P. S. Carter, RCA Communications, New York, N. Y.

Design and Equipment of a 50-Kilowatt Broadcast Station for WOR, by J. R. Poppele, Station WOR, Newark, N. J., and F. W. Cunningham and A. W. Kishpaugh, Bell Telephone Laboratories, New York, N. Y.

10:00 A.M.-11:00 A.M.:
Official greetings at ladies' headquarters.

11:00 A.M.-5:00 P.M.:
Trip No. 1. Ladies' sight-seeing trip.

12:30 P.M.-2:00 P.M.:
Luncheon and inspection of exhibits.

2:00 P.M.-3:30 P.M.:

Technical Session, Large Meeting Room:

Automatic Selectivity Control, by G. L. Beers, RCA Victor Division, RCA Manufacturing Company, Camden, N. J.

Automatic Frequency Control, by Charles Travis, RCA License Laboratory, New York, N. Y.

Radio-Panel Lamps and Their Characteristics, by J. H. Kurlander, Westinghouse Lamp Company, Bloomfield, N. J.

2:00 P.M.-3:30 P.M.:

Technical Session, Small Meeting Room:

Magnetron Oscillators for Generating Frequencies from 300 to 600 Megacycles, by G. R. Kilgore, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

An Unattended Ultra-Short-Wave Radio-Telephone System, by N. F. Schlaack and F. A. Polkinghorn, Bell Telephone Laboratories, New York, N. Y.

Some Notes on Piezoelectric Crystals, by Isaac Koga, Tokyo University of Engineering, Tokyo, Japan.

3:30 P.M.-6:00 P.M.:
Trip No. 2. General Motors Research Laboratory.

6:00 P.M.-7:00 P.M.:
Inspection of exhibits.

TUESDAY, JULY 2

9:00 A.M.:
Registration and opening of exhibition.

10:00 A.M.-11:30 A.M.:

Technical Session, Large Meeting Room:

Recent Developments of Class B Audio- and Radio-Frequency Amplifiers, by L. E. Barton, RCA Victor Division, RCA Manufacturing Company, Camden, N. J.

General Theory and Application of Dynamic Coupling and Power-Tube Design, by C. F. Stromeyer, Revelation Patents Holding Company, New York, N. Y.

Notes on Intermediate-Frequency Transformer Design, by F. W. Scheer, S. W. Sickles Coil Company, Springfield, Mass.

10:00 A.M.-11:30 A.M.:

Technical Session, Small Meeting Room:

Some Theoretical Considerations Relating to Vacuum-Tube Design, by G. D. O'Neill, Hygrade Sylvania Corporation, Salem, Mass.

Ratings and Operating Information on Large High-Vacuum Tubes, by R. W. Larson, General Electric Company, Schenectady, N. Y., and E. E. Spitzer, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

Analysis of the Operation of Vacuum Tubes as Class C Amplifiers, by I. E. Mouromtseff and H. N. Kozanowski, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

10:00 A.M.-11:30 A.M.:
Trip No. 3. Ladies' Shopping Tour.

11:30 A.M.-6:00 P.M.:
Trip No. 4. Greenfield Village.

6:00 P.M.:
Exhibits Close.

7:00 P.M.:
Annual banquet and entertainment, Main Banquet Room.

WEDNESDAY, JULY 3

9:00 A.M.:
Registration and opening of exhibition.

10:00 A.M.-11:30 A.M.:

Technical Session, Large Meeting Room:

A New Tube for Use in Superheterodyne Frequency-Conversion Systems, by C. F. Nesslage, E. W. Harold, and W. A. Harris, RCA Radiotron Division, RCA Manufacturing Company, Harrison, N. J.

A New Type of Gas-Filled Amplifier Tube, by J. D. LeVan and P. T. Weeks, Raytheon Production Corporation, Newton, Mass.

10:00 A.M.-11:30 A.M.:

Technical Session, Small Meeting Room:

Ultra-Short-Wave Propagation Over Land, by C. R. Burrows, Alfred Decino and L. E. Hunt, Bell Telephone Laboratories, New York, N. Y.

A Note on the Source of Interstellar Interference, by K. G. Jansky, Bell Telephone Laboratories, New York. N. Y.

Comparison of Cosmic Data with Characteristics of the Ionosphere at Washington, by E. B. Judson, National Bureau of Standards, Washington, D. C.

A Study of Radio Field Intensity Versus Distance Characteristics of a High Vertical Radiator at 1,080 Kilocycles, by S. S. Kirby, National Bureau of Standards, Washington, D. C.

11:00 A.M.-6:00 P.M.:
Trip No. 5. Ladies' luncheon and sight-seeing trip.

11:30 A.M.-1:00 P.M.:
Luncheon and inspection of exhibits.

1:00 P.M.-6:00 P.M.:
Trip No. 6. Ford Motor Plant.

4:00 P.M.:
Closing of exhibits.

Design .. Notes And

WHAT NEXT IN RECEIVERS?

THE ART OF BROADCASTING has been brought to a high state of perfection since its advent some fifteen years ago. In spite of its many laurels, however, there are on the horizon many new possibilities both in the way of improvement in present apparatus and technique and in new services. During the past year considerable progress has been made both in the fidelity of reproduction of radio receivers and in the equipment and technique of broadcast transmitters. There are today a number of broadcast transmitters equipped to transmit a program 20 kc in width with a remarkable degree of fidelity. Transmitter distortion both due to harmonics and to intermodulation* has been reduced to a few percent. Acoustic treatment and studio technique have brought about further increases in naturalness. However, due to the 10-kc spacing of broadcasting stations, it is not yet practicable to use all of the 20-kc band even if it were broadcast. It is indicative of the open-mindedness of the industry and of the FCC in particular that a band has been set aside for experimental high-fidelity transmissions in which the stations are spaced at 20-kc intervals, thus permitting an even greater increase in bandwidth. Due to the low power of these transmitters, it is extremely unlikely that interstation interference will be a problem even if each station transmitted a 40-kc program and receivers were available to receive them. In the first place, a 20-kc beat note is generally inaudible, and secondly, the geographical separation and low power of the stations are such as to preclude the possibility of interference.

PRESENT DESIGN FEATURES

It is only during the past year that programs greater than plus or minus 4000 cycles have been available. The recent increase in receiver bandwidth represents practically one octave at the high-frequency end, to say nothing of improvements in loudspeakers which have permitted the extension of the program band to frequencies lower than ever before. Practically any radio receiver, except those of the cheapest variety, is limited in sensitivity by thermal noise arising ahead of the first tube. Beyond this point any increase in sensitivity is useless. Probably the selectivity of modern superheterodyne receivers is entirely adequate. In addition, most modern receivers cover a frequency band of 150 to 30,000 kc. Moreover, the use of delayed automatic volume control, squelch circuits, and other accessories to normal reception, are too common to need mention. With all of this behind us it might appear at first glance that there is little left in the way of refinement for future radio receivers.

*For interesting reference, see "Intermodulation in A-F Amplifiers," by A. C. Bartlett; *The Wireless Engineer*, Feb., 1935, page 70.

SIGNAL-NOISE RATIO

Probably the thing needing most attention in modern radio receivers is signal-to-noise ratio. With the extension of transmitter power up to 500 kw it may well be that we have reached the limit in high power, because of the Luxemburg effect, which is now receiving so much attention in Europe. Of course, high-power transmitters are probably the most effective means at our disposal of insuring good signal-to-noise ratio. There are, however, other possibilities which as yet are largely unexplored and which may soon be brought into play to relieve this situation. For example, volume compression[1] at the transmitter, with or without subsequent re-expansion at the receiver, appears to offer some very considerable advantages in that it permits the transmission of a relatively deeply modulated signal at all times, thus permitting sufficient sideband power to be radiated to override the noise level. In Europe, and to some extent in this country, some thought has been given to the use of a "floating carrier," which consists in reducing the amount of transmitted carrier when the sideband power is reduced at low-level points in the program. This, of course, is much the same sort of thing as volume compression in effect, in that it permits the transmission of deeply modulated signals at all times.

TUNED ANTENNA CIRCUITS

All the possibilities of improving signal-to-noise ratio in the receiver circuit have not been exhausted, however. It would appear that some considerable improvement might be had by the use of antenna circuits which will improve the antenna stepup. Some attempts in this direction have already been made in automobile receivers with very gratifying results. It may not be too much to expect that tuned antenna circuits will eventually come into general use. This, of course, implies some control over the antenna used with the receiver. If receivers are to be designed for wide variations in antenna capacity, the effects of tuning the antenna will of course be nullified. However, the increasing use of antenna systems with efficient transmission lines for distribution in urban communities tends toward standardization in these localities. In suburban and rural communities in which it is possible to erect sizeable antennas, it would seem that more nearly constant antenna capacities can be had. If a receiver is to be designed to meet only these two conditions, there appears to be no good reason why higher antenna stepups than those common at present can not be had in the broadcast band. At short waves, much of the static is of the peaked variety, such as that due to auto-ignition interferences, etc. This can be reduced very effectively by the use of amplitude-limiting circuits in the receiver. Several methods have been proposed and even used to accomplish this. One method consists in the use of a non-linear resistor shunted across a suitable receiver circuit. Another method might be the use of vacuum tubes having sharp cut-off.

1N. C. Norman: "The Voice-Operated Compandor"; COMMUNICATION AND BROADCAST ENGINEERING; Nov., 1934; Page 7.

SELECTIVITY AND OVERMODULATION

Probably present selectivity is entirely adequate to meet present receiving conditions since the limitations on selectivity are now largely those imposed by overmodulation of transmitters which slop over into adjacent channels. It is gratifying to note that transmitter engineers recognize this problem and there is some evidence that something is to be done about the matter. For example, several suggestions have been advanced for circuits to prevent overmodulation of transmitters.[2] With the advent of high-fidelity transmitters and better studio technique, there seems little doubt that the slop-over into adjacent channels due to overmodulation will soon become a thing of the past. This will, of course, allow the use of more selective receivers in the broadcast band if those in present use are not sufficiently selective.

BEAT-NOTE INTERFERENCE

No doubt the problem of beat-note interference on shared channels will be with us as long as there are such things as shared channels. It is gratifying to note, however, that some thought is being given to the directivity of high-angle radiation to prevent interference by the sky wave of one station with the ground wave of another. As an indica-

[2]P. S. Gates: "Controlling Overmodulation"; COMMUNICATION AND BROADCAST ENGINEERING; April, 1935; Page 18.

tion of what can be done in this line, the new antenna system at WLW presents ample evidence.[3] It is not enough to suitably shape the ground-wave pattern of antenna systems, although this can be used to obtain greatly increased coverage as has been done by WOR. Again it seems probable that some relief can be afforded by the use of directive antennas for reception. As every experimenter knows, it is not particularly difficult to obtain a cardioid pattern from relatively simple receiving antennas. If we are about to witness a period in which antennas will become more standardized, it would appear that the use of directive antennas with the minimum directed toward interfering stations may eventually be with us. This does not seem to be such a serious problem if only one case of serious interference is to be remedied at any given receiver location. Some of the modern all-wave antenna systems employ doublets for short-wave reception and the combination of doublets and lead-in as a T-antenna for broadcast reception. Doublets, of course, are very effective in reducing local interference which appears to be largely vertically polarized. This does not imply that man-made interference is all vertically polarized, but it does mean that most of the resultant noise field predominates in vertically-polarized waves. In addition, the increasing use of automobile radio with suitably treated auto-ignition systems will in time reduce one very serious source of interference. Moreover, the present campaign being waged toward the general reduction of interference from electrical devices should in time help the matter considerably. While ignition interference may not be the most serious offender at broadcast frequencies, man-made interference still presents something of a problem in this band. The possibility of locating antennas well outside the interference field promises considerable improvement even in the broadcast band.

SQUELCH CIRCUITS

Squelch circuits have been with us for some time and are becoming increasingly popular. There is no doubt that they serve a very useful purpose in preventing interference pickup between stations. Their most serious drawback appears to be that the sensitivity of the squelch device, or the threshold value at which it will operate, is not easily adjustable, if indeed any adjustment at all is provided. If such an adjustment could be made easily it would appear that possibly two values of threshold signals which would operate the squelch circuit might be sufficient. This would require no more controls than are at present used on many receivers, since it is customary to employ a switch to cut the squelch circuit in or out at will. This same switch might be the sensitivity adjustment, provided one degree of sensitivity for winter reception and another for summer reception are all that are required. At any rate, a control, even though it be variable over a wide range, should not offer any insurmountable difficulty to the operator. And it should not be necessary to adjust it except at long intervals.

[3] "Unique 'Suppressor Antenna' at WLW": COMMUNICATION AND BROADCAST ENGINEERING; May, 1935; Page 22.

RECEIVER CALIBRATION

Receiver manufacturers have every reason to be proud of the degree of precision which they have maintained in the calibration of receivers. With the advent of adjustable coils which eliminate the necessity for grouping at the factory it would appear that even closer calibration may be possible. It may well be, therefore, that the necessity for beat oscillators to assist in tuning in short-wave stations may be done away with entirely by closer calibration. This would certainly be a desirable step. Along with this, greater stability of the conversion oscillator might well be required. Several methods of doing this have been advanced. For example, the use of bi-metallic condenser plates for temperature compensation have already received their baptism of fire. Methods of stabilizing oscillators for voltage variation by suitably selected circuit components are already well known and in common usage. It would appear that variation in frequency due to changes of tubes could be eliminated by the inclusion of a small vernier.

VOLUME RANGE

It has long been realized that considerable improvement can be effected in both transmitters and receivers by increasing their volume range. Until very recently neither transmitters nor receivers have had a volume range in excess of about 40 db. This has made it necessary for control operators to manually reduce the cresendos very considerably. On many occasions this deliberate manual compression of the program is very noticeable. It goes without saying that distortion of this type, while not as serious as certain other types of distortion, is nevertheless very disagreeable when listening to a concert. The best grade of new high-fidelity transmitter has a volume range of the order of 60 db. Very few modern receivers have a volume range of more than 40 db and many are considerably worse than this.

Of course, the principal disturbance which limits the lower level of volume in radio receivers is ac ripple. In many cases a large part of ac ripple is developed in the last audio stage. Obviously this can be reduced in a very straightforward manner. It is entirely practicable with modern tubes to reproduce a volume range of better than 50 db without taking any undue precautions or materially increasing production costs. It is unfortunate that this matter has been overlooked as long as it has and it is probably one of the reasons that most radio programs ave been relegated to the status of providing background music for bridge games, etc., rather than being used as a source of entertainment.

LOUDSPEAKER DIRECTIVITY

Before a high-fidelity receiver can be fully justified, some attention must be given to directivity of loudspeakers. A certain amount of progress has already been made in this regard and there seems no reason to believe that matters will not improve. Means are already available for increasing the high-frequency response of loudspeakers by means of either a special high-frequency unit or by means of a single unit including the proper design features. Means are also at hand for extending the low-frequency range without undue baffle areas as, for example, by means of the acoustic labyrinth. There is still room for progress, however, in the reduction of transients set up by the loudspeaker at frequencies corresponding to the peaks in the response characteristic. It is estimated that peaks of the order of 3 db begin to be noticeable; however, peaks of the order of 10 db are not at all uncommon in even the best loudspeakers.

AUDITORY PERSPECTIVE

There has been a great deal of talk in the past relative to the possibility of increasing the naturalness of reproduced programs by employing directional effects or, as it has so aptly been termed, auditory perspective. There can be little doubt that the use of auditory perspective would add considerably to the naturalness of certain types of radio programs. However, like wide bandwidths, it would necessarily be limited to the primary service area of any broadcast station. Most of the methods so far proposed for adding this feature to a radio

(*Continued on page 24*)

CODE WITH NEMA ENDS

RMA CONTINUES INDEPENDENT SERVICE FOR RADIO INDUSTRY

By BOND GEDDES
EXECUTIVE VICE-PRESIDENT, RMA

LARGER PAY ENVELOPES for many radio employees were an immediate and beneficial result of the Supreme Court's decision May 27 annulling all NRA codes, including the electrical manufacturing code under which radio manufacturers have been temporarily operating.

Relieved from the 36-hour minimum weekly restrictions of the electrical code, some radio manufacturers immediately instituted a 40-hour week for their employees. The electrical code was one of very few codes restricting employees' hours to a maximum of 36 hours a week and was one of the most severe code handicaps under which radio manufacturers operated. Overtime restrictions of the electrical code also were removed.

CODE REPORTS SUSPENDED

Another immediate effect for radio manufacturers of the Supreme Court decision was to suspend the many code reports required, including monthly labor reports, sales and other statistical reports and special reports of "emergency" and "seasonal or peak" overtime. These code restrictions were ended as the radio industry enters its seasonal peak operations.

The RMA may salvage from the code wreckage the beneficial features of code operations, including the open price-filing system of set manufacturers and also radio industry statistics. Future operations, however, would be under the RMA independently and without connection with NEMA, the electrical code authority.

FILING OF PRICES

Set manufacturers have been requested to voluntarily continue filing all their prices with Arthur T. Murray, chairman of the RMA Set Division and code supervisory agency for set manufacturers.

Compulsory compliance under the electrical code having terminated radio manufacturers will not be requested by the code supervisory agencies and are not obligated to file the labor and other statistical reports. A bulletin advising RMA members was issued May 29 covering as far as possible on that date the code status and procedure.

While the future plans of the Administration, Congress and NRA remain at the present date unsettled, there is no uncertainty regarding the termination of the electrical code so far as compulsory compliance is concerned. The Supreme Court held that "manufacturing" is intrastate commerce and apparently this removed radio manufacturing from any future code and also probably much other legislation pending. The labor problem is the most difficult and important. Labor organizations have immediately turned to the 30-hour week bill of Senator Black and to the Wagner Labor Relations Bill, but the outcome, and their constitutionality also, uncertain.

OTHER CODES SUSPENDED

In addition to the termination of the electrical code, the supplemental code of the radio wholesaling trade also was automatically suspended. Also in the code discard are the supplemental codes proposed by NEMA for transformer, transmitting apparatus, public address and other manufacturers.

At the Chicago convention of RMA the Association members will consider the voluntary continuation of procedure under the code which has been helpful. This will include possible voluntary continuation of price-filing by set and other manufacturers, if desired, collection by the RMA of industry statistics and other procedure.

Compulsory powers of NRA and NEMA, the code authority, having ended under the electrical code, there will be no future code reports by radio manufacturers or code relations with NEMA.

RMA members are fortunate in exemption from any code assessments or expenses. All of these have been carried for RMA members from the Association's treasury. In the case of other codes there is discussion of liability by code authorities for return of assessments now asserted to be illegal in view of the unconstitutionality of the codes.

The RMA emerges from the code operations with a larger membership, a stronger and more stable organization, with complete industrial independence as a result of past policies followed by the RMA Board of Directors and its code committees, and with independent position to continue its service to the industry.

REPRODUCERS WANTED IN AUSTRALIA

D. M. DOW, Official Secretary for Australia in the United States, has requested that the following announcement be made:

"The Australian Postmaster General's Department, which controls the National Radio Broadcasting of Australia, is inviting offers for the supply of reproducers for the reproduction of 'vertical cut' disc sound records of the type described by H. A. Frederick in the 'Journal of the Society of Motion Picture Engineers' of February, 1932.

"Further particulars in regard to the foregoing may be obtained by interested parties on application to the Official Secretary for Australia, 25 Broadway, New York City." (*Electrical Division, Department of Commerce.*)

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NOTES AND COMMENT

(*Continued from page* 23)

program would result in a considerable increase in the cost of the radio receiver. There would, of course, also be some additional cost in the transmitting equipment, but it would appear that any such cost would be negligible in comparison with the cost of the remainder of the plant. Methods have already been devised, which will require no increase in channel spacing, by means of which programs with suitable directive qualities can be broadcast on a single channel with as good fidelity as may be had with a monaural program. It would therefore appear that the additional expense entailed in radio receivers adapted for this type of program would furnish manufacturers with reasonable technical justification for a high-priced receiver. There is no reason why such a receiver should not be used for monaural reception without any changes or switching and that it might be provided with all of the gadgets common to the modern radio receiver.

· RMA NEWS ·

TRADE TREATY WITH FRANCE

IN REPRESENTING radio industry interests, the RMA is preparing to intervene in negotiations announced by the State Department for a reciprocal trade treaty with France. This is the most important trade agreement action under the reciprocal tariff act yet taken by the State Department. It affects the largest nation and also the most important radio market since the State Department began its negotiation of reciprocal trade agreements. Also any agreement reached in the French treaty will apply to all foreign countries.

All RMA members have been requested to contribute to the data and statement which the RMA will present to the State Department during the negotiations with France in June.

INCREASED MARCH BUSINESS

The barometer of the federal five percent excise tax on radio indicated considerable increase of sales in March with excise tax payments 31 percent above those during March, 1934. According to the official reports of the Internal Revenue Bureau, the excise tax collections in March were $350,334.03 against $268,136.45 in March, 1934.

RADIO EMPLOYMENT INDICES

The report of the U. S. Department of Labor, Bureau of Labor Statistics, on radio factory employment for the month ending February 15, 1935, showed the expected seasonal decrease. Fifty-three radio and phonograph establishments reported employment of 32,080 employees, compared with 34,658 employees reported by fifty-two companies during the preceding month. No wage increases were reported during February.

Per capita weekly earnings in radio factories during February, 1935, were $17.93, compared with $18.44 in January, a decrease of 5.5 percent.

Average hours worked per week during February were 31.2 hours, a decrease of 4.3 percent from January, and 3.2 percent under February, 1934.

Average hourly earnings of radio factory employees during the month ending February 15, 1935, were 57.5 cents, the same as during the previous month, but 4.3 percent over average hourly earnings during February, 1934.

As compared with the three-year average of 1923-25, radio employment during February was increased 86 percent, while February payrolls were 3.2 percent above the three-year average.

RADIO SALES IN BELGIUM

Recent devaluation of the currency in Belgium and injury to the large American radio sales to that country prompted the RMA to take up the matter with the Department of State. The RMA asked the Government to take any action in connection with the new reciprocal trade treaty with Belgium, effective May 1, which could aid the American radio market in Belgium. A reply to the RMA from Francis B. Sayre, Assistant Secretary of State, explained that in negotiation of the Belgium trade agreement "the possibility of the belga's depreciation was given careful consideration . . . and account taken of it in the recommendations which were submitted to the President.

"Although the purchase price in Belgium currency of goods imported from this country is increased by the belga's devaluation," Assistant Secretary Sayre continued in his letter to Bond Geddes of the RMA, "the tariff and other concessions obtained from Belgium are unimpaired and, I am sure you will recognize, the combined obstacles to the export of American goods to Belgium will be less as a result of the trade agreement than they would be in its absence. The dollar was devalued on January 31, 1934, by 40.94 percent, whereas the devaluation of the belga did not occur until April 1, 1935, and amounts to only 28 percent."

Revision of the Belgian reciprocal trade agreement to balance trade conditions resulting from devaluation of the belga appears improbable, but the radio tariff reductions in the Belgian treaty, 15 percent on sets and 50 percent on tubes, should materially decrease export trade difficulties resulting from the Belgian currency devaluation.

ANOTHER RADIO "LUXURY" TAX BILL IS DEFEATED

Added to the several attempts in various State Legislatures to tax radio as an alleged "luxury" is a bill in Oklahoma. The Oklahoma bill proposed a special "luxury" tax of 3 percent on radio. It was vigorously opposed by the RMA and, like several similar bills, it failed of passage during the last fortnight.

Still pending in California but successfully opposed thus far is a measure proposing a 10 percent sales tax on radio. Radio interests in California, headed by the Pacific Radio Trade Association and in cooperation with the RMA, are engaged in vigorous opposition to the California measure and the present prospects indicate its probable defeat.

FEBRUARY RADIO EXPORTS

The February, 1935, report of the Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce on radio exports record foreign sale of 46,470 receiving sets, valued at $1,262,556; 403,141 tubes valued at $183,602; 10,500 speakers valued at $28,441, and transmitting apparatus valued at $149,326.

The February exports showed a substantial gain over January, and Mexico continued to be the leading purchaser.

MARCH SALES IN CANADA

The Canadian RMA reports sales by members for the month ending March 31, 1935, of 8,947 receiving sets. Of these 6,543, valued at $611,604, were ac sets; 759, valued at $64,351, were battery sets, and 1,645 automobile sets valued at $115,762.

Canadian inventories reported were 27,270 ac sets; 3,929 battery sets, and 3,712 automobile sets.

RMA COOPERATION WITH FRANCE

The RMA has received and accepted an invitation from the French radio industry for cooperation in the exchange of information and mutual services. Through the good offices of Mr. A. M. Brace, President of the American Radio-Import Committee, the Syndicat Professionnel des Industries Radio-Electriques, representing the radio manufacturers of France, corresponded recently with the RMA. Arrangements have been made for exchange of official publications and also statistics.

MARCH RADIO EXPORTS

Radio exports in March, 1935, totaled $2,063,195, according to the monthly report of the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. During March the exports of receiving sets were 47,693, valued at $1,251,486; tubes, 457,008, valued at $210,010; loudspeakers, 14,100, valued at $44.633; parts and accessories, alued at $412,559, and transmitting apparatus valued at $144,507.

APRIL EXCISE TAXES

A 25 percent increase during April, as compared with April, 1934, in the federal 5 percent excise tax collections is reported. The official report of the U. S. Internal Revenue Bureau for April reported excise collections from radio and phonograph manufacturers of $253,066.45 as compared with $202,301.98 in April, 1934.

FLASH—RMA URGES ABOLISHMENT OF FRENCH RADIO QUOTAS

Abolishment of the French import quota system restricting American radio sales in France was urged in a brief submitted by the RMA to Government officials in connection with the June negotiations between the United States and France for a reciprocal trade agreement.

Reduction of the French tariff on American radio products was an alternative recommended by RMA, and individual letters from many American manufacturers were appended to the RMA brief filed with the U. S. Tariff Commission. The brief and data of individual radio manufacturers will be used in the Government's negotiations with France.

The French import quotas and their administration, it was stated in the RMA brief, are the principal obstacles preventing wider sale of American radio products in France. If the French import quota cannot be abolished in the proposed reciprocal trade treaty, the RMA stressed that a large increase in American quotas should be provided.

The primary recommendation of the RMA was for abolishment of the French quotas or, as alternatives, their enlargement for American interests or reduction of the French tariff. Discrimination, bribery and bootlegging are notorious among the defects of the French quota system and administration, it was stated, and the best remedy urged was termination of the quota system.

News Of The Industry

OHIO CARBON FOLDER

The Ohio Carbon Co., 12508 Berea Road, Lakewood, Ohio, have just issued a folder describing their new low-resistance LV "Ohiohm" carbon resistors used for increasing the sensitivity range of certain types of industrial electronic-control apparatus and radio hookups. Several graphs, compiled from the results of thousands of tests, illustrate the useful properties of these resistors, as regards their life and overload qualities, their constancy of value under extreme humidity conditions, and their load and voltage characteristics.

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NEW CROWE BULLETINS

The Crowe Name Plate and Manufacturing Company, 1749 Grace Street, Chicago, Illinois, have just issued Bulletins No. 60 and No. 61.

Bulletin No. 60 covers Crowe dial plates and knobs for panel mounting for constant impedance or gain control and other purposes. All items are illustrated.

Bulletin No. 61 deals with remote controls for automobile radios, instrument-panel mounting kits, universal heads and the like. Illustrations and complete descriptions are given for each article.

Both bulletins may be obtained by writing to the above organization.

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MUDRA HONORED AT LUNCHEON

Frank Mudra, Office Superintendent of Electrical Research Products, was guest of honor at a luncheon given by more than 200 present and former associates at the Great Northern Hotel recently to celebrate his 25th anniversary with the Bell System. Among the guests were three of his former department heads at the Western Electric Company: S. T. Rockwell, Superintendent of Installation, Jack Lawler of the Installation and Accounting Department, and William Weitzenberg, Division Superintendent of Installation, and the following, also from Western Electric: Sam Henzey, Wayne Beers, Doc Finch, Dave Young, Jimmie Jamieson, Ed Zahn and William Metzger.

Bert Sanford, Northeastern Division Sales Manager of ERPI, acted as toastmaster and supervised the presentation of a traveling set, a gift from Mudra's associates in appreciation of the occasion. Doc Kniewell and Charles Fanning of ERPI formed the committee in charge of arrangements.

Earlier in the day J. E. Otterson, President of Electrical Research Products, Inc., had presented Mudra with the gold award emblematic of 25 years' service with the Bell System.

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GARDINER APPOINTS WESTERN AGENCY

The Gardiner Metal Company, Chicago, Illinois, announces the appointment of Morris P. Kirk and Son, Inc., 2717 Indiana St., Los Angeles, California, as direct factory representatives for the former's complete line of flux-filled solders. The Los Angeles concern will handle the distribution of the Gardiner product in Arizona and southern California and will maintain a complete warehouse stock to facilitate prompt shipments.

RAH BULLETINS

Joseph C. Rah and ompany, 5745 West Ohio Street, Chicago, Illinois, have just issued two very interesting 4-page bulletins. One bulletin is entitled "Electrical Application of Plastics," while the other covers the subject of "Moisture Proofing."

These publications may be obtained by writing to the above organization.

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RCA MOVES NEW YORK OFFICE

The New York Office of the Victor Division, RCA Manufacturing Company, has been moved from 153 East 24 Street, New York City, to Room 1813, RKO Building, 1270 Sixth Avenue, New York City. Mr. T. A. Smith is the District Manager.

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"TUBING BY SUMMERILL"

"Tubing by Summerill" is a large 56-page catalog of the products of the Summerill Tubing Company, Bridgeport, Pennsylvania. In presenting this catalog special emphasis is placed on the position occupied by Summerill in the production of seamless tubing, and a deliberate attempt has been made not to define too specifically the various particular uses already in vogue. The aim has been to emphasize the versatility and adaptability of seamless tubing.

This well-illustrated and informative publication should be of assistance to present and prospective users and should suggest to design engineers many new uses for seamless tubing.

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RCA MAINTAINS NRA CODES

David Sarnoff, President of the Radio Corporation of America, on June 3, made the following statement:

"The Radio Corporation and its wholly-owned companies are continuing the same hours and wage scales as were in effect under the NRA codes."

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DEPARTMENT OF COMMERCE PAPERS

Four very interesting and informative papers published by the Government Printing Office, Washington, D. C., are now available.

One publication, Circular C406, issued March 20, 1935, is entitled "Standard Time Throughout the World." This paper is a revision and enlargement of Circulars 280 and 399. It gives a brief historical sketch of the development of the standard time system, time-zone maps of the United States and of the world, a list of stations transmitting radio time signals, a list of the times used in several large cities, a list of the legal times used in most countries, and the like.

Research Paper RP759 is entitled "The National Primary Standard of Radio Frequency" and is by Elmer L. Hall, Vincent E. Heaton and Evan G. Lapham. Included is a description of the primary standard, methods used in determining frequency and description of apparatus, uses of the primary frequency standard, and the like.

"Multifrequency Ionosphere Recording and Its Significance" is the title of Research Paper RP769. Theodore R. Gilliland is the author. Briefly, this paper contains: Day E and F_1 layer and Night F layer results and the application of the results to practical communication problems.

The method and equipment used in monitoring the standard-frequency emissions are described in Research Paper RP766. This publication is entitled "Monitoring the Standard-Frequency Emissions" and is by Evan G. Lapham.

These papers are for sale by the Superintendent of Documents, Washington, D. C. The price is 5 cents each.

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NEW RESISTANCE HANDBOOK

Wilbur B. Driver Company (formerly Gilby Wire Co.) of Newark, N. J., manufacturers of resistance wire for the electrical, radio, chemical, mechanical and automotive industries, have just published a new 60-page resistance handbook. This manual contains a great many tables and charts pertaining to the design and construction of electrical heating units, and will be of keen interest to the engineering profession. Copies may be had by simply writing to the main office and works located at Riverside Avenue, Newark, N. J.

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SPRAGUE CONDENSER FOLDER

A new folder, "Facts You Should Know About Condensers," has just been issued by Sprague Products Co., North Adams, Mass.

In this folder particular attention has been paid to determining the quality of dry electrolytics through the following four factors: Power factor, leakage, capacity and voltage. Actual tests are detailed.

The folder is prepared in a concise, easily understandable style. A request to the above organization will bring a free copy.

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NATIONAL UNION MOVES OFFICES

New York City headquarters of the National Union Radio Corporation were moved on Saturday, April 27, from the quarters which they have occupied since 1929 at 400 Madison Avenue to larger space at 570 Lexington Avenue, New York City.

At the new location, National Union has, in addition to more floor space, quarters which are air-conditioned and scientifically lighted.

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TURNER BULLETINS

The Turner Company of Cedar Rapids, Iowa, have available a number of technical bulletins covering their different products in the sound-equipment field.

Bullet No. 1A covers the Turner MC-16 Class A Amplifier and the Turner MC-50 Amplifier (Class B), both being high-gain units with inputs for crystal microphones. Bulletin No. 2A deals with the Turner S-16 Portable Public-Address System and their Line Amplifier (ac operated), while Bulletin No. 3A covers Pre-Amplifiers. Bulletin No. 4A and B gives data on the C-100, M-16 and M-8 Amplifiers in addition to specifications for a Field Supply unit. Also available is literature covering their new "Dia-Cell" Microphones and the Type "G" Crystal mike.

NEW PRODUCTS

INDICATOR TATTELITES

Indicator Tattelites are a line of tiny neon pilot lights operating on standard commercial voltages (90-250) ac or dc. They tell when the motor, heater, electric clock, radio, or toaster is operating, either directly or in remote-control circuits. Conversely they can be made to indicate open circuits or switches, blown fuses, etc.

The current consumed is about 1/1000 ampere. They are not affected by vibration. The life is 3,000 hours.

The neon bulb used in this lamp is said to be the smallest commercially used in the world—only 1 inch by ¼ inch diameter. It is equipped with octagon-shaped bases, similar to those used on switchboard lamps.

Dead front panel-type mountings, having clear phenolic resin caps, are available. A limiting resistor is used on all neon lamps and, in this case, is built into the mounting. For circuits requiring no resistor (such as oscillators, r-f indication, etc.) a direct terminal is provided. These units are designed especially for small space requirements. The manufacturer is Littelfuse Labs., 4507 Ravenswood Ave., Chicago. Descriptive folder on request.

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NEW UNIVERSAL REMOTE CONTROL

The Reliance Die and Stamping Company, 1260 Clybourn Ave., Chicago, have announced their new universal remote control, which is said to have a flexibility of application in mounting and design compelling consideration by the engineer.

The control head of this unit is available in ratios of 6 to 1 and 8 to 1, although other ratios are available on special order. The station-finder pointer rotates in the same direction as the knob.

As standard equipment a die cast mounting bracket and adjustable strap for various diameters of steering posts is furnished. At a small extra cost there is also available an angle bracket for dash mounting. In addition, matched dash plates pierced and formed to fit both the instrument panel and control complete with mounting brackets are available for late models of Ford, Hupmobile, Graham Paige, Studebaker, Nash, DeSoto, Chrysler, Dodge, and Plymouth.

Metal scale with celluloid window and indirect lighting, all celluloid dial and frame and diffused lighting, and etched glass scale and masked pointer are the three types of dial scales available. Illumination is secured by means of 6-8 volt bulb inserted in the rear of the one-piece head.

The volume control is of the non-removable type. This permits the use of male and female fitting on the volume-control end.

A tone control located between the volume and tuning control just below the bezel can be added: Two-position control, or variable control (100,000 ohms).

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CLASS A RECORDING AMPLIFIER

The Universal Microphone Co., Inglewood, Cal., has just placed on the market a three-stage Class A recording amplifier which is said to have an overall gain of 82 db, a frequency range substantially flat from 40 to 8,000 cycles, and an output of 12 watts with harmonic distortion of less than 2 percent.

The equipment uses large coupling transformers which are first shielded in copper, and then in cast iron. Laminated iron shelving separates the various stages.

The amplifier is entirely mounted on duraluminum panels in rack form. The power consumption from 110 volts ac is 65 watts.

Variable input and output impedance combinations are instantly available for use in impedance matching and tone regulation.

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NEW KAY HEAD

For the past few years there has been an increasing demand from distributors and dealers of automobile radio for a remote-control unit that could be installed on the instrument panel of any car for any set.

The new Kay head, shown in the accompanying illustration, requires no fitting, cut-

ting or drilling. It is designed in a modern style with illuminated airplane dial, red and black pointers, and chromium-plated bezel ring.

Further information may be obtained from the Kay Products Co. of America, 1036 Bedford Ave., Brooklyn, N. Y.

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UNIVERSAL RADIO POWER TRANSFORMER

The Thordarson Electric Manufacturing Company, 500 West Huron Street, Chicago, announces a universal power transformer, T-7036, for radio receivers manufactured for export and for portable public-address systems which must operate on widely variable frequency or voltage supplies.

A simple arrangement of taps on the transformer permits selection of the correct winding for the following primary voltages: 108, 125, 150, 220, and 250 volts at any frequency between 25 and 100 cycles.

The shield over the primary taps may be removed by releasing four thumb screws. A flexible lead is arranged for connection to any of the primary taps without the use of tools or soldering equipment.

The secondary windings are: 660 volts, center tapped for 90-milliampere dc load, 2 amperes at 6.3 volts and 2 amperes at 5 volts. Size, 3⅜ by 4 by 5-13/16 inches. Weight, 9½ pounds.

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"PERMA-SET"

A new small ceramic base trimmer just brought out is designed to eliminate drifting, as constructional features which might cause drifting are said to have been eliminated. A distinctive feature is that under the pressure of average settings, the top plate has anchorage at both front and rear.

The new trimmer is called the "Perma-Set," and is supplied in maximum capacities of 30 mmfd to 180 mmfd.

Solar Manufacturing Corporation, 599-601 Broadway, New York City, are the manufacturers. They also produce wet and dry electrolytics, paper, mica, and trimmer condensers.

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CINCH TERMINAL STRIPS

The new Cinch terminal strips are used to connect external parts and controls to the set, i. e., dial lights, volume controls, speaker controls, etc. These small, compact strips are made of 1/16-inch bakelite. The contact openings are plainly labeled for easy assembling. Collet type of contacts are used. The cord tips are standard tube prongs, the prongs being fitted with fibre insulator grip.

The Cinch terminal strip is manufactured by Cinch Manufacturing Corporation, 2335 West Van Buren Street, Chicago, Illinois.

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NEW VARIABLE CONDENSERS

The Reliance Die and Stamping Company, 1260 Clybourn Ave., Chicago, have available their new series 50 and 60 condensers. These units are of new reinforced construction. Characteristics of the condensers mechanically are said to be extreme rigidity, smooth uniform shaft tension and universal mountings. Electrically the construction results in an extremely low power loss, it is stated. The minimum of the series 50 condenser is 12.5 mmfd and of the series 60 condenser, 9.5 mmfd. In addition, compensators which have an effective capacity of 22 mmfd may be attached without disturbing the stator alignment.

NEW GOAT TUBE SHIELDS

The demands of the radio industry for constant improvement have been met by Goat Radio Tube Parts, Inc., Brooklyn, N. Y., by the development of the new type form-fitting tube shields shown in the accompanying illustration. The shield assembly consists of cap, body and base.

The body of the shield is composed of two identical half shields. The half shields slightly overlap to insure complete enclosure and glove-like fit, regardless of variations in the diameter of the bulbs.

When the two half shields are fitted to the tube, the shield can easily be slipped into

the base. The half shields are then pressed together near the top and the cap snapped on. The shoulder of the bulb acts as a pivot and the halves are forced outward at the bottom, tightening the shield in the base.

This insures positive contact between shield and chassis and also tends to hold the tube rigidly in the socket. The latter feature is especially important in automobile sets and portables and is said to also be highly desirable in receiving sets of any class.

A shielded tube can be quickly and easily taken out of the set by first removing the cap from the shield and then simply pulling out the tube.

The caps, bodies and bases can be used in any combination, that is, any cap fits any body and any body fits any base.

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HIGH-PERMEABILITY TRANSFORMER CASTINGS

The Alloy Transformer Company, 135 Liberty Street, New York City, are now producing a new line of high-permeability, hum-proof transformer castings. These units are obtainable in all sizes.

All types of audio, power and transmitting transformers will be built to order.

Literature may be obtained on request.

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NEW CRYSTAL LAPEL MICROPHONE

A new crystal lapel microphone of small dimensions has just been announced by Shure Brothers Company, 215 West Huron Street, Chicago. The instrument is known as the Model 73A and weighs only 1¾ ounces exclusive of the twenty-five feet of shielded cord which is furnished. Finish is baked rubber-black japan which makes the unit very inconspicuous against the speaker's lapel. A special spring clip is provided for this purpose.

The Model 73A employs a specially shaped diaphragm and a unique mechanical coupling system which result in a relatively high output level, considering the small size and indirect placement with respect to the speaker's mouth, it is stated.

Due to its small size, the new instrument has many other applications in hearing devices, for crime-detection work, and in laboratory and industrial equipment. The diameter of the unit is only 2 inches; thickness, ⅝ inch. The 73A is fully licensed under patents of the Brush Development Company.

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DECADE RESISTANCE BOXES

The Shallcross 800 Series Decade Resistance Boxes are designed to provide a convenient instrument where a wide range of resistance is necessary, and are said to combine the features of reasonable cost, ruggedness, portability and accuracy.

The following gives the resistance ranges:

Type 825, Range 10 (1-10-100-1000). Total, 11,110 ohms.

Type 826, Range 10 (10-100-1000-10,000). Total, 111,100 ohms.

Type 827, Range 10 (100-1000-10,000-100,000). Total, 1,111,000 ohms.

The Decade Resistances are assembled in an oak box 4¾ inches wide by 7 inches long, having a bakelite panel on which are mounted specially designed rotary selector switches.

These Decade Resistance Boxes find a wide application in practically all fields of electrical measurements.

Complete information may be obtained by writing to the Shallcross Manufacturing Company, Collingdale, Pa., for Bulletin No. 800.

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HIGH-IMPEDANCE VELOCITY MIKE

Retaining such features as natural reproduction and the elimination of feedback, the new high-impedance velocity by Amperite is said to have the added feature of operating directly into the grid—meaning the elimination of the input transformer, and the elimination of the pre-amplifier with amplifiers having a gain of 100 db or more. The high-impedance microphone can be fed directly into the photo-electric cell jack of "talky" amplifiers without any circuit

changes. Condenser and crystal microphones can also be replaced in a similar manner. Another distinct advantage of the high-impedance velocity is said to lie in the fact that ordinary carbon volume controls can be used as mixers. Special low-capacity coupling is used for the microphone lead which should not run over 30 feet.

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UTC VARITONE

The UTC Varitone is an audio device which permits control of the frequency response of any audio amplifier or receiver. Using this device tone correction can be effected for defects in accoustic conditions or overall audio response, it is said. It is also possible to produce new tonal effects from phonograph records or radio broadcasts. This device is made in three types, as follows:

The VT-1 is incorporated with a universal audio transformer. Two primaries are provided. One is suitable for working from a single or double-button microphone, a low-impedance pickup or a line. The other primary is designed to work out of the plate of a tube or from a high-impedance pickup. The secondary winding is center-tapped and is equally suitable for working into one or two grids.

The VT-2 is a varitone control unit incorporated with an impedance-matching device so that it can be connected directly across a 200 or 500-ohm line, low-impedance pickup or mike. It can also be used in shunt with the plate circuit of triode or a high-impedance pickup.

The VT-3 is a complete, self-contained unit which does not use external control. The components are adjusted so that 10 db equalization is effected at 80 and 7,000 cycles. This unit is connected directly from plate to B plus of first audio triode.

These units are manufactured by the United Transformer Corporation, 264-266 Canal Street, New York, N. Y.

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MACY DIRECTIONAL BAFFLE

The Macy Engineering Company of 1451 Thirty-Ninth St., Brooklyn, N. Y., has just released a new model all-metal aluminum baffle. Its use permits a more even sound distribution and very effectively reduces bothersome feedback difficulties, it is stated. It is further stated that its use has been found to increase the efficiency of a cone speaker by as much as forty percent. It is weatherproof, light in weight and free from any metallic resonance conditions. It is demountable and is joined to-

gether with special wing nuts holding the felt-insulated sections together. Mounting loops are supplied for use in hanging the baffle unit to bracket or ceiling support. Back pressure relief is obtained by openings located on the under side of the cone housing. The finish is a brilliant aluminum lacquer. The model MB-10 is supplied for use with all models and sizes of speaker cones up to 12 inches overall size, bell 17 inches, length 20 inches. All hardware for mounting the cone speaker in baffle is supplied.

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NEW NON-INDUCTIVE RESISTORS

The Ohmite Manufacturing Company, 636 North Albany Avenue, Chicago, have recently announced their new non-inductive resistors. These are wire-wound, vitreous enameled units which may be used at their full wattage ratings; and they are said to have very little inductance even on frequencies as high as 2000 kc. This makes them suitable for the entire radio-broadcast band.

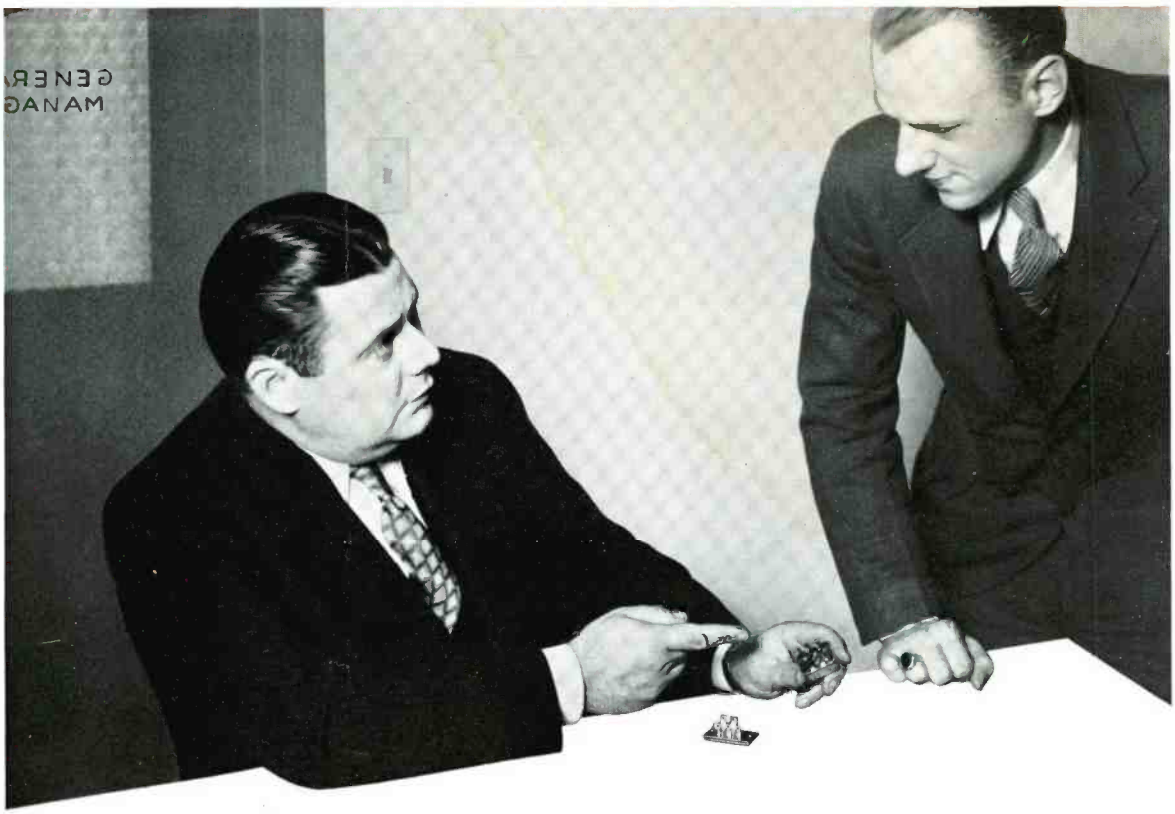
These new non-inductive resistors may be secured in the same sizes as standard Ohmite resistors and with the same wattage ratings. The Ohmite Manufacturing Co., will welcome inquiries concerning these new units.

THE average *paid* monthly circulation of Radio Engineering for the last 6 months of 1934 was 5,028. Total monthly distribution approximately 5,700. (See A. B. C. Audit figures.)

The paid circulation today is approximately 5,400 with a total distribution of well over 6,000.

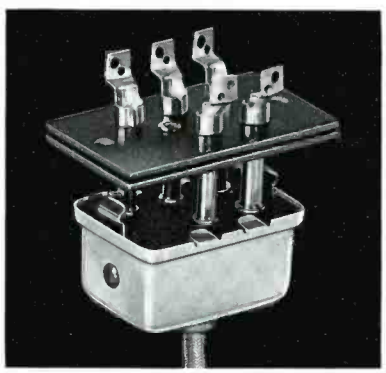
At the I. R. E. CONVENTION in DETROIT, JULY 1, 2 and 3, Radio Engineering will be located in Booth No. 3. Extra copies will be available.

INDEX TO ADVERTISERS



LET'S TELL ALL OF THEM ABOUT THE "SQUARE" PLUG

■ "It saves time, labor and money!" "NEW, MODERN!" "Well satisfied!" These and other comments from present auto set users of the new "square" plug prompted the General Manager to suggest this advertisement. So here it is . . . a scientifically matched "square" plug and chassis socket (pictured here). Dependable, completely shielded, interior of shell insulated with sheet fibre, convenient shoulder on cap for soldering braided cable shield; two bronze spring clips, which snap through chassis when plug is inserted, grounding plug and cable to chassis; these are some of the features. Extra long tube pins, large and small diameter, insure polarization. The socket has full floating CINCH solder coated contacts and a 1/16" bakelite cover insulator plate. This new, serviceable "square" plug and socket comes with two, or up to six, prongs. Users of this "square" plug have been emphatic in its praise—they have told us —and we can just partly tell about it here—so for further information, without obligation of course, write or phone



Designed "square" to eliminate customary twisting or turning for removal.

CINCH

Manufacturing Corporation

2335 W. Van Buren Street, Chicago, Ill.

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Solar Type GEP Capacitors Offer Remarkable Compactness

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Size comparisons are indicated in the illustration above. Approximately three times the capacity will fit the same space; for the same capacity, one third the space is required, as compared with older construction. Most important, the electrical characteristics are superior for many values.

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