MARCH, 1929

25 CENTS

RADIO

IN THIS ISSUE

RADIO RECEIVER DESIGN CONSIDERATIONS

CORRECTION OF CABINET RESONANCE IN DYNAMIC SPEAKERS

ELECTROSTATIC SPEAKERS · A.C. SCREEN-GRID TUBE

SYNCHRONIZATION IN VISUAL COMMUNICATION

A PRACTICAL VACUUM TUBE VOLTMETER

60 70 75 80 85 90 95

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Beautiful butt burl walnut cabinet finished in two tones.
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Established 1917

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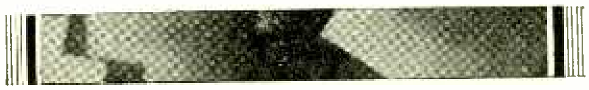
FORECAST FOR APRIL ISSUE

P. S. Lucas describes the construction of a remarkably effective short-wave receiver using the Marshall circuit. Frank C. Jones continues his series on the design of radio receivers; he also tells how to measure the r.f. resistance of coils. Harry R. Lubcke presents information on the construction of an inexpensive high range voltmeter. Max P. Gilliland exposes some mystifying mind reading tricks by the aid of a midget radio receiver. John P. Arnold proposes a tentative system of terminology for visual communication, describes several patented scanning systems, discusses new lamp characteristics, and presents a large amount of miscellaneous information about recent developments in picture transmission. Glenn Browning analyzes band pass filters for use with screen-grid tube r.f. amplifiers. G. F. Lampkin details the 8CAV method of remote control by radio. A. Binneweg, Jr., describes a constant-frequency 20-meter transmitter. R. Wm. Tanner tells how to build a constant-regeneration short-wave receiver.



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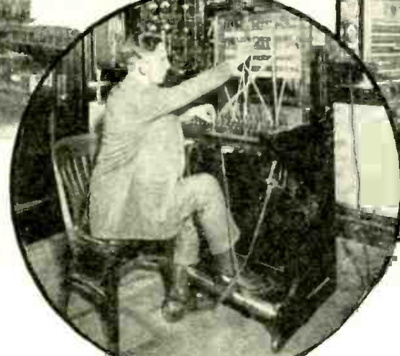

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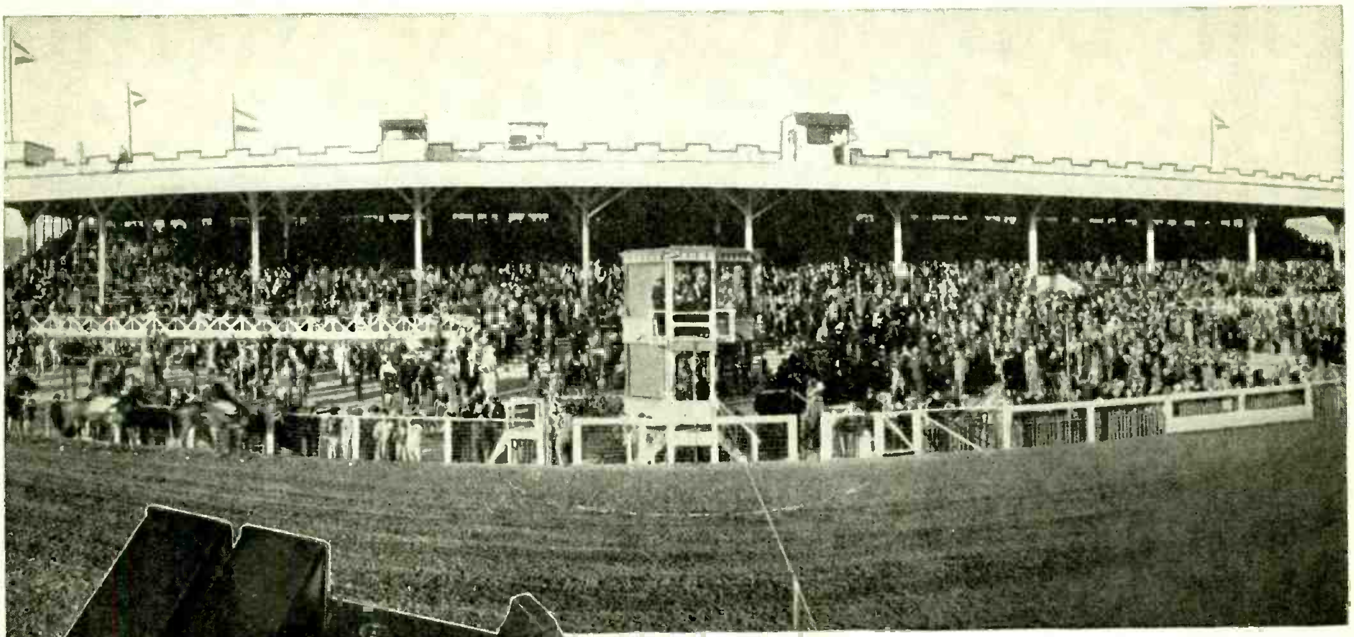

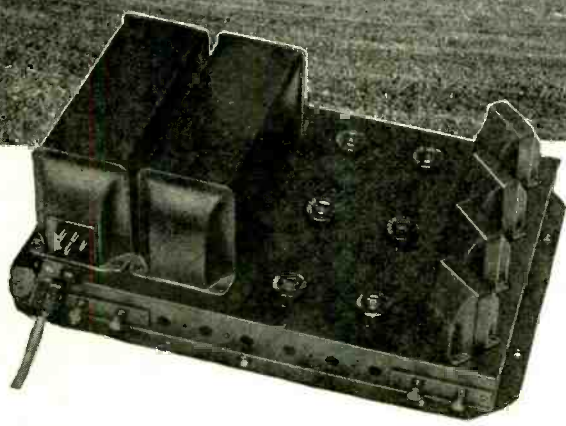

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Price, without tubes, $175.00

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BANG! They're off like a flash—and at Tia Juana (pictured above) the spectators, wherever located about the track, know the whole story because they are informed by means of a PAM 19 and MIK 1.

Every race track is a prospect for you and remember this is but one of a thousand applications for "PAM" amplifiers which are keeping professional set builders and service men busy throughout this country.

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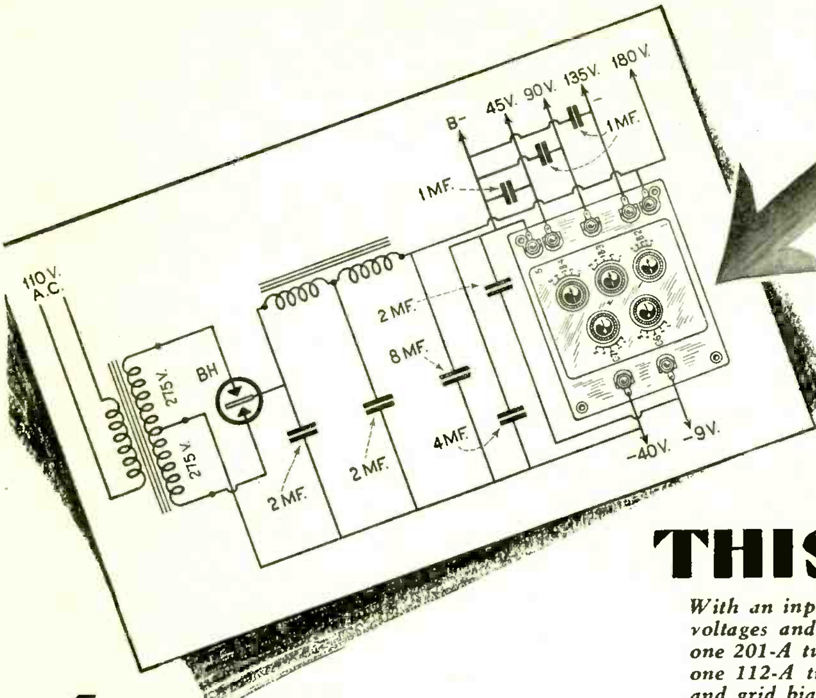


WHAT is the simplest solution to THIS PROBLEM?

With an input voltage of 220—required: to supply plate voltages and grid bias to a six-tube T.R.F. receiver with one 201-A tube at 45 volts, three 201-A tubes at 90 volts, one 112-A tube at 135 volts, one 171 tube at 180 volts, and grid biases of —9 and —40 volts.

Answer:-

The TRUVOLT DIVIDER

U. S. Pat. No. 1676869
and Patents Pending

THE Truvolt Divider is a *universal* resistor. It eliminates the use of a special resistance for each required voltage. By simply connecting it to the output terminals of the filter circuit of the eliminator, the Truvolt Divider will deliver proper plate and grid voltages to any receiver of present or anticipated future design.

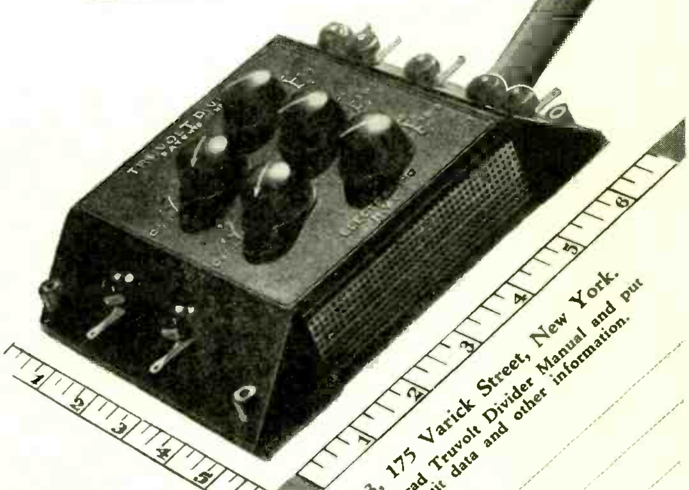
The Truvolt Divider uses a wire-wound resistor having five variable taps. Referring to the diagram above, a maximum fixed voltage of approximately 180 volts is obtained from binding post number 1; tap B-2 will supply any voltage from 160 to 110, tap B-3 any voltage from 110 to 65, tap B-4 any voltage from 55 to 20. The grid bias tap C-6 will supply a grid bias of from —1 to —20 volts, and tap C-7 a bias voltage of from —20 to —40.

Each of the Divider's taps is *calibrated* and practically any desired voltage variations can be obtained by adjusting the various knobs in accordance with easily understood tables and charts, thus eliminating the need of an expensive high resistance voltmeter and complicated calculations.

The Truvolt Divider is handsome in appearance, made of genuine Bakelite, and can be mounted in any desired position on baseboard or sub-panel, or used as a front panel on a metal cabinet, at the same time providing binding posts for all B and C voltages.

Electrad specializes in a complete line of controls for all Radio purposes, including Television.

$12.50



ELECTRAD, INC., Dept. PR-3, 175 Varick Street, New York.
Please send me Free copy of Electrad Truvolt Divider Manual and put me on your mailing list for circuit data and other information.
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ELECTRAD INC.

RADIO

VOLUME XI | MARCH, 1929 | No. 3

Radiotorial Comment

THE imminence of successful television, by wire, is indicated by the statement of Frank B. Jewett, President Bell Telephone Laboratories, that "Today we are relatively farther along in our work on television than we were on transoceanic telephony in 1915, when we conducted the first successful test from Washington to Paris and Honolulu." Yet more than ten years elapsed before commercial transatlantic radio telephone service was established.

Looking to the future of radio motion pictures, David Sarnoff, executive vice-president Radio Corporation of America, believes we shall be well launched into the dawning age of sight transmission by radio within three to five years. "In the meantime, it must be remembered with the poets that art is long and time is fleeting. There is no shortcut in the logical unfolding of an art that promises to extend the range of the eye, as it has extended the range of the ear, to the four corners of the earth."

* * *

FORECASTS of the most modern type of radio receiver which is to be marketed next season indicate that it will use a.c. screen-grid tubes for r.f. amplifiers, and possibly for detector. The r.f. tuners tend toward the band-selector type with ganged condensers adapted for operation with a single dial which is equally divided in terms of kilocycles or channels.

Line voltage control will be an integral part of the most advanced sets, instead of being an accessory. In fact, such sets will require no accessories, as the manufacturers will incorporate all the usual accessories, including the loudspeaker, as an integral part of the set. Most of the new sets will be equipped with dynamic speakers, since the electrostatic speaker is still in the accessory class. Several of them will contain provision for automatic control of volume by means of an additional tube. Automatic tuning will probably be limited in application.

The more expensive sets will be combined with an electric phonograph pickup and turntable, as well as a talking motion picture attachment. The complete instrument will be designed as an effective means for entertaining a family at home.

* * *

MODIFICATION or repeal of the Davis amendment to the Radio Act of 1927, is one of the remedies proposed for extricating radio broadcasting from the troubles with which it is still afflicted. The National Electrical Manufacturers' Association's committee on broadcast allocation states that only the complete repeal of the amendment will be helpful in the present emergency. The Radio Manufacturers' Association recommends that it be amended so as to provide a more suitable and practicable basis for the distribution of broadcasting facilities than is afforded by the present zone arrangement.

Nema believes that modification of zone boundaries and the number of zones, no matter how skillfully done, cannot be a fair basis for equalization. To support this opinion they state that any zoning plan is certain to discriminate against one zone or another in one or more of the fundamental factors, such as total population, density of population, area, type of terrain, geometric shape, and economic conditions. Each of these has an important bearing upon equitable service.

Both associations feel that the Federal Radio Commission has failed to accomplish the prime purpose for which it was organized—namely, the reduction of the actual number of stations licensed, RMA recommending the deletion of stations which are not performing a real service to the public and Nema urging the commission to adopt a standard basis for rating stations for the purpose of deciding the relative values of their service.

Neither has officially expressed its opinion of the efforts of the commission chairman to prolong the commission's life. One of the most capable of the commissioners, however, has suggested that the duties of the commission should be turned over to the Department of Commerce, as originally intended.

The necessity for corrective action along these general lines has been repeatedly stressed in these columns. That the two most influential associations in the industry should publicly concur in urging such changes is indicative of their eventual accomplishment, especially as their criticism is of a constructive character.

* * *

THE broadcast receiver of today represents an evolution from a scientific to a musical instrument. The early radio sets were merely amplifiers of energy. As a laboratory product, they were equipped with laboratory instruments and controls. Their ability to reproduce crudely voice and music was incidental to their ability to amplify electrical voltages.

The first step in their evolutionary development was the simplification of the many controls. These were necessary in the adjustment of a laboratory instrument by a scientist, but were not suited to operation by a novice. Some of the early sets had a dozen or more controls, and were more formidable than the barodiek made famous by Rube Goldberg. Even the first models of the neutrodyne had these tuning controls in addition to filament controls. But now many sets have but a single dial which is marked with the names of the stations which may be heard.

The next step was the concealment of unsightly parts in beautiful furniture. The radio was promoted from the boy's work bench to the family living room, where its howls and squeals, as well as its DX fascination, created many radio widows and orphans.

Then the a.c. filament tube dispensed with the need for messy batteries which always seemed to be run down when most wanted. The radio service man has lost many a good customer because of the a.c. tube.

Latest in this march of progress are the audio transformers and power tubes, together with the dynamic speaker, whereby the lost chords in music have been found.

* * *

COMMERCIAL aviation's greatest problem is psychological rather than mechanical. The public must be sold the idea that flying is safe. Anything that can accelerate the normally slow growth of confidence will hasten the development of aviation.

From this standpoint the necessity for radio communication between plane and ground has been somewhat overlooked. It has been highly regarded as an operating aid, but not as an aid to safety. Yet, even if it were of no especial advantage as a means for directing plane action and notifying of plane troubles, the high regard in which radio is subconsciously held by the public would justify its use.

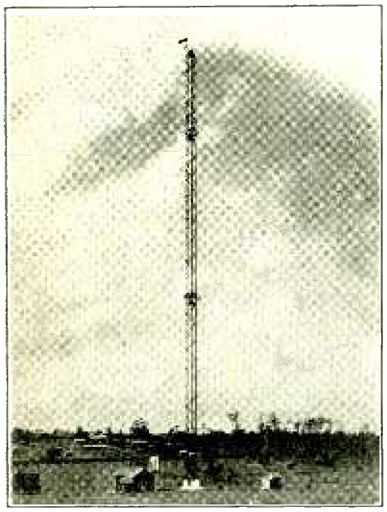
If radio is synonymous with safety in water navigation, how much more important is it in air navigation? It gives the pilot advance notice of weather conditions and keeps him in constant touch with flying fields. Radio beacons guide him through darkness and fog. And finally it is a means for summoning aid in case of emergency.

Governmental and private agencies are rapidly supplying ground radio equipment. The Federal Radio Commission has allocated sixty 10-kilocycle channels between 109 and 133 meters for aircraft communication. But the installation of plane transmitters seems to be lagging, notwithstanding the fact that suitable equipment is available for this purpose. One cause is the difficulty that pilots have in mastering the code, since phone transmission is still in the experimental stage. Furthermore the aviation companies are loath to carry an extra man to act as operator.

Yet the pilot of a steamship is not required to be a radio operator, though it was not until after a number of wrecks that it became obligatory for a steamship to carry a radio man. Eventually, of course, the laws will catch up with progress, and every passenger-carrying plane will be obliged by law to have radio equipment and personnel. But if the air transportation companies are seriously interested in popularizing aviation they will anticipate such a law by providing proper radio facilities at once.

Australian Short-Wave Radio

RADIO telephony between Australia and the United States, and between Australia and Java became an accomplished fact with the inauguration of service on November 1, by Amalgamated Wireless (*A'sia*) Ltd. This service is maintained by means of a 20-k.w. short-wave transmitter at Pennant Hills, and by receiving equipment at La Perouse, both of these stations being connected by wire telephone with the control office at Sydney. This equipment has communicated directly with Bandoeng, Java, and WGY at Schenectady, N .Y., and will eventually be used for telephoning to London.

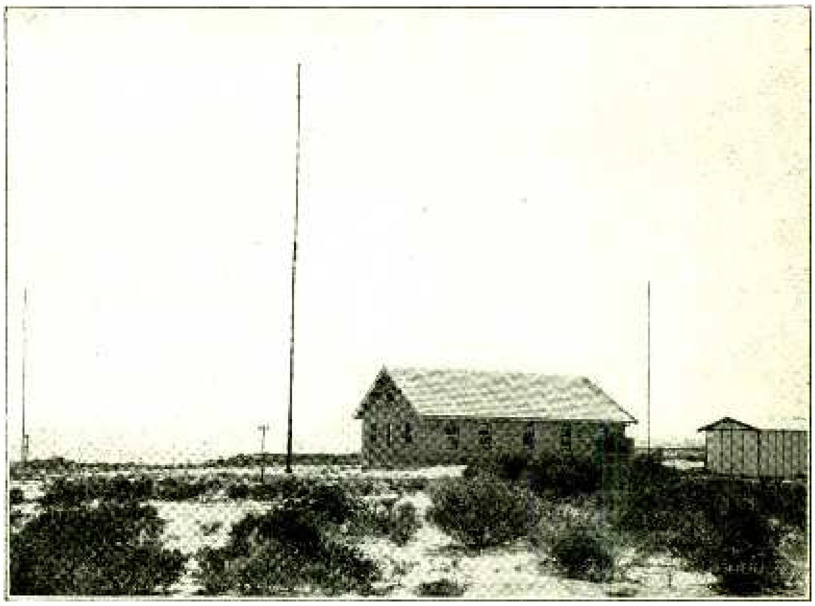


400 ft. Mast at A. W. A. Radio Center, Pennant Hills, Sydney, Australia

Other services maintained by A. W. A. under the supervision of E. T. Fisk, managing director, are the beam feeder communication with Melbourne; between the Coastal Radio Service, Adelaide, Perth, Townsville, and Brisbane; the Island Radio Service with A. W. A. stations at Rabaul, and Fiji, as well as to Noumea, New Caledonia; the N. S. W. police transmitters communicating with police patrol cars; Sydney Radio short-wave long distance transmitters, communicating with ships off the Australian coast; the ordinary 600 and 800-meter marine transmitters communicating with trawlers operating off the N. S. W. Coast; and broadcasting station 2FC.

The whole of these services is operated either from the A. W. A. Receiving Center at La Perouse or from Wireless House, York Street, Sydney, with the exception of Police transmitters.

The 20 k.w. transmitter feeds into one of the aerials supported by the 400-ft. mast at Pennant Hills, 14 miles from Sydney. The transmitter consists of seven units which are designated as follows:



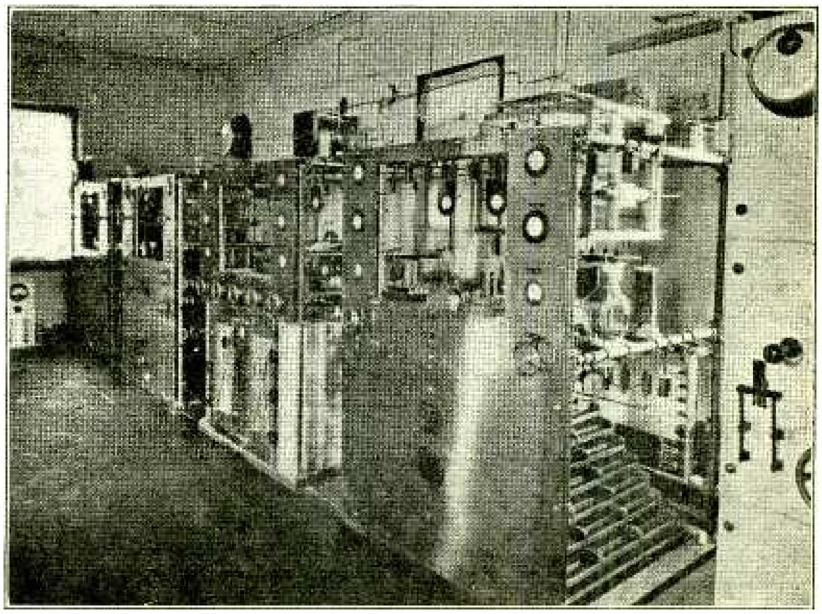
A. W. A. Receiving Center at La Perouse, near Sydney, Australia

1. Drive and No. 2 Magnifier (1 k.w. each).
2. No. 1 Magnifier (3 k.w.)
3. Power Magnifier (20 k.w.)
4. Keying Unit (20 k.w.)
5. Modulator Unit (25 k.w.)
6. Large Rectifier.
7. Small Rectifier.

The tube filaments in the first 5 units are heated from two 140-amp., 25-volt d.c. generators, with the exception of the drive and sub-modulator tubes, which are heated from a 500 amp. hour battery. The filaments of the rectifying tubes are heated by current at 12½ volts, 50 cycles, stepped down from 240 volts.

Plate voltage is obtained from a 30-k.w. rectifier unit, comprising 6 large glass rectifying tubes, and appropriate smoothing circuits, composed of inductances and condensers, while power for the anodes of the drive and buffer circuits is obtained from a 3-k.w. rectifier. The plates are cooled by means of an oil-circulating system.

The wave range of the transmitter is 15 to 50 meters, and can be used for telegraph signals up to 300 words per minute or for telephony. The aerial, which is of the vertical type, is about 400 ft. from the transmitter and is fed by means of lecher wires, which arrangement permits of the greatest possible efficiency being obtained from the radiating system.



20 K.W. Short-Wave Transmitter at 2ME

Radio Receiver Design

The First in a Series of Discussions and Solutions of the Problems Confronting the Factory Engineer

By FRANK C. JONES

PRELIMINARY to the actual design, a study should be made of the conditions under which the receiver is to be operated, the cost of the completed set, and the quantity to be manufactured. An engineer must have a mental picture of the finished product before he starts. The details of the picture may then be changed after laboratory tests have been made.

A receiver should be designed to give the best possible results for the money expended. One costing $400 will be different, and generally easier to design, than one costing $200. Sometimes a low-priced receiver represents a great deal more engineering than does a really expensive set, simply because every penny of its cost has to be put to best advantage. Generally the performance of such a receiver is nearly as good as the more costly receivers. Certainly the manufacturers have less trouble with the sets which have been sold. Any person buying an expensive receiver expects it to be nearly perfect and free from minor defects and promptly reports his difficulties. He expects to run into such things with cheaper sets and generally has some local service man fix it.

The first thing in designing a new receiver is to decide the price class into which it should fall. In practice this should be done by consulting with the heads of the manufacturing concern and making a study of the present, past and possible future market. A new receiver must perform better in at least one way than other receivers of the same cost in order to be a successful seller.

Suppose the concern decides that a $400 set will meet public approval. In such a case the receiver may be designed so as to give lasting satisfaction to the buyer with very little service trouble, or it may be designed for some special feature such as extraordinary distant reception. I say *or* in the latter case because such receivers are generally a source of grief to the buyer, the store, the jobber, the manufacturer, and the poor engineers who designed them. It generally happens that in this case the receiver is designed without a view toward simplicity and long life with little servicing. For example, such a receiver usually has numerous bypass condensers for each part of the circuit with the possibility of punctured condensers after a little use. I mentioned this particular item because many manufacturers in the past have had this trouble. Likely many will in the future.

Care has to be taken to allow an ample factor of safety on all parts that go into the complete receiver and still not throw away money. If the latter happens some other manufacturer will surely get the business with a less costly set, while if the receiver develops lots of service grief, the same thing happens before the radio season is over. Too many of the $400 to $600 class of receivers are designed for the utmost in quality, selectivity and sensitivity without proper thought of service trouble from faulty parts. As a result the public has found that it pays to buy an all-electric receiver costing from $150 to $250 which does not give quite as good results in some ways but doesn't generally become inoperative as easily.

Last season's $300 to $400 receiver may be duplicated, by proper engineering, for $200, as far as quality, selectivity, sensitivity, and appearance are concerned, as will be demonstrated during the coming radio season. Production of a cheaper set, complete with loudspeaker, cabinet, and tubes, is not the function of a relatively small manufacturer, especially if he is not advantageously situated to meet the larger quantity output necessary for this type of set, with its larger market. Operating costs and overhead are high in a small concern and low profit per set means a real financial problem in paying the large patent minimum royalty payments per year.

In case a manufacturer decides not to pay royalties on circuits and parts he uses, it is necessary for him to set aside a good percentage of his profits for later legal battles. By spending a large amount on engineering, some of the more important patents may be evaded and sometimes a real advance is accomplished in the radio art. Certainly independent research is to be commended and should be done even though the manufacturer is fully licensed to use the more important patents. It is only by research in engineering lines that competition can be successfully met each year.

Yet, if too much is spent for research, all the profits are lost, though this seldom occurs. The real trouble can usually be traced to inefficient engineers. They may be either too theoretical or may not have sufficient knowledge of basic principles. There has to be a happy medium.

The next thing after price classification, is to plan the complete set. This depends a good deal upon what patents are available for use in the way of circuits, parts and methods of manufacture of parts. If such are open for use, then some standard form of circuit such as tuned radio frequency, detector and audio-amplifier system will probably be chosen. Trick circuits are usually hard to handle in large production as well as being too costly in manufacture. These circuits have their place in the gradual line of development and often lead to worth while circuits. The radio frequency amplifier circuit will depend upon the various conditions under which the set will be sold and operated. The audio-frequency amplifier and type of loudspeaker depend on the quality of reproduction desired in consideration of cost. *Cost* is the all important word to the engineer.

The fact that a large number of prospective set buyers live in the country or in smaller cities some distance from any good broadcast stations, means that the manufacturer will either have to have a very good amplifier or neglect all of this field. Again, many large city dwellers, especially new buyers, want a radio receiver that will pick up stations several thousand miles away. As an engineer, I deplore this state of affairs, but as an individual I still get a thrill out of picking up some station several thousand miles away in spite of the poor quality and loud background of noise. So with all of us. It gives anyone a nice feeling of superiority to be able to tell his neighbor next morning about getting Japan or whatnot. As far as quality of reproduction is concerned, distant reception is a total loss.

All of these things have to be considered by the engineer and a sacrifice made in the audio system perhaps to obtain good sensitivity or vice versa. Again *cost* plays the leading role. The engineer has to be able to judge accurately what the public will most desire in a radio receiver several months in advance. The receiver has to incorporate new desirable features in exactly the same way that each season's new automobiles have new desirable features. For a given sum of money, the value to the customer has to be increased each season.

Some of the very interesting technical problems confronting the engineers in r.f., detector, a.f. and power supply circuit designs will be taken up in succeeding articles.

Cabinet Resonance in Dynamic Speakers

An Analysis of Its Cause and Cure Based Upon Response Curves

By FRANK C. JONES

CABINET resonance is responsible for much of the booming effect frequently heard from dynamic speakers. In fact some authorities have said that a dynamic speaker in a small cabinet is no better than a good magnetic speaker.

The cabinet provides a convenient and sightly housing for the baffle which is necessary for the satisfactory operation of a cone dynamic speaker. The low frequency sounds are produced by the plunger action of a small cone diaphragm, while the higher frequencies are produced by a combination of this plunger action and the wave motion effects of the cone. Without a baffle, especially at low sound frequencies, the air set in motion by the front and back surfaces of the cone circulates and interferes to reduce the sound output. The baffle tends to separate these two sets of sound waves so that they do not circulate. This baffle preferably should be flat, but may take the form of a cabinet for the sake of appearance.

The baffle consists of a large surface extending out from the front edges of the cone, preferably at right angles to its line of motion. Best results are usually obtained when this surface is so heavy that it has no natural vibration period within the audio-frequency range of the loudspeaker. A baffle does not ordinarily prevent interference of sound waves which are emitted from front and rear of the cone, but does prevent air circulation within certain limitations. This latter effect prevents the listener from hearing any really low frequency sounds in any location in a room unless the baffle is made large enough. This effect is negligible as long as the path through air around the baffle from front to rear of the cone is at least a quarter wavelength of the sound waves.

For example, an 80 cycle per second tone has a wavelength, from one rarefication or condensation of the air to the next, of $1120 \div 80 = 14$ feet. The value 1120 is the number of feet per second through which sound will travel in air at ordinary temperatures and densities. A quarter wavelength then would be $\frac{1}{4} \times 14 = 3\frac{1}{2}$ feet.

A baffle about 3½ feet square, or of that diameter if round, would present a path through air from front to rear of the cone of the proper length to allow the loudspeaker to function down to eighty cycles per second. Below that frequency the sound produced would consist mostly of harmonics which would be many times as intense in volume as the fundamental frequency. This also happens for nearly all frequencies below 200 cycles per second when any magnetic type of loudspeaker is used. The human ear will combine two tones to hear another tone such as 240 and a 160 cycle per second tones giving a third tone of 80 cycles. There is probably a higher resultant tone also, but the apparent lower tone of 80 cycles is quite noticeable if there is present a slight amount of the actual 80 cycle per second tone from the loudspeaker.

A loudspeaker hasn't a perfectly smooth response curve, but varies somewhat with many points of maximum and minimum sound output over the audio-frequency range. Fortunately the human ear is not perfect enough to notice small variations for different frequencies. A variation of less than 10 per cent in volume is very difficult to discern. This means that for ordinary room volume, the loudspeaker may vary about 5 T.U.'s before the change is perceptible to the ear. The variation in intensity of sound for different frequencies at different points in a room often varies much more than this value.

This latter effect is due to reflection of sound waves from walls and other objects in a room and the establishment of standing waves of sound. Standing waves means that the reflected wave is in phase with the direct wave and so there are points of maximum and minimum sound in the room. The location of these waves depends on the frequency of the source of sound. This effect is much worse in a room in which the echo or reverberation is bad. Some surfaces absorb more sound than others and so the use of window drapes, rugs, porous plaster and upholstered furniture aids in making a room suitable for good music reproduction from a radio set. Since the reverberation is less in such a room, the music will be clearer and more sharply defined as one note will not drag over into another more than is desirable. Perfect absorption of sound is not desirable because a small amount of drag-over tends to sustain the music.

These different effects are discussed briefly to show some of the difficulties encountered in making a study of loudspeaker cabinet resonance. The measurements of sound intensity are subject to error due to room reverberation and standing wave effects which may apparently overshadow the effect of cabinet resonance. It was necessary to run a great many response curves, some of which are shown in Figs. 1 to 3. The curves of Fig. 1 were sound intensity measurements taken about 6 in. from the front, rear and sides of a loudspeaker in a small cabinet. The curves are of apparent response and not true response since a small cabinet cuts off at about 70 or 80 cycles per second so far as fundamental tone is concerned.

These curves show a decided cabinet resonance at from 200 to 300 cycles per second. The curves taken from the rear show that the response is much greater at these frequencies relatively than from the front. When the measurements are taken so close to the front the effect of cabinet resonance is nearly negligible. Measurements several feet away from a loudspeaker show, even directly in front,

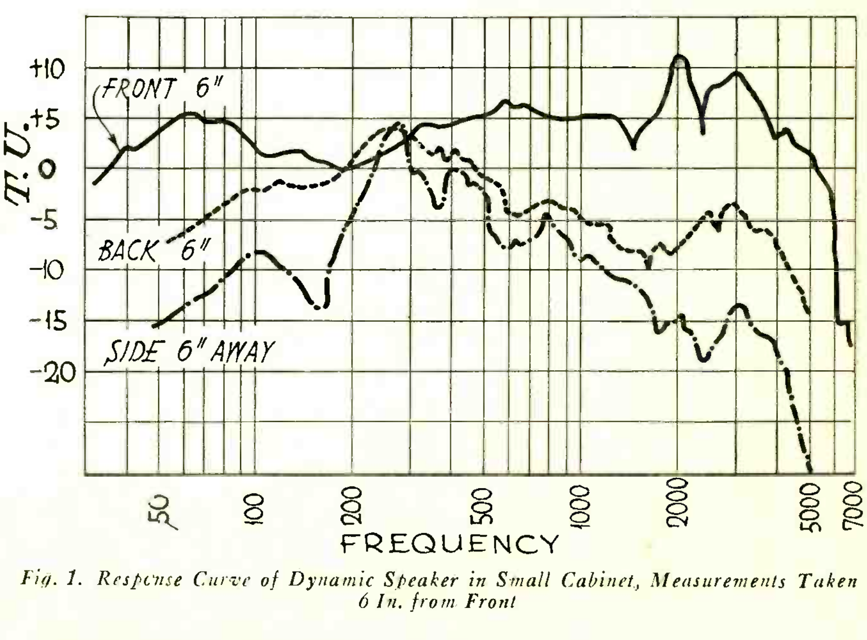


Fig. 1. Response Curve of Dynamic Speaker in Small Cabinet, Measurements Taken 6 In. from Front

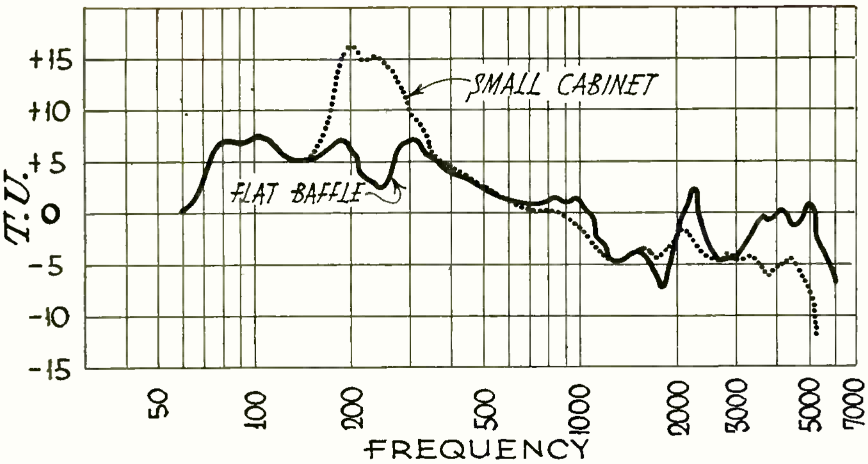


Fig. 2. Response Curve for Small Cabinet and Flat Baffle, Measured 5 Ft. from Speaker

unmistakable signs of resonance, as can be seen in Fig. 2. This illustrates the comparison between flat and cabinet baffles. The baffle in each case is cut off at about 70 or 80 cycles per second, and so gave an interesting comparison. On speech this cabinet resonance peak gives a "barrel" effect while the flat baffle gave very natural reproduction. The voice was much clearer and more defined in the latter case while in the former it was unnaturally deep. The same held true with music.

In Fig. 1 the response 6 in. from the sides shows very great resonance peaks at about 200 to 300 cycles per second. This would indicate that the sides of the cabinet were acting as diaphragms which had a natural period at about that frequency. Making the cabinets of heavier material or of some less elastic material would greatly lessen this fault. Padding the inside with felt would not help much because the felt is hardly heavy enough to damp out the motion of the sides of the cabinet at medium or high volume. Felt is an efficient absorbent of sound waves at high frequencies but is quite poor at low frequencies. Some form of acoustic Celotex or some such material would probably be better and might be advantageously used for the sides of larger cabinets with a thin veneer of wood on the outside for appearance.

Bending the sides of a baffle back in the form of a cabinet forms a cavity or air cushion which tends to absorb the high frequencies somewhat. A cabinet acts somewhat like a horn or megaphone in attenuating the higher frequencies from 4000 to 6000 cycles per second. This effect may be reduced greatly by drilling large holes in the sides so as to let some of the sound waves out. This reduces the effective baffle area but probably its beneficial effects would more than counterbalance that. The sides of the cabinet would also lose their tendency to vibrate at some frequency within the audio range of the loudspeaker. Bending the sides back at an angle of 45 degrees instead of 90 degrees would likely reduce cabinet resonance to nearly a negligible amount. This would give a rather unusual shape of cabinet, but nevertheless might be made artistic.

Fig. 3 shows some curves of sound intensity measured 5 ft. from the loudspeaker of still another cabinet. The resonance at 200 or 300 cycles is less pronounced with this cabinet than in the case of the one measured in Fig. 2, as shown by the solid curve of Fig. 3. The dotted curves of Fig. 3 show that the effect of cabinet resonance is quite bad. These curves of Fig. 3 are quite different from those of Fig. 1, because of the effects due to the room reverberation and standing waves of sound.

Larger cabinets, such as used in console type radio sets with incorporated dynamic loudspeaker, are not subject to such noticeable resonant effects. The natural period is at some lower frequency usually between 75 and 200 cycles per second. The effect on the higher frequencies is also less since there is a larger space around the back of the loudspeaker. Very often the natural period may be roughly located by noting at what low frequencies the sides of the cabinet vibrate strongly. The same methods of reducing cabinet resonance apply for large as do for small cabinets.

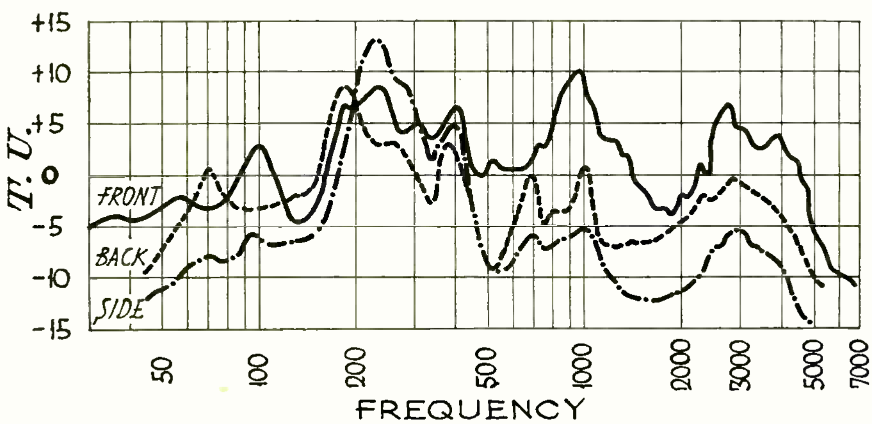


Fig. 3. Response Curve for Small Cabinet, Sound Measured 5 Ft. from Speaker

Measuring Gas Content of Tubes

By Milton A. Ausman

A knowledge of the gas content of a vacuum tube provides a good index as to the tube's probable life, and constancy of characteristics. While these also depend upon the arrangement and spacing of the tube elements, as well as upon the currents and voltages which are applied, the most practical method for predicting the life is based upon a measurement of the gas content, which corresponds to the degree of vacuum.

In general, tubes which have a low gas content are the best performers. So in repairing a tube the gas content should be minimized by highly heating the internal elements and the glass, so as to drive off any occluded gas.

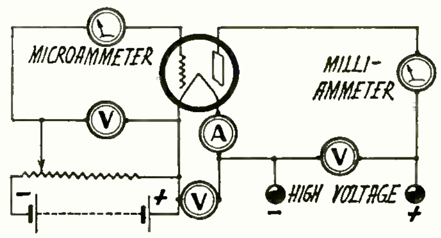


Fig. 1. Circuit for Measuring Gas Content of Vacuum Tube

The relative gas content of tubes may readily be determined from the reading of the micro-ammeter in the grid circuit of Fig. 1. The first reading is taken after five minutes' operation of the tube in this circuit, under its rated or normal plate and filament voltages, and with the potentiometer adjusted across the *C* battery so as to give normal plate current. This first reading is called the total grid current.

A second reading is taken when the tube has cooled after the filament current has been turned off, but while the plate voltage remains on the tube. This reading is the leakage.

Filament voltage is again applied and the meter needle closely watched during its upward swing. In its initial swing the inertia of the needle will carry it beyond a certain point to which it will subsequently drop back before it again climbs upward. The reading at this certain point is recorded. This reading *minus* the leakage reading is the true gas reading of the tube under normal operating conditions.

The Electrostatic Loudspeaker

An Explanation of the Fundamental Principles of the Unilateral and Bilateral Types of Condenser Speakers

By "YOSE"

THE condenser or electrostatic type of loudspeaker is the latest development of intensive research by radio-acoustic engineers. They are continually trying to get greater fidelity in tone production and greater energy from all types of electrophonic devices. Nor do they claim that the electrostatic type is the last word in speaker design, any more than were the electromagnetic and the electrodynamic types. Audio-frequency currents and voltages may yet be converted into sound of greater fidelity to the original in half a dozen other ways, including magneto-striction and corona discharge. But the electrostatic type has graduated from the laboratory and is now a commercial product.

In the simple magnetic type of speaker an iron diaphragm is pulled away from its neutral position by audio-frequency currents which pass through a coil of wire wound around a permanent magnet. If the magnet were taken away and the telephone currents were powerful enough to give the same motion to the diaphragm as before, the predominating sounds, neglecting the effects of eddy currents, would have double the normal frequency; i.e., a 256 cycle note would be heard principally as a 512 cycle note.

The action of a simple electrostatic speaker having one fixed and one movable electrode is quite similar to this theoretic magnetic type. As shown in

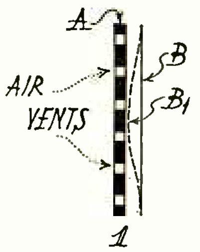


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Fig. 1. Unilateral Speaker without Polarizing Voltage

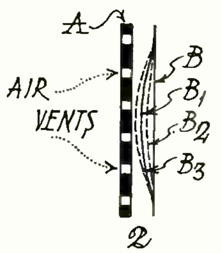

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Fig. 2. Unilateral Speaker with Polarizing Voltage

Fig. 1, the movable metal diaphragm B is attracted toward the fixed diaphragm A, so that B may be strained to a position B_1 at the left of its neutral position, but never to a position at its right. Consequently, this is called a unilateral system, in contrast to the bilateral system to be described later. Like its magnetic counterpart, it normally doubles all frequencies unless preventive means are adopted.

With the magnetic diaphragm, this doubling of frequency is avoided by passing an extra unidirectional magnetic flux through the driving coil. Similarly with the electrostatic type, a "polarizing" voltage is maintained between A and B, which are less than one millimeter apart.

A simple parlor experiment to illustrate this principle was described in an English magazine seven years ago. A thin sheet of bond paper is lightly pasted to the palm of the right hand of several persons, each of whom places the paper against the ear of his right-hand neighbor. The two end persons in this human circuit, whose only bodily contacts are through the pieces of paper, then grasp the output terminals of a radio receiver having at least 180 volts on the plate of the last audio stage, the usual loudspeaker being removed.

When this is done, a soft and clear rendition of speech or music is heard, due to the opposite charges induced on the paper and the ear. If too much paste is used the effect is deadened. In fact it is well to use no paste, but to press all the "diaphragms" in place over the ears and then complete the chain by having the end parties grasp the output terminals. Three hundred or more volts can be used with still better results, but watch for defects in your paper! In this experiment we have both the audio voltage on the electrostatic speaker, plus a d.c. "polarizing" (plate) voltage.

Polarizing voltages and magnetic fields increase the original effects and cut down the doubling of the impressed audio frequencies. Fig. 2 shows the action of a unilateral speaker with a polarizing voltage. The fixed member A attracts the movable member B to a new permanent neutral position B_1 as soon as a d.c. polarizing voltage of say 200 to 800 volts is impressed between A and B.

To pursue the analogy of the telephone receiver, we may think of A as the permanent magnet or magnetic field attracting the telephone diaphragm B away from its ordinary neutral position to a new neutral position. In both these instances the new neutral position has one advantage which the old neutral position B in Fig. 1 did not have—that is, the diaphragm B_1 moves both to right and left of this new position. It takes up positions B_2 and B_3 corresponding to given but opposite strengths of audio frequency voltage or current, as the case may be, and this irrespective of the frequency.

Hence it is easy to see that the original frequency given out of the last plate circuit will be reproduced in the loudspeaker. If the old action as shown in Fig. 1 were still present (and it is to a very slight extent) we should find that the diaphragm would only move from B_1 to B_3 on both sides of an audio frequency cycle.

The polarizing voltage is best applied through high resistances of the order of .5 to 2 megohms. Theoretically, an a.f. choke of 30-50 henries would be efficient in keeping the speaker permanently charged and yet in preventing its variations of potential, as it vibrated, from expending energy in the circuit supplying this polarizing voltage. In Fig. 3 such chokes are indicated at C and D. As their effect is uneven over the audio

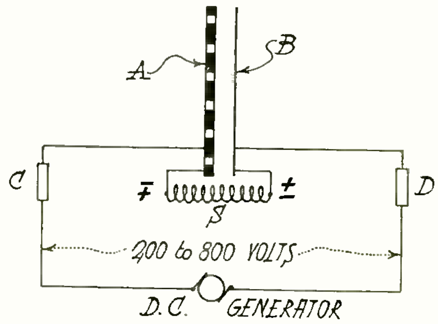


Fig. 3. Method of Applying Polarizing Voltage to Unilateral Speaker

range, they would permit the bass notes to be lost through the d.c. generator or B battery, while the high notes would come through normally: the chokes would prevent their leaking away.

If, however, C and D are high resistances, their effect is uniform over the whole a.f. scale. Resistances also minimize the development of electrical resonance at a certain frequency, which chokes at C and D might produce, considering A and B as a series condenser. A 12-in. disc separated by less than one millimeter from another has an appreciable capacity of the order of 800 m.m.f.

Most commercial types of electrostatic speakers employ a thin membrane as a movable element and an air-vented fixed element which also protects the membrane. This somewhat limits the amplitude of the direct piston action, which is one of the factors upon which depends the fidelity of tone reproduction.

Greater piston action could be had by using a larger moving element as illustrated in Fig. 4, where *a* shows elements of equal diameter and *b* and *c* show the same size for *A*, but larger diameters for *B*. When the greatest displacement of B toward A is the same in all three cases, the larger diaphragms require a greater restoring force. As the radial stresses in B for the type of speaker in Fig. 4*a* with a 12-in. speaker are close to the elastic limit of the 5 mil. membrane which is used, the larger B elements have not yet been commercialized. The obvious trick of fastening a stiff circular patch to the larger B elements

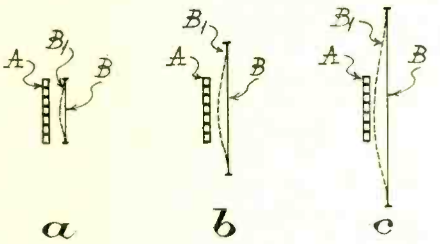


Fig. 4. Larger Movable Plate Gives Greater Piston Action

reduces the amplitude and makes the response curve more "lumpy."

The other factor which gives such great fidelity to an electrostatic speaker is its high damping with consequent freedom from membrane "ripples" and "weaving." This absence of diaphragm resonance is illustrated by the unusually flat response curve.

In the unilateral type the pull on a given surface in B is inversely proportional to the square of its separation from A. At half the separation, the pull is four times as great; at one-third, nine times, etc. For acoustic fidelity, B's motion from its neutral position should be strictly proportional to the voltage between B and A, which can be true only when B's displacement, even under great loads, is small compared to the separation between A and B. This condition can be attained either by stretching B more tightly or by increasing the separation between A and B, which introduces some difficulty in the operation of the unilateral type of speaker.

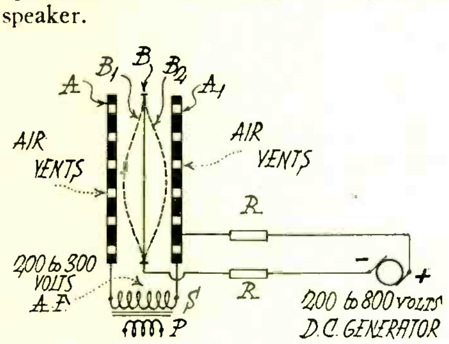


Fig. 5. Bilateral Speaker

Fig. 5 shows a bilateral speaker in which the two fixed plates A and A_1 are connected to the secondary of an audio transformer whose primary is in the output circuit of a 200-400 volt a.f. stage. The movable element B is accurately adjusted so as to be exactly midway between and parallel to A and A_1, whose inner faces are carefully machined to plane surfaces.

A polarizing voltage is ordinarily used with a bilateral speaker to strengthen B's response to a.f. voltage, although it is not necessary to prevent doubled frequencies, which cannot occur if B is exactly midway between A and A_1.

Fig. 6 is the circuit diagram for an oscilloplane type of electrostatic speaker with two '50 tubes in push pull. Plate voltage for the tubes and the polarizing voltage for the speaker are supplied from a 400-800 volt d.c. source. The polarizing voltage is supplied through resistances R and R_1, which are from 1 to 2 megohms each. The plate voltage is supplied through the chokes K and K_1, which are from 25 to 50 henries each and so placed that a.f. currents cannot pass through them, but are bypassed through 2.4 mfd. condensers C and C_1.

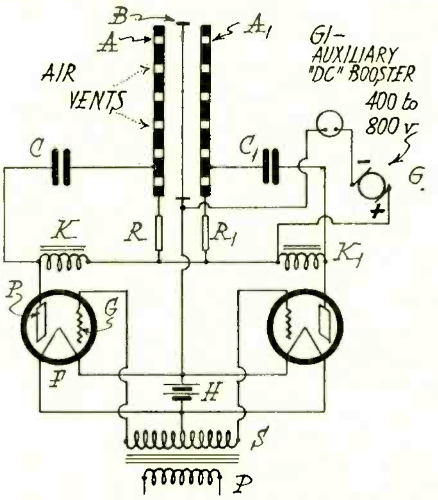


Fig. 6. Diagram of Connections for Bilateral Speaker

This type of speaker uses a thin alloy diaphragm of great elasticity and tensile strength. Other manufacturers are proposing to use metal foil as a conducting covering for a thin porous dielectric of flock paper, balsa wood, or exploded rubber. Some are curved like a sphere, so as to destroy self-vibration and be more nearly dead-beat. These are being adopted under the theory that a resilient, spongy dielectric more quickly recovers its dimensions under stress than does a stretched vibrating surface whose energy is dissipated in the air. Some of the many patents will undoubtedly form the basis for an electrostatic speaker giving fine quality and good volume through the entire audio-frequency range.

An inexpensive and effective relay may be made from an old door bell by removing the vibrator contact and bell, changing the wiring so that the current will flow directly through the windings, and arranging a contact on the clapper arm. This can be most easily done by mounting it on a wooden block 4 x 6 x ¾-in.

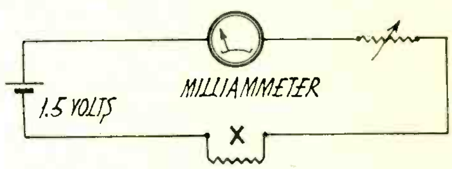
A DIRECT READING OHMMETER

By Carl Joseph

An ohmmeter is useful for checking circuits, a.f. transformers for burnouts, etc., and for roughly obtaining the resistance values of power pack resistors. It is inexpensive, easy to construct, and what is often more important to the home constructor, it can be calibrated by computation and therefore requires no additional laboratory equipment.

The material required is a milliammeter of 1, 5, or 10 milliampere range, a variable high resistor, a flashlight size dry cell, and a suitable panel and case.

The maximum resistance value obtainable depends upon the meter, the 1 milliamp meter giving a maximum reading of about 15,000 ohms, the 5 milliamp about 6000 and the 10 milliamp about 3000 ohms. Theoretically, the maximum value of all the units is infinity,



Circuit Diagram for Direct Reading Ohmmeter

but due to the crowded scale for the higher values, the least reading on the meter determines the useful range.

Having chosen the meter, the nominal value of the resistor can be determined by Ohm's Law: $R=E/I$. I must be in amperes, not milliamps, and E may be taken as 1.5 volts for the dry cell.

If we insert an unknown resistance in the circuit at X, $X=E\ (1/i-1/I)$ where i represents the current shown by the meter with X in the circuit. $1/I$ is a constant for any one meter and is the reciprocal of the full scale current of the meter. It will be noted that this equation is independent of the voltage of the cell, any change in cell voltage being compensated by the variable high resistor R which is adjusted for full scale reading before making any measurements.

The range of the instrument may be increased by increasing the voltage, being doubled or trebled by using two or three cells respectively. At the same time the resistance of the variable resistor R must be increased so as to give a zero reading with the greater voltage. The added voltages are of especial value in increasing the range of 5 or 10 m.a. instruments. If a 1 milliamp meter is used, a 10 milliamp shunt will greatly increase its useful range, one range having a maximum of 3000 ohms and the other 30,000 ohms. In using the shunts, the same variable resistor can be used, it

(Continued on Page 34)

Radio Picture Transmission and Reception

Photoelectric Equipment and Methods for Visual Communication

By JOHN P. ARNOLD, *Departmental Editor*

SYNCHRONIZATION IN VISUAL COMMUNICATION

THE problem of synchronization in visual communication is that of maintaining the apparatus for scanning the subject at the sending station in step with the apparatus for recomposing the images at the receiving station.

The meaning of the terms *isochronism* and *synchronism* should be fully understood in this connection. Isochronism refers to mechanisms that rotate, vibrate, or move in equal intervals of time. For example, we have two clocks, both keeping correct time, but one is set for 12 o'clock and the other for 6. Both of these clocks will mark off the seconds, minutes and hours together (i.e., in equal intervals of time), and thus they are in isochronism but not in synchronism. To operate synchronously, both clocks must be set exactly to the same hour, minute and second, and thereafter the hands must move around the dials simultaneously. When this takes place, clocks, motors, pendulums, etc., are said to be in step, phase or synchronism.

Various methods have been suggested for this purpose. Those described here have been in operation at one time or another and have the merit of being something more than an engineering job worked out on paper. For this reason, they are worth studying.

I. Phototelegraphy

It is well known that the frictionless pendulum, when compensated for temperature, is an accurate instrument for marking off equal intervals of time. This compensation is usually effected by employing metal rods of dissimilar linear coefficients of expansion in order that the distance of the bob below the point of suspension always remains the same. Rods of iron and copper, for instance, might be used for the shaft, the former tending to lower the bob while the latter tends to raise it. When the total lengths of both sets of rods are made inversely proportional to the coefficients of expansion of iron and copper, complete compensation for temperature is secured.

The very first system of phototelegraphy used pendulums for obtaining synchronism. As a matter of historical interest, one of the drawings of Alexander Bain's patent of 1842 is reproduced here, (Fig. 1). The pendulums at both the sending and receiving stations were kept in step by electromagnets. If one pendulum arrived at the end of its arc before the other, it was held up until the second pendulum reached the same position; then they began a new swing by being released simultaneously. The pendulums controlled the apparatus at both stations for scanning and reproducing (by the electrolytic method) the original subject matter.

In addition to the temperature effect, the value of gravity, which varies at different points on the earth, is another factor that will prevent accurate synchronism between stations widely separated. For this reason, it is more satisfactory to use only one pendulum, and that at the sending station, which controls by electrical signals sent to the receiving station the movement of the reproducing apparatus.

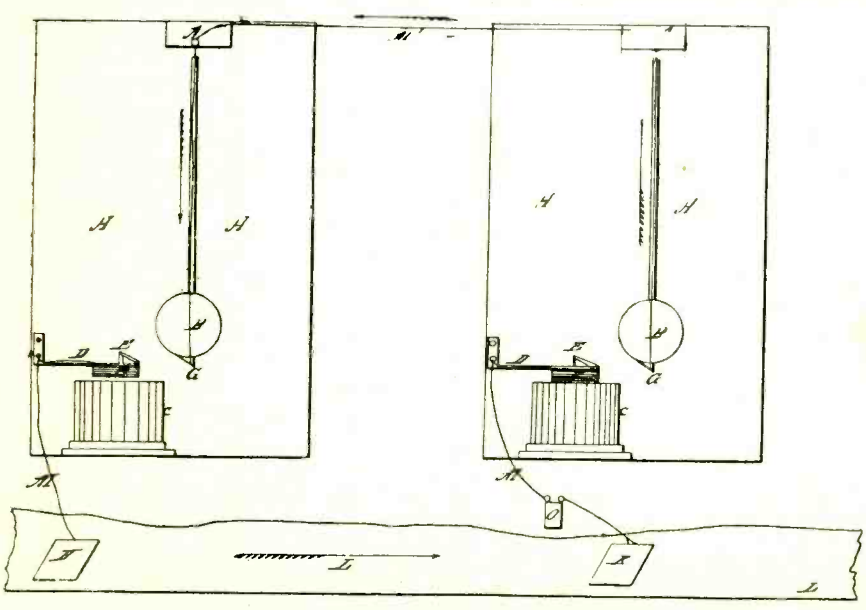


Fig. 1. Copy of Bain's Original Patent

The use of pendulums for synchronizing naturally suggested to the early experimenters in phototelegraphy other forms of clockwork to obtain isochronism or accurate timing of two or more mechanisms. A special form of chronometer, shown in Fig. 2, was employed by T. Thorne Baker for transmitting pictures by wireless.

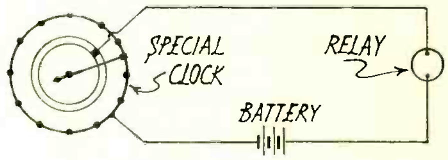


Fig. 2. Baker's Method

In an address before the Royal Institution of Great Britain on April 22, 1910, he described the method as follows:

"The first method secures accurate synchronism independently of any wireless communication. You have already seen how in the ordinary telegraphic work the receiving cylinder is driven rather faster than the sending one, and when it finishes up a complete turn too soon it is arrested until the sending cylinder has caught it up, when the latter sends a reverse current which is responsible for its release. But in the wireless apparatus both sending and receiving cylinders are driven too fast, so to speak; that is, they are made to revolve in four and three-quarters seconds instead of a nominal five. A check comes into play at the end of the revolution, and the cylinder is stopped until the five seconds are completed, the motor working against a friction clutch in the ordinary way during the stop. At the end of the fifth second each cylinder is automatically released by chronometric means. . . .

"Here you will see that a special form of clock is used, with a centre second hand which projects beyond the face about an inch, and to the end of it is attached a brush of exceedingly fine silver wires. At every twelfth part of the circumference of the clock dial is fixed a platinum pin, and consequently every five seconds the little brush wipes against the convex surface of one of them. Each of these pins is connected with one terminal of a battery, the other side of the battery leading to the relay as does also the center second hand. Therefore each time the brush wipes against a pin the circuit is closed, and the relay throws into action the local circuit connected up with the terminals. This circuit excites an electro-magnet, which attracts an armature and pulls away the check which is holding back the cylinder. At the end of each five seconds the cylinders consequently recommence turning.

"Well calibrated clocks of the pattern used will keep good time for the period taken to transmit a picture, one gaining on the other quite an inappreciable amount, depending on the friction of the brush against the pins. By this means the two cylinders are kept in very fair synchronism independently of any wireless communication, and the less the interval between the stopping and restarting of the cylinders be made, the more accurate and satisfactory will be the effect."

The so-called "stop-start" system, which was successfully developed by D'Arlincourt, Korn and others and which is now used in the Cooley method of transmitting photographs by radio, is shown in an elementary form in Fig. 3.

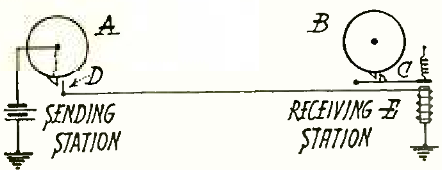


Fig. 3. "Stop-Start" Method of Synchronism

Here two cylinders, *A* and *B*, at the sending and receiving station respectively, are driven by electric motors, the receiving cylinder turning over at a rate about one per cent faster than that of the transmitter. At the completion of every revolution a projection on *B* comes in contact with the check *C*. Thus the receiving cylinder is held up until a contact on the sending cylinder completes the electric circuit through *D*, which energizes the electromagnet *E* and causes it to release *C*. Both cylinders therefore always begin a new revolution together and, as the synchronism is checked at each rotation, an accumulation of errors, which would spoil the picture, is avoided. The driving power is usually transmitted to the receiving cylinder in such a system through a friction clutch or a like mechanism in order that the power may be applied instantly when the cylinder is free to turn. The fact that the receiving cylinder moves slightly faster than the one at the sending station does not cause serious distortion of the received pictures if so adjusted that the interval during which the check *C* holds up the cylinder is reduced to a minimum. Still, this method has become antiquated, since other means have been developed.

An accurate and very satisfactory method of synchronism is that which employs electrically-driven tuning forks to control phonic wheels or impulse motors. Two or more of these motors can be maintained in exact synchronism by a tuning fork vibrating at a constant frequency. Although temperature variations will affect the frequency of the fork slightly, this is of no moment if the fork is located at the transmitting station and the impulses are sent to the receiving station or stations to control similar impulse motors at that point. A complete discussion of the construction and operation of impulse motors and driving forks is given in "Printing Telegraph Systems," Bell Trans. A. I. E. E., Vol. 39 (1), pp. 167-230; 1920.

Such a system is described by Edward F. Watson (U. S. Pat. 1,590,270; June 29, 1926) and shown in Fig. 4. The cylinder, *1*, at the sending station is driven by the phonic wheel, *3*, controlled by the tuning fork, *4*. This fork has a definite natural period of vibration which is maintained by the electromagnet, *5*. A carrier current is generated by means of the a.c. generator, *7*, geared to the shaft of the phonic wheel. Thus the current generated will have a frequency which varies directly as the speed of the phonic wheel motor. The current from the generator is applied to the input of the modulator, *12*, together with the picture currents and then transmitted to the receiving station.

The receiving drum, *17*, is also connected to another phonic wheel driven by a tuning fork, *20*, which has a natural period the same as the fork at the sending station. The frequency of this fork is also maintained by a driving magnet, *21*. An a.c. generator, *22*, is also directly geared to the phonic wheel motor. Thus, the speed of the generator varies directly as the speed of the phonic wheel, *19*, and accordingly, the frequency of the current produced by the generator is a rectilinear function of the speed of the shaft *18*. This generator is so designed that when the cylinders, *1* and *17*, are rotating in exact synchronism, the frequency of the current produced by the generator is a given definite amount less than the frequency of the current produced by the generator, *7*; for example, a difference of 100 c.p.s. It will also be noted that the generator, *22*, has its output fed to the input to a beat frequency detector ***BD***, the output of which is connected to the relay, *41*, the latter controlling the frequency of the fork, *20*, and thereby the speed of the cylinder.

In operation the relay operates at a rate determined by the beat frequency of the two currents (the current from the line and that produced by generator, *22*) impressed upon the input of the beat detector. Should the receiving cylinder vary in speed from that of the sending drum, the frequency of the current produced by the generator, *22*, would vary and thereby the beat frequency current would vary. For example, if the speed of the receiving cylinder falls off, the difference between the beating frequencies increases and accordingly the rate of operation of the relay increases. The increased speed of operation increases the speed of the fork, *20*, whereby the cylinder is accelerated and brought into synchronism with the sending cylinder. In this way exact compensation or correction is made for any tendency toward speed variation of the receiving cylinder with that at the sending station.

(To Be Concluded)

Large holes may be easily drilled in bakelite by first drilling a small hole with a No. 45 drill, then clamping it in a vise with a piece of hardwood at its back, and finally following the small drill hole with a large one. One or two large holes for meters, etc., can thus be further drilled with an extension wood bit, drilling halfway through the panel from either side. If more holes are to be drilled, a regulation tool should be used, as the wood bit will soon be dulled. Any swelling of the bakelite can be remedied by tightly clamping it between metal plates held in a large vise.

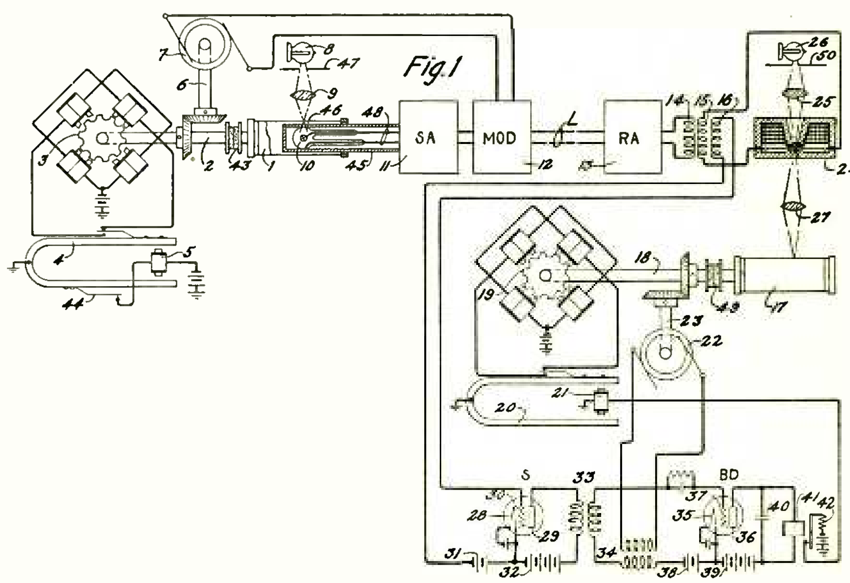


Fig. 4. Tuning Fork Method of Synchronism

NEON LAMP CHARACTERISTICS

The place of the gas-filled, glow discharge tube—better known to experimenters as the neon lamp—in television systems can be understood only when one is familiar with some of its fundamental principles of operation. For this purpose it is necessary to refer to the characteristics of a particular type of neon lamp which has recently been developed. The appearance of this lamp is well enough known, but a little light on the subject of how it should be operated will not be out of place.

The characteristics of such lamps are best presented in the form of curves or graphs which reveal at a glance the conditions under which they can be most satisfactorily employed. The curves, shown here, and the explanation and interpretation of them which follows, are taken from an article by D. E. Replogle of

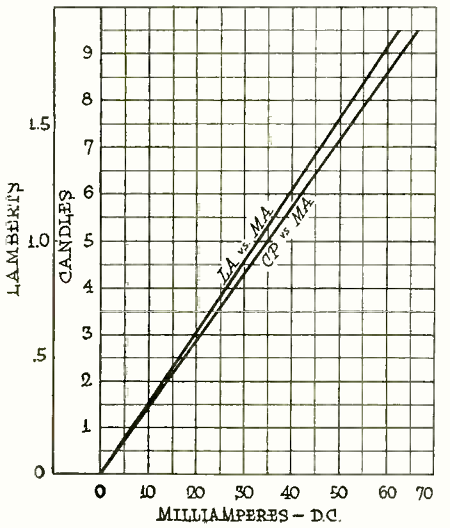


Fig. 1. Relation of Light Output and Brightness to D. C. Current

the Raytheon Manufacturing Company. Hence the discussion refers particularly to the product of that company, but the facts, if not the figures, are equally applicable to other neon lamps which necessarily (on account of the purpose for which they are designed) are constructed in much the same manner, and these facts will be helpful in solving some of the problems which arise in connection with their use in television receivers.

Fig. 1 shows the variation in apparent candlepower (the luminous intensity given by a standard candle) as viewed in the direction normal to the cathode surface and also the surface brightness measured in lamberts as the current through the tube is varied. (The lambert is the measure of surface brightness and is the surface brightness that will give one lumen—one candlepower will radiate from a flat plate approximately π lumens—per square centimeter or gives a luminous intensity of .32 candlepower per square centimeter of projected area.)

It is readily seen that both the apparent candlepower and surface brightness are directly proportional to the current and the proportionality factor or slope of the curve is respectively .14 candles per milliampere of current through the tube and .03 lamberts per milliampere through the tube.

For the best results in a television receiver the slope of these lines is particularly important as it is the variation between maximum and minimum brightness with maximum and minimum current that gives definition to the received image. In designing these lamps this slope is made as steep as possible and it is an excellent index of the performance of the tube.

Direct current of a minimum value is passed through the lamp at all times, this current being either the plate current of the power tube or supplied from an external battery. An a.c. voltage, which is the output from the power tube as the result of the received television signal, is then impressed on the lamp. This voltage causes a varying current to flow. If a black background is desired in the received image the amount of a.c. variation should be such that the lamp ceases to glow at the minimum value and should glow as intensely as possible with the maximum impressed voltage.

In the ordinary use of the lamp for television reception it is desired to obtain the greatest possible contrast between the light and dark portions of the image as viewed, in other words between the brightness of the lamp at maximum and minimum value of current. This is determined largely by the amplitude of the a.c. current which is supplied to the lamp by the receiving set. The minimum steady current at which the glow covers the surface uniformly is approximately 5 milliamperes. If the current is reduced below this, the glow first fails to cover the entire surface, leaving dark areas on the plate, and later the lamp goes out entirely.

The curves of Fig. 2 are based on

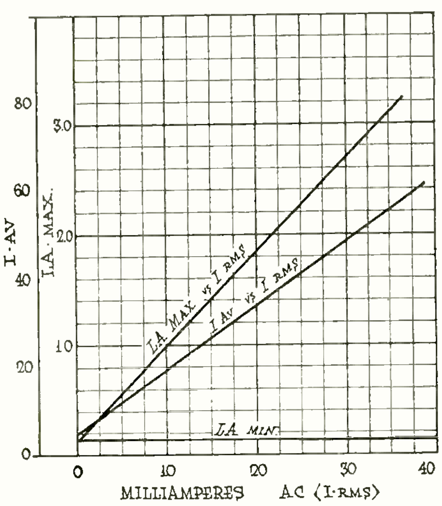


Fig. 2. Relation of I-RMS and of Brightness to I-AV

the operation of the lamp so that the total current falls to a value approximately 5 milliamperes. They show first, the value of surface brightness in lamberts corresponding to this minimum value of current; second, the brightness corresponding to the average current, namely, 5 milliamperes d.c., plus the average of the a.c. component; third, they give the corresponding value of maximum brightness in lamberts for a given impressed a.c. current. It is readily seen that the difference between the maximum brightness and minimum brightness increases in direct proportion to the amplitude of impressed a.c., which is the picture signal.

The curve of Fig. 3 shows the corresponding ratios of maximum to minimum brightness and gives an indication of the

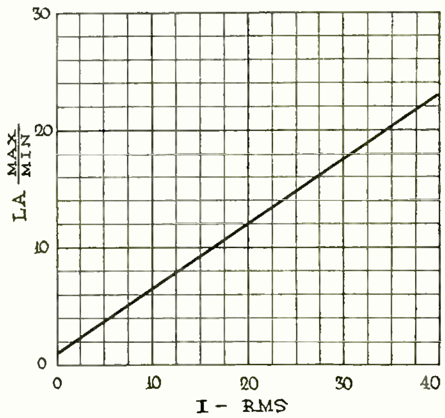


Fig. 3. Variation in Brightness With Change in Alternating Current

relative brightness of light and dark portions of the picture as received with various values of a.c. current through the tube. Since the smallest change in brightness that the eye can detect is directly proportional to the instantaneous brightness, the visual contrast between two intensities of light having different values of brightness is best expressed in terms of the logarithm of the ratio of the two brightness values. Thus, the curve of Fig. 4 gives the logarithm of the

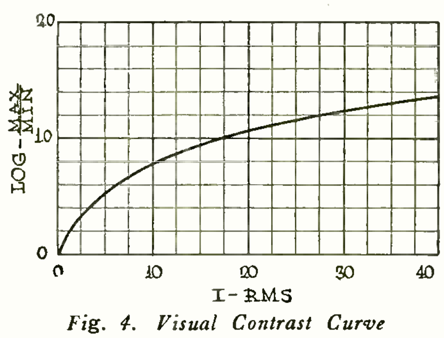


Fig. 4. Visual Contrast Curve

brightness ratio shown in Fig. 3 and the ordinates of this curve may be taken as a measure of the relative visual contrast between the bright and dark surfaces under the conditions previously stated.

As gas discharge tubes are inherently

unstable, that is, have a very pronounced negative resistance characteristic, it is always necessary to operate them with a series resistor to prevent the current from rising to an excessive value.

The second curve of Fig. 6 shows the approximate value of resistance required to hold the current in the lamp to any desired value when operating on 180 volts direct current. Both the curves in this set show average values and are given only as an aid to set design. Individual tubes will show variation from values indicated in these curves and in practice the series resistance should be adjustable to compensate for variations in the lamps.

When a series resistance is used other than the amplifier tube itself or the coupling resistors, it should be shunted by a large bypass condenser so that the impedance to the a.c. component of current will be low.

The curve of Fig. 5 is based on the value of lamp resistance shown by the curves of Fig. 6 and represents average values. As stated previously, it is obvious that the greatest contrast is obtainable by operating the lamp so as to give the lowest possible instantaneous value of current and the highest possible value of current, the contrast being determined by the values of the fluctuation of current in the lamp itself. The value of the fluctuating component of current in turn depends on the amplitude of the signal received and the degree of amplification in the receiving set.

The amplitude of the a.c. component that the lamp will handle and the corresponding image brightness and the contrast obtainable with strong signals are limited by the average or d.c. component of current that can be safely passed through the lamp. Good contrast can be obtained by a steady d.c. current of 10 milliamperes and it is recommended that the d.c. current be not allowed to exceed 20 m.a. Operation at higher value of current, while making the image brighter, is not needed as the contrast of minimum to maximum intensity does not increase rapidly with higher values of steady d.c. component of current. An excessive d.c. current through the lamp will result in a proportional reduction in its life which will be manifested by a gradual increase in operating voltage and resistance of the lamp and a gradual blackening of the bulb.

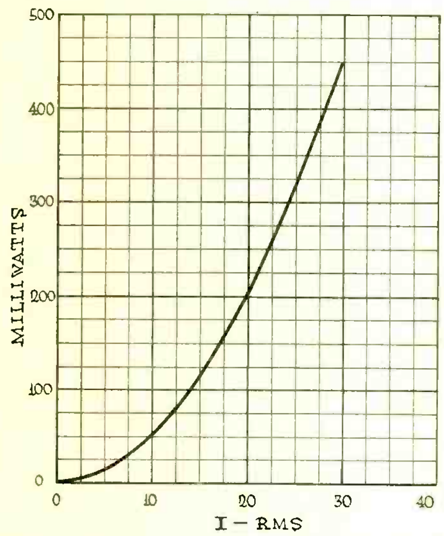


Fig. 5. Relation of Current Output to Power Output

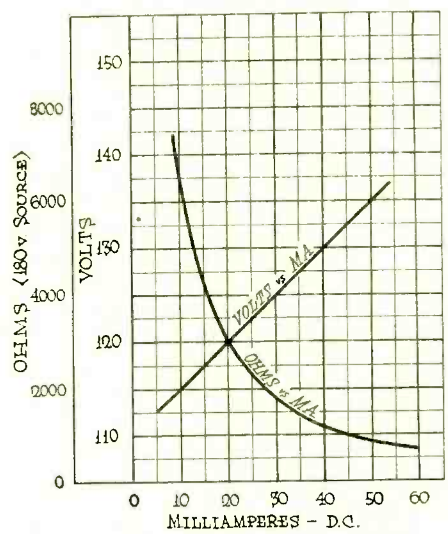


Fig. 6. Value of Current-Limiting Resistance and Internal Impedance

In Fig. 5 the curve shows the relation between the a.c. current output and the milliwatts required to supply it. Lamps of the type described here should be operated from a d.c. voltage supply of approximately 180 volts. The average variation of voltage drop in a lamp with varying current is shown in Fig. 6. This is also approximately a straight line, the slope corresponding to approximately 500 ohms. This represents a resistance offered by the lamp to changes in current within the operating range and can be considered its internal impedance.

While the impedance of this lamp is 500 ohms it can be used directly in the plate circuit of power tubes such as 171 or 210 without any effort made to match the impedance of the tube used. When so used, the undistorted output in wattage will be less than if the impedance were matched, yet the response of the tube will be satisfactory. Various methods of coupling the lamps in vacuum tube circuits are shown in Fig. 7.

OPERATION OF RAYPHOTO SYSTEM

(Concluded)

Reception of photographs by radio requires a certain amount of experience and some skill on the part of the receiving operator. This should not be taken to mean that a highly specialized technical training is demanded; yet the fact remains that the excellence of reproduction does depend in a measure on the ability of the operator. The skillful man coaxes the last long mile in DX reception where the dub produces nothing but squeals from the ordinary receiver. Also, in picture communication, one man will obtain reproductions which closely follow the original subject, while another, the conditions of transmission being the same, will secure distorted, poorly contrasted pictures as a result of his lack of ability in operating his receiver, and due to his ignorance of the processes of developing the photographs.

In receiving photographs by the Cooley method two major adjustments of the receiver are important. The first is necessary in obtaining synchronism with the transmitting station. When a picture is broadcast, a series of warning signals are first transmitted, consisting of the 800-cycle picture signal and the 1500-cycle synchronizing signal. Assuming that the apparatus has been set up as previously described and the preliminary adjustments have been made, the phonograph motor should be wound and the switch of the recorder turned on. The control R_1 is then turned slowly from left to right until the cylinder starts rotating and the trip magnet begins to click regularly in step with the 1500-cycle note, which may be distinguished from the picture signals by its higher pitch.

Regulate the speed of the drum by adjusting the phonograph speed regulator. With the regulator in the "fast" position, observe that the bevel gear at the top of the vertical shaft holds momentarily. Gradually reduce the speed of the phonograph motor until the in-

(Continued on Page 35)

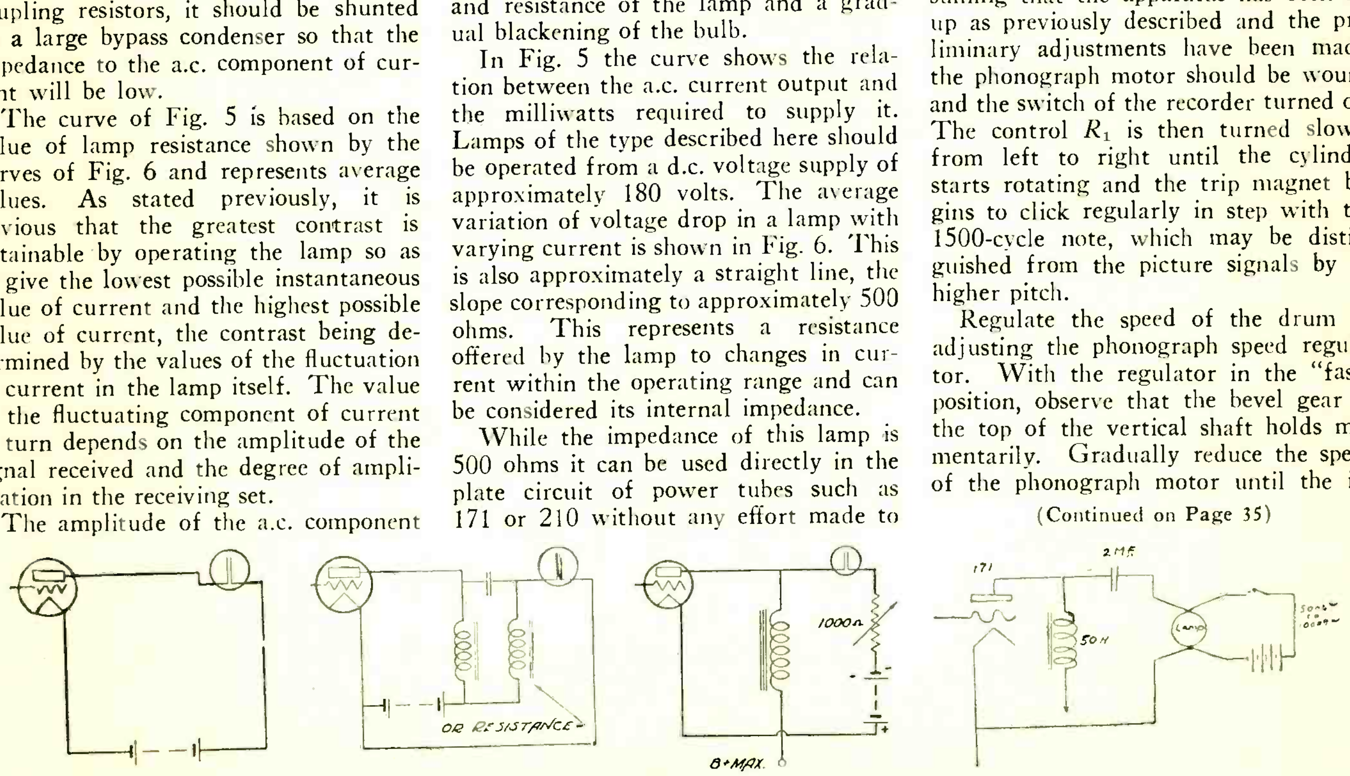


Fig. 7. Methods of Coupling Lamps in Circuits

The A. C. Screen-Grid Tube

An Analysis of the Gain and Selectivity Which It Gives in Tuned R.F. Amplifier Circuits

By GLENN BROWNING

NO VACUUM tube marketed during the past five years has created such widespread interest as the screen-grid tube. By reducing the feed-back between plate and grid, so that no neutralization is needed in a multiple stage tuned r.f. amplifier, it opens a new field in r.f. amplification. Yet its characteristics are so different from the ordinary tubes that much design work is necessary in order to realize its inherent advantages.

The reduction in feed-back is accomplished by shielding the tube's plate with an extra screening grid so that electrical charges on the regular control grid will have no reaction on the plate, and vice versa. This principle of electrostatic shielding was discovered by Faraday who stated that outside charges would not affect charged bodies which were enclosed in a conducting cavity. In the case of a screen-grid tube the shielding is not complete enough to prevent all feed-back between the plate and control grid, but the feed-back is greatly reduced as compared with a three-electrode tube.

When such a tube was constructed and the screen grid grounded through a 45-volt *B* battery, it was also found that a very high amplification factor was obtained. This was coupled with a high plate resistance, which is undesirable from the standpoint of designing apparatus to work with the tube. The figure of merit for a radio frequency tube is the amplification factor divided by the square root of the plate resistance or $\mu/\sqrt{R_p}$. A study of the characteristics of both the three- and four-electrode tubes will determine whether there is any advantage in using the screen-grid tube as r.f. amplifiers other than the fact that neutralization is not needed.

Figs. 1, 2 and 3, show the amplification and plate resistance of a d.c. screen grid, a.c. screen grid, and '01-A tube, respectively. It should be noted that the screen-grid tubes with 1½-volt grid bias have an amplification factor of 150 and 375, respectively, while the '01-A has a factor of only 8.5.

TABLE I. R.F. TUBE FACTOR OF MERIT

TUBE	$\mu/\sqrt{R_p}$	CAPACITY BETWEEN PLATE AND GRID
'01-A	.076	12.0 mmf.
'22	.186	....
'22 (a.c.)	.485	....
'26	.085	12.6 mmf.
'27	.095	6.6 mmf.

Table 1 gives an idea of the worth of the different types of tubes as r.f. amplifiers, the factor of merit being calculated and the capacity between grid and plate being measured. The figure of merit shows that the a.c. tube is twice as good as the d.c. and four times as good as any of the others. According to the tubes measured by the writer, the '27 type is slightly better than the '26 type as an r.f. amplifier. However, there is some variation in these tubes, so that the average characteristics of a few tubes should be taken to prove this point conclusively.

The capacity between plate and control grid is so small in the case of the screen-grid tubes that it was omitted. In the case of the '27 the capacity is smaller than in the '26 or '01-A, a fact that will surprise many readers.

Of the various types, the screen grid tube not only has the advantage of eliminating the necessity for neutralization in the r.f. amplifier, but also shows up the best from the standpoint of r.f. gain. However, there still remain the design problems caused by the high plate resistance.

There are two general methods for obtaining r.f. gain, other than regeneration and tuning the signal to the amplifier as in the superheterodyne. One is by untuned amplifiers, such as an untuned r.f. transformer, impedance, or resistance. The other is a tuned transformer, or auto transformer, better known as a tuned impedance. As the untuned systems are not only inefficient but do not add selectivity to the receivers, they will not be discussed here, for the present-day broadcast receiver requires not only r.f. gain, but also great selectivity.

In any tuned r.f. amplifier three questions must be answered by analysis and laboratory measurements: First, how much amplification does the device give? Second, how selective is it? Third, how much tendency is there to make other circuits oscillate due to feed-back through the amplifier tube? In using the screen-grid tube as the amplifier, the last question is not important, for the feed-back through the internal capacity of the tube is very small.

The voltage amplification from the general circuit of the tuned r.f. transformer with screen-grid tube, shown in Fig. 4, is E/E_g. For alternating current, Fig. 5 is the equivalent of Fig. 4, a voltage μE_g being applied in series with the plate resistance R_p and the primary of the transformer L_1. Mathematical analysis shows that when C_2 is tuned to resonance,

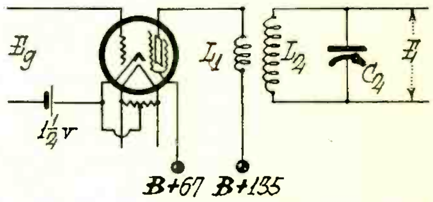


Fig. 4. Circuit of Screen-Grid Tube With Tuned R.F. Transformer

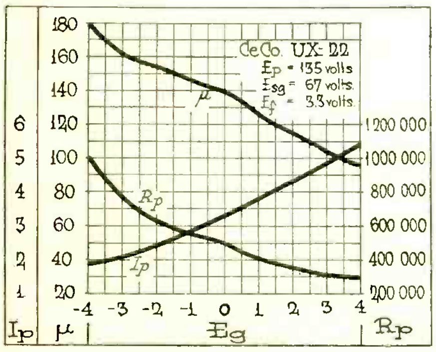


Fig. 1. Amplification and Plate Resistance of D.C. Screen-Grid Tube

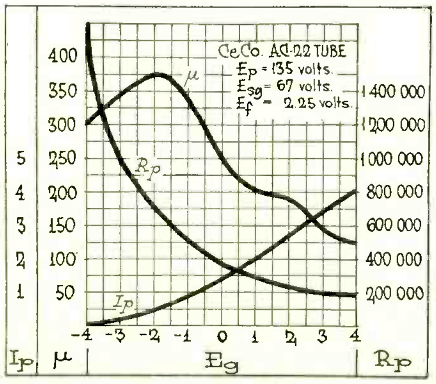


Fig. 2. Amplification and Plate Resistance of A.C. Screen-Grid Tube

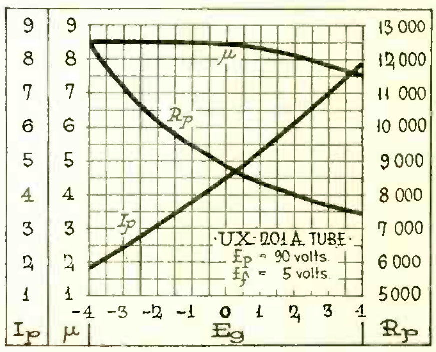


Fig. 3. Amplication and Plate Resistance of '01-A Tube

$$E/E_g = \frac{\mu K\sqrt{L_2/L_1}}{K^2+\eta_1\eta_2} \text{ ....(1)}$$

where μ is the amplification factor of the tube, K the coefficient of coupling between primary and secondary, L_2 secondary inductance in henries, L_1 primary inductance in henries, $\eta_1 = R_p/L_1\omega$, $\eta_2 = R_2/L_2\omega$, and ω is 2π frequency.

The amplification of the transformer may be further increased by choosing the

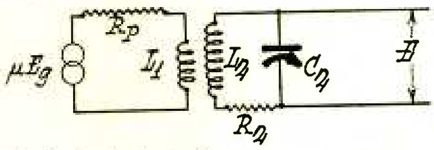


Fig. 5. Equivalent of A.C. Circuit of Screen-Grid Tube With Tuned R.F. Transformer

proper relations between η_1, η_2 and K. For maximum amplification this relation is $K^2 = \eta_1\eta_2$.......(2). This simple equation determines whether or not the transformer is efficient. In the ordinary transformer K will be about .5, and η_2 about .009. This means that η_1 should be 35.7. But with a plate impedance of 500,000 ohms, this would mean a primary inductance of .294 mh., or about 60 turns of wire on a 2-in. form. If a transformer were made up to these specifications it would be evident that something was wrong, for on the lower waves the secondary tuning would be very queer.

This is due to the fact that the primary itself is tuned by its distributed capacity *plus* the capacity between the plate and ground in the screen-grid amplifier tube. This capacity is much larger in the four- than in the three-electrode tube, due to the proximity of the screen grid. Consequently, the primary turns on the transformer must be reduced. This means reducing the signal strength unless the coefficient of coupling can be increased.

The writer conducted a series of experiments to determine just how much coupling could be obtained by careful design. It was found that by using a short winding length for the secondary, together with a slot-wound primary, that couplings up to .91 could be obtained. (The greatest theoretical value is 1.) With this coupling and as many primary turns as could be employed, consistent with keeping the primary

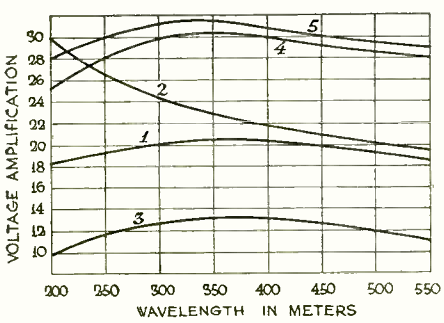


Fig. 6. R.F. Gain With Various Tubes and Tuned Circuits

from being tuned in the broadcast band, a transformer was made which gave a very creditable amount of amplification.

In Fig. 6, Curve 1 shows its performance. It should be noted that the gain is almost constant from 200 to 550 meters, being 18.5 at the lowest point and 20.5 at 325 meters. The gain that this transformer should give, theoretically, is shown in Curve 2. There is a great discrepancy between measured and calculated values at the lower waves, while at 550 meters the two curves check reasonably well. This is probably due to the fact that in obtaining the high coefficient of coupling, the capacity between primary and secondary is quite great. However, there is some advantage derived, for otherwise, the gain would be far from constant. For comparison, Curve 3 shows the gain of a good transformer used in conjunction with a '01-A as an r.f. amplifier. The advantage of the a.c. '22 is very apparent. Curves 4 and 5 are the measured and theoretical gain with a tuned impedance system.

Theoretically, the selectivity of this transformer is given by a factor $\eta'_2 = \eta_2 + K/\eta_1$.......(3), where η'_2 is $R'_2/L_2\omega$, R'_2 being the effective resistance in the tuned circuit. If the relation between η_1, η_2 and K given by equation (2) is satisfied, this reduces to $\eta'_2 = \eta_2 + \eta_2/K$ ....(4).

This equation shows a fact that is believed to have been generally overlooked in design work. This is in tuned r.f. transformers with a given amount of r.f. gain and an equal amount of secondary resistance and inductance, the larger the coefficient of coupling, the sharper the transformer will tune. Fig. 7, Curve 1, gives the experimental tuning curve of the transformer.

In the case of a tuned impedance system, such as shown in Figs. 9 and 10, the amplification theoretically is given by the equation:

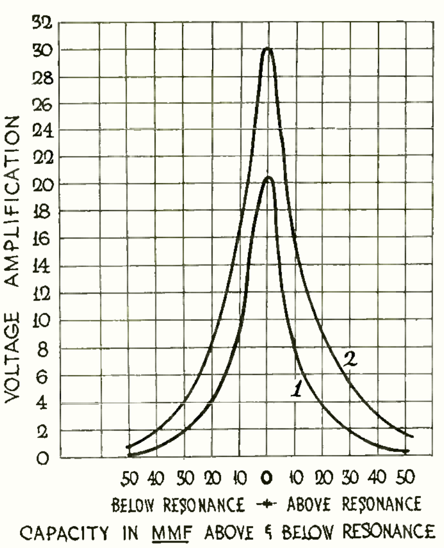


Fig. 7. Resonance Curves of a Tuned R.F. Transformer (1) and a Tuned Impedance (2)

$$E/E_g = \frac{\mu R}{\eta R_p + R} \text{ ....(5)}$$

The calculated gain for such a system is given in Fig. 6, Curve 5, while the measured values are given by Curve 4. Both these curves have the same shape,

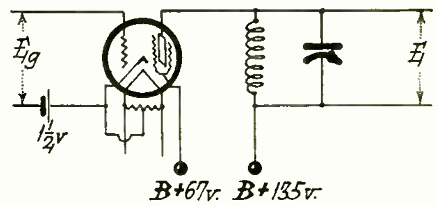


Fig. 8. Circuit of Screen-Grid Tube With Tuned Impedance

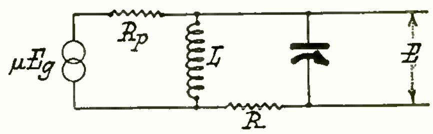


Fig. 9. Equivalent of Circuit of Screen-Grid Tube With Tuned Impedance

though the calculated values are somewhat greater than those measured.

The selectivity of the tuned impedance system is dependent upon the effective resistance in the tuned circuit. This resistance is

$$R' = R + \frac{L\omega^2}{R_p} \text{ ....(6)}$$

where R' is the effective series resistance in the tuned circuit. Notice that R' will increase as the square of the frequency so that the selectivity on the short-wave stations will be much less than on the long waves. Curve 2, Fig. 7, shows the measured selectivity of a tuned impedance system. This curve was taken with resonance at 400 meters.

Thus we have analyzed the common tubes used as r.f. amplifiers and have shown that the a.c. '22 tube is by far the best radio frequency amplifier, both because of its characteristics and because no neutralization is necessary in a multiple stage r.f. amplifier. The untuned systems for obtaining amplification were disregarded because they were neither efficient nor did they add selectivity to the receiver. The two fundamental circuits for obtaining amplification and selectivity were considered. A comparison of the two in Fig. 6 and 7 shows that the tuned impedance system used in conjunction with the a.c. screen-grid tube gives greater gain than the tuned transformer. However, the transformer described is efficient and has the advantage over the tuned impedance when selectivity is considered.

The only other method outside of the superheterodyne which the writer believes deserves consideration is a combination of the two systems described. This might be called a tuned-plate tuned-grid circuit. However, this will be reserved for a separate article because of the length of the analysis involved in such a combination.

Vacuum Tube Voltmeter Design

By HARRY R. LUBCKE

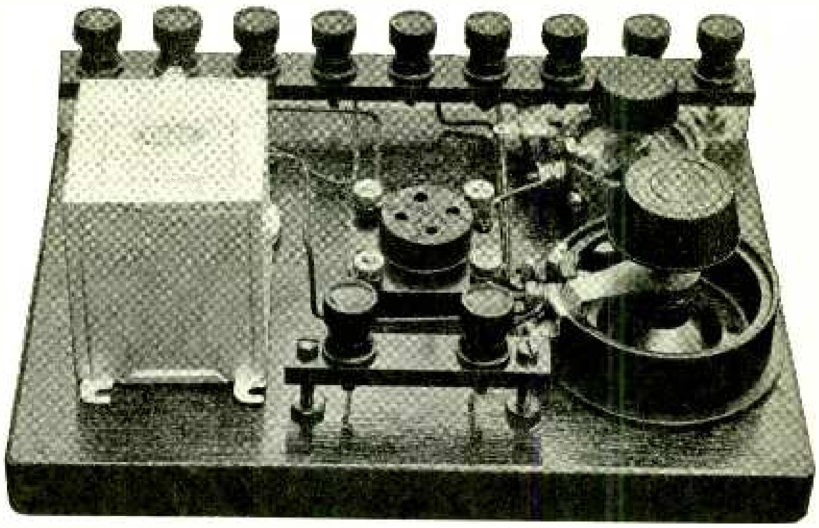


Fig. 1. Vacuum Tube Voltmeter Having Zero Frequency Error

PERHAPS no instrument has contributed more toward making the scientific design of radio receivers a practical reality than has the vacuum tube voltmeter. It has made possible the measurement of feeble radio and audio-frequency voltages that previously were guessed at. It comes the closest to the ideal voltmeter that man has been able to produce, drawing hardly more current than can leak across a piece of insulation between two binding posts.

With all of its usefulness, little has been accomplished to facilitate its design, which has largely been a matter of cut and try, or of copying some existing instrument that has been previously "cut and tried." Consideration of the theory underlying the instrument greatly reduces the uncertainty of design by facilitating a close predetermination of circuit constants. These are found by means of three simple equations whose application is here illustrated in the design of an exceptionally fine voltmeter.

The first of these equations is predicated upon the fact that the grid must never become positive, as current will otherwise be drawn from the circuit which is being measured and thus introduce an error in the measurement. This limitation is expressed by the equation

$$Eg = 1.5E \qquad (1)$$

where Eg is the tube's grid bias in volts and E is the maximum effective voltage to be measured, being the r.m.a. value as read on an a.c. voltmeter.

The plate voltage which is necessary to give the vacuum tube characteristics used in equation (3) is given by

$$Ep = kEg \qquad (2)$$

where Ep is the required plate voltage, Eg the grid bias of the tube in volts, and k a constant depending upon the type of tube and the maximum plate current, it is approximately equal to the tube's amplification constant. Fig. 2 gives some empirically determined values of k.

A consideration of vacuum tube theory yields

$$R'p = \frac{\mu E - IpRp}{Ip} \qquad (3)$$

where $R'p$ = plate circuit series resistance, in ohms, μ = amplification factor of tube, E = maximum of desired voltage, Ip = maximum reading of plate meter in amperes, Rp = plate impedance of tube at A, B and C voltages used. The plate circuit series resistor is thus determined from the tube characteristics and the plate meter range.

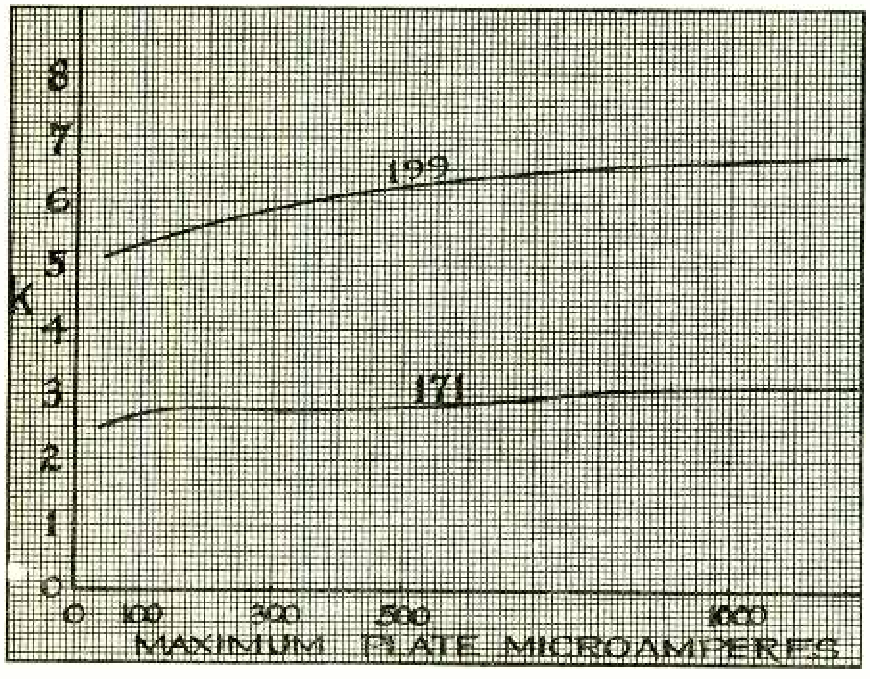


Fig. 2. Empirical Values of "k"

The use of these equations may be illustrated by the calculations for the meter shown in Fig. 1. This meter has a 0-2.7 volt range, employs a '99 tube, and a 0-100 microampere plate meter. Equation (1) gives the grid bias:

$$Eg = 1.5 \times 2.7 = 4.05 \text{ volts}$$

With a value of 5.4 for k, as taken from Fig. 2 for a '99 tube and 100 microampere meter:

$$Ep = 5.4 \times 4.05 = 21.8 \text{ volts}$$

Finally, the plate resistor value:

$$R'p = \frac{6 \times 2.7 - .0001 \times 150{,}000}{.0001} = 10{,}200 \text{ ohms}$$

The value of plate impedance, Rp, can be taken from manufacturer's curve sheets for the proper plate voltage and grid bias by extending the curves. It is interesting to note that the plate impedance at which a tube is worked under optimum conditions is a constant for a given plate meter. For a '99 tube and 100 microampere plate meter Rp is 150,000 ohms, very nearly, for all values of grid bias from 4.3 to 13 volts, plate voltage from 22.5 to 71, and plate circuit series resistors from 10,000 to 350,000 ohms. For a '99 tube and 1,000 microampere (1 milliampere) plate meter Rp is 50,000 ohms; for a '71 tube and 100 microampere meter, 10,000 ohms; and for a '71 tube and 300 microampere meter, 40,000 ohms.

These computed constants give the calibration curves shown in Figs. 3 and 4. The plate voltage used 23, being that from a new B battery, rather than the calculated 21.8 which required a larger grid bias of 4.4 volts. The plate resistor was 10,000 ohms as against the 10,200 ohm value calculated.

Another calculation of constants for the same instrument with a range of 0-5.7 volts gave Eg as 8.7 volts, Ep as 47 volts, and R'p as 200,000 ohms. Actual values used gave Eg as 9 volts, Ep as 48 volts and R'p as 200,000 ohms. A zero reading of 10 microamperes was used for all work, a slight change in plate or grid voltage being made to secure this value when necessary.

Fig. 3 gives the calibration results for the 0-2.7 volt range for various frequencies without bypass condensers. Instead of a single calibration curve holding for all frequencies, as would be highly desirable, three curves are obtained. A basic or 60 cycle curve secured with the ordinary power supply as an input lies above a group of coincident curves for 500, 5,000, and 16,000 cycles, and below the curve for 1,000,000 cycles, which is a radio frequency in the broadcast spectrum.

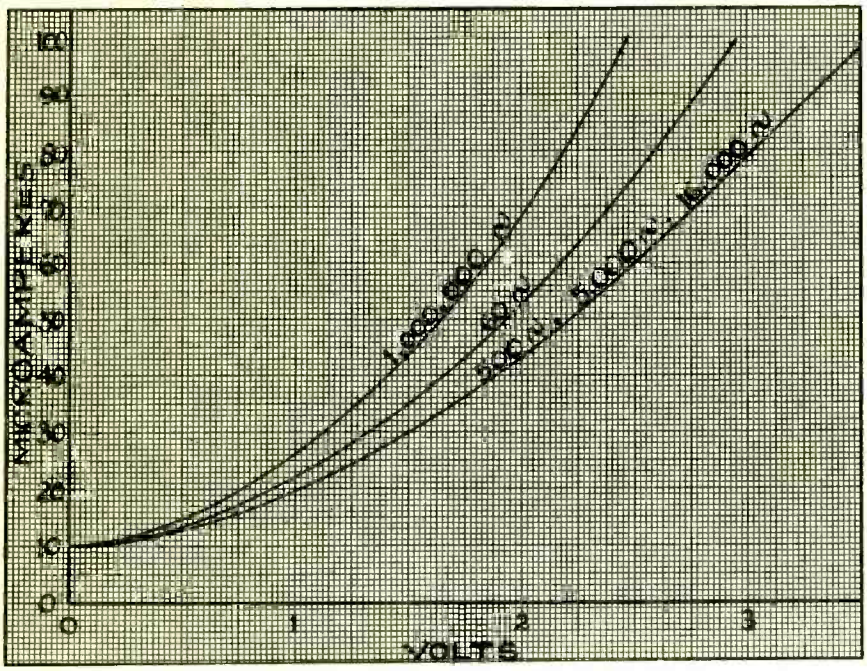


Fig. 3. Calibration of Meter Without Bypass Condensers

These results are explained by considering the plate circuit impedance through which the rectified current affecting the plate meter must flow. For 60 cycles a certain impedance is presented, mainly resistance, which causes the calibration curve to fall in its indicated position. At the higher audio frequencies the inductance of the plate meter causes the impedance to rise considerably and thus lower the reading secured for a given voltage input. Conversely, at radio frequencies the distributed capacitance of the plate meter moving-coil, and the resistor and battery portion, provides a path of low impedance and the curve secured lies above that for the 60 cycle input.

When the condensers C_1 and C_2 in the circuit diagram of Fig. 5, 1 mfd. and 4 mfd. respectively, are used, the impedance of the plate circuit is constant regardless of frequency. When thus bypassed the three curves coalesce into the one shown in Fig. 4. The many points surrounding the curve drawn-in represent the plotting of the several frequency runs. The condenser C_2 serves to store energy during the peaks of the plate voltage wave and to give it back during the troughs, thus leveling off the peaks and filling in the hollows of the plate current variations, and rendering negligible the effect of inductance or capacity.

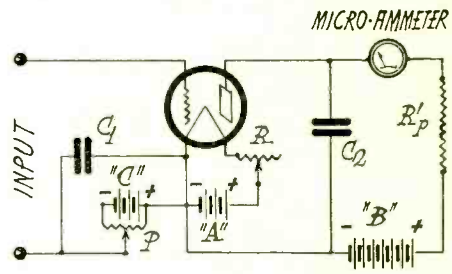


Fig. 5. Circuit Diagram of Vacuum Tube Voltmeter

LIST OF PARTS FOR ZERO FREQUENCY ERROR VOLTMETER

	'99 vacuum tube and socket.
"u AM."	0-100 Microammeter. Jewell.
"P"	200-ohm General Radio potentiometer
"R"	25-ohm General Radio rheostat.
"C_1"	1 mfd. Tobe bypass condenser.
"C_2"	4 mfd. Tobe bypass condenser.
"R'_p"	10,000-ohm Wire wound resistor, Super-Davohm.
	11 Binding posts.
	2 Formica strips.
	6 ft. Solid No. 14 Braidite wire.
	7 x 10 in. base.
	4.5 volt "C" battery (4.4 volts used).
	22.5 volt "B" battery.
	4 or 4.5 volt "A" battery (3.0 volts used).

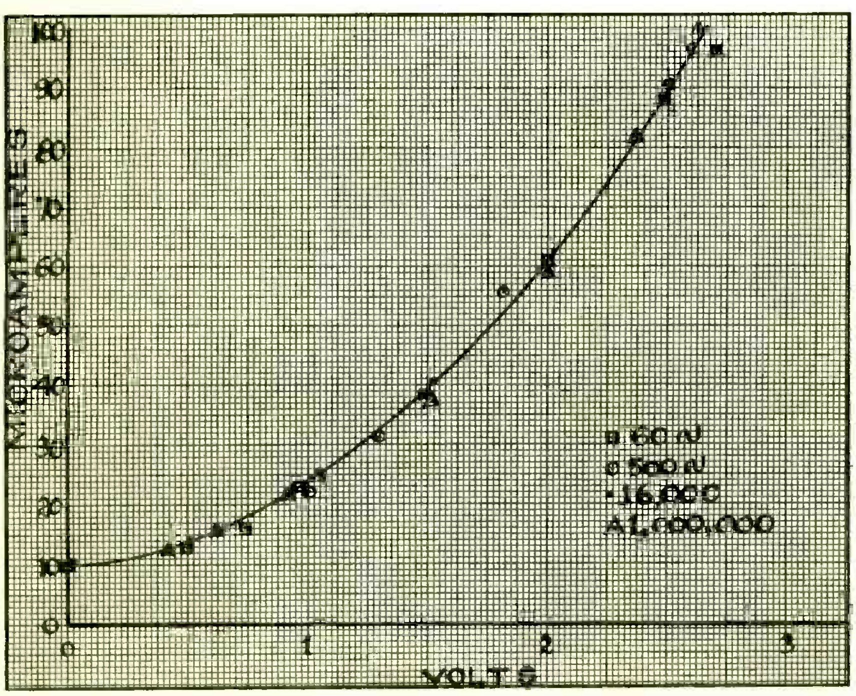


Fig. 4. Calibration of Meter With Bypass Condensers

By reproducing this instrument of identical parts and imposing the same operating conditions, a vacuum tube voltmeter of known behavior at audio and radio frequencies can be secured by merely calibrating it with a 60 cycle supply. The user can be confident that this calibration will hold throughout radio and audio frequencies because of the tests already made on an exactly similar meter. A potentiometer, step-down transformer, and low reading a.c.

(Continued on Page 33)

TECHNICAL BRIEFS

MAGNETO-STRICTIVE properties are being used by Prof. G. W. Pierce of Harvard, as a source of constant frequency for the control of oscillation in a vacuum tube circuit. Under the influence of an increasing magnetic field certain metals undergo a complete cycle of elongation and contraction, so that with a.c. there are two cycles of metal change for each magnetic field cycle, unless a constant magnetic field is also present.

Nickel and some of its alloys are very active in this respect; monel metal or nichrome often being used. Fig. 1 shows

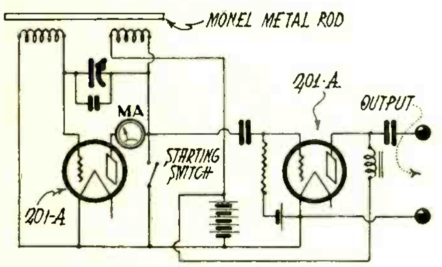


Fig. 1. Magneto-Striction Oscillator

the diagram of connections where a monel metal rod is placed inside of the plate and grid coils, and clamped in the middle so that it can vibrate longitudinally, with a node at the center, when the circuit is tuned to the rod's natural frequency. As a constant magnetic field is also maintained by the d.c. plate current in one of these coils, the resultant field is pulsating, without change in polarity, so that the rod vibrates at the same frequency as the alternating current.

If the circuits are tuned to the proper frequency, a surge or change in the vacuum tube's plate current will cause either an elongation or contraction of the rod. This deformation does not occur instantaneously along the whole rod but travels along it at a definite speed depending on the material of the rod. When this deformation reaches the grid coil, the magnetic field inside of this coil is changed due to the change in dimensions of the rod. This change of magnetic field causes a voltage change across the grid coil which is amplified by the vacuum tube. This changes the plate current again, so a condition of continuous oscillation is set up, as determined by the natural period of the rod from $F = 2L/V$, where F = frequency in cycles per second, L = length and V = velocity of sound in the metal.

This type of oscillator may be used for frequencies up to 2,000,000 cycles per second, though its greatest use is only up to 25,000 cycles per second, to extend the useful range of piezo-electric crystal oscillators. The frequency is remarkably constant, provided constant temperature is maintained. The plate and filament voltages and the tuning condenser may be changed quite a large amount without making an appreciable change in the frequency of oscillation.

RATINGS of the new power tube soon to be available are:

Filament voltage—2.5 volts.
Filament current—1.5 amperes.
Plate voltage (max.)—250 volts.
Plate current—30-35 m.a.
Grid voltage—50 volts.
Amplification factor—3.5.
Plate resistance—2000 ohms.
Mutual conductance—1750 micromhos.
Undistorted power output—1.6 watts, (max.)
Base—Large UX.
Size bulb—Same as UX-210.
Ventilation requirement—Same as for UX-250.

The maximum undistorted output at 250 volts is practically the same as for a type 210 power tube at 425 volts. This is quite sufficient for a good dynamic loudspeaker when used for either phonograph or radio reception at fairly high volume.

This tube at its rated voltages will give over twice the undistorted output that can be obtained from a '71 power tube at its rated voltage. It would seem to be an ideal power tube for ordinary use.

GOOD practice in transformer design demands that the flux density be less than 60,000 lines per square inch. This can be quickly checked from the formula $B = 10^8 E \div 4.44\ A\ N\ F$, where B is the flux density in lines per square inch, E the supply voltage, A the cross sectional area of the magnetic circuit in sq. in., N the number of turns in the primary winding, and F the frequency of the supply voltage. Because of oxide or varnish on the core laminations the value of A is usually from 5 to 10 per cent less than the physical measurements would indicate. The gauge of the wire may be checked from the fact that 1500 circular mils are customarily allowed per ampere of current. Because of the low efficiency of small transformers the primary current is ordinarily 10 to 20 per cent greater than the secondary load would indicate.

PERFORMANCES of various detector tubes in a grid-leak-condenser circuit are reported by Terman and Googin in the I. R. E. *Proceedings* for January, 1929. On the basis of audio-frequency power output preceding transformer coupled amplification, disregarding quality, they conclude that the '27 heater-type tube is definitely superior to all other standard receiving tubes. The types '12-A, '26 and '12 are approximately tied for second place, and are followed by a third group made up of types '40, '71-A and 200-A. The next group includes types '01-A and '99, while the '20 type is the poorest detector of all.

If the quality of output is taken into account, the types '27, '12 and 200-A gain an additional advantage over the rest. When resistance-coupled amplification is used, types 102-D, '40, and 200-A are to be preferred in the order named. The '12-A tube is better than the '01-A type as a detector when both are at the same plate voltage and filament power. They recommend that at least 45 volts be used on the plate and state that 67 to 90 is better.

THE Hiler tuned double impedance system of audio-frequency amplification employs a single encased unit to transfer the plate voltage of one tube to the grid of the next tube. This unit consists essentially of two choke coils shunted by a fixed condenser. The coils are wound on the outer legs of a laminated "figure 8" core, L_1 of Fig. 2 being in the plate circuit and L_2 in the grid circuit.

The condenser C is tuned to series resonance with L_2, which has an inductance of about 250 henries. This condenser not only provides capacitive coupling between the plate and grid circuits, but is also designed to shunt, and thus nullify, the high-leakage reactance of the coils. Such nullification is intended to maintain constant frequency amplification characteristics in the coupling unit when the load is varied on the plate of the following tube and to prevent resonance which might otherwise unduly accentuate the amplification of some audio frequency. Nullification of the leakage reactance prevents resonance due to any change in the capacity between the grid and filament

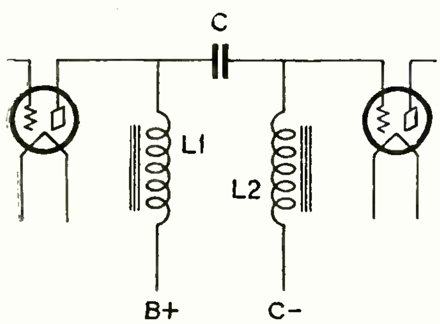


Fig. 2. Tuned Double Impedance System

of the input tube which might be caused by load variation in the output circuit.

Inductive coupling between the plate and grid coils through the core is so minimized that it has no effect upon the frequency setting of the resonant circuit CL_2. Furthermore, any appreciable current through L_2 has no effect upon L_1 or upon the frequency characteristics of the coupling unit.

The effect of regeneration in raising the phase angle of the various impedances is under such complete control that its effect can either be entirely eliminated from the operating band or be confined to one portion of the frequency spectrum.

The unit is claimed to give practically equal amplification for all frequencies within the audio spectrum. Furthermore its response characteristics can be changed without sacrifice of amplification so as to match the characteristics of the speaker with which it is used.

"A" METAL is a nickel steel of high permeability available as standard stampings for making cores of small audio transformers which have as good frequency-response characteristics as transformers with larger coils and silicon steel laminations. "A" metal laminations are also combined with silicon steel to improve the transformer characteristics.

Several manufacturers secure a remarkably good frequency-response curve, at low cost, by resonating the transformer for the low frequencies. Fig. 3 shows the circuit. The resistance is from 25,000 to 100,000 ohms, and the con-

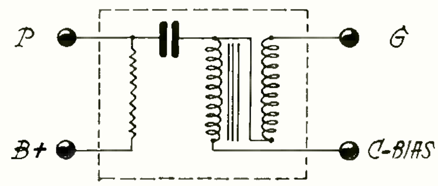


Fig. 3. "Resonated" Transformer

denser from .02 to .2 mfd. The primary and secondary are usually connected as an auto-transformer so as to give a greater step-up ratio.

FREQUENCY is the first factor in determining the distance that a radio wave will travel. Increasing the frequency is equivalent to increasing the wave's angle of elevation. H. E. Hallborg has found that high angle waves, those whose frequency exceeds 60,000 k.c., are normally not audible at distant receiving stations, since they do not return to earth. He reasons that the amount of energy at a given frequency that will pass between sending and receiving stations is determined by the relative amount of light and darkness in the path between them, this photoelectric effect being similar to light control of current flow in a photoelectric cell. Very high frequencies can be brought to earth only by the high ionization due to great illumination. Consequently he argues that 60,000 k.c. (5 meter) waves should be more effective in daylight and that the longer wavelengths, having lower elevation, would be more effective at night when the ionization of the signal track is low. The relative amount of light and darkness over a path also varies with the season and the latitude.

Mr. Hallborg's experiments with transatlantic communication show that 16.17 meters is better than 14.02 meters for daylight service; 21.48 meters is good for daylight transmission in winter and for night work in summer, and 43 meters is favorable for night work during summer or winter.

The long distance short-wave stations of the world are at present separated by channel widths of .2%. The increasing demand for channels is so great that it appears likely that a separation of .1% will eventually be necessary. Even with this .1% separation only 1587 standard channels distributed among the nations of the world are available between 1500 k.c. (200 meters) and 23,000 k.c., which is 13.11 meters. It is obvious that there is a definite saturation point in the ultimate number of long distance radio circuits and that the most stringent measures are necessary to keep each service in its allotted channel.

SHORT-WAVE broadcasts to America from Geneva through PCLL at Kootwijh, Holland, on 38.8 meters are to be made on March 12, 19 and 26, at 22-23 G. M. T. This corresponds to 5-6 p. m. E. S. T. These broadcasts from the Secretariat of the League of Nations are to be in English, French and Spanish and are in the nature of the repetition of the first trials which were made last May and June. Similar tests are to be made at the same hours on March 14, 21 and 28 in English on 18.4 meters in an endeavor to reach Australasia. The League Secretariat at Geneva will appreciate any reports on the reception of the transmissions.

WHILE any of the a.c. tubes work equally well with d.c. of the proper voltage, the relatively great filament current requirements of the a.c. tubes, all of which have oxide-coated filaments except in the case of the '27 type, makes battery supply inadvisable. The '27 and the '22 (a.c.) draw 1.75 amperes, the new power tube 1.5, the '10 and '50 taking 1.25, and the '26 type 1.05 amperes, as compared with the .25 amp. of the '01-A, '12-A, '71-A and '40, as well as the .132 amp. of the '22 (d.c.), 1.25 amp. of the '01-B, and the .06 amp. of the '99. Yet while a seven-tube a.c. set would quickly discharge a 6-volt storage battery, its total current drain would be only about .25 amp. at 110 volts, since the a.c. tubes are working on an average of only about 2½ volts.

A.C. HUM in a loudspeaker can often be traced to the plate circuit of the detector tube which either picks up the 60-cycle modulation from the a.c. filament supply or is directly affected by a pulsating d.c. plate supply. A slight ripple in the plate supply which would be hardly noticeable in the output of the amplifier tubes, is greatly intensified in the detector circuit. The practical means adopted to minimize it are the use of heater-type tubes, complete filtering of the rectifier output to the detector plate, and the use of audio transformers which do not pass 60 and 120 cycles. In the case of a dynamic speaker it may also be reduced by shunting a 4 to 10-ohm resistance directly across the speaker's moving coil.

Bakelite can be sawed straight with a hacksaw after clamping the bakelite between two pieces of strap iron, held in a vise. The edges of the iron bars should lie along the line to be sawed and the saw teeth continually pressed against them. A flat file will remove any slight roughness.

Translating Foreign Circuit Diagrams

By R. RAVEN-HART

ANYONE who is cursed with the job of wading through the technical radio literature of the world, soon reaches a state of confusion where he has no idea whether the thing with a light in it is a "lamp," or a "tube," or a "valve"; whether it works from *A* and *B* batteries, or from *Low* and *High Tension* batteries, or from *Heating* and *Anode* batteries; and uses *Reaction*, or *Regeneration*, or *Back-coupling*.

As a result, one gets into the habit of reading the diagrams rather than the text. Even here, all is by no means plain sailing, as the four diagrams show. Although it may not be evident, they all represent the same circuit.

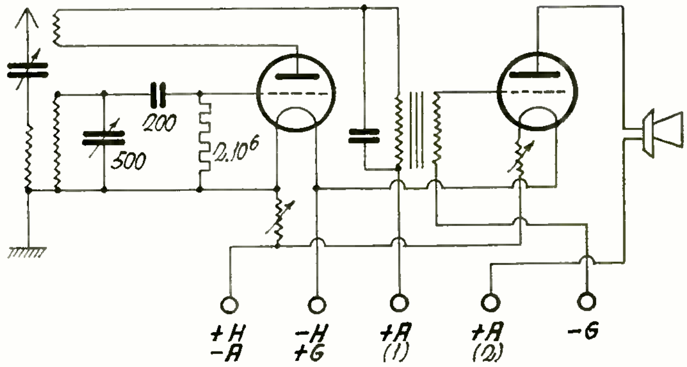


Fig. 3. German Version

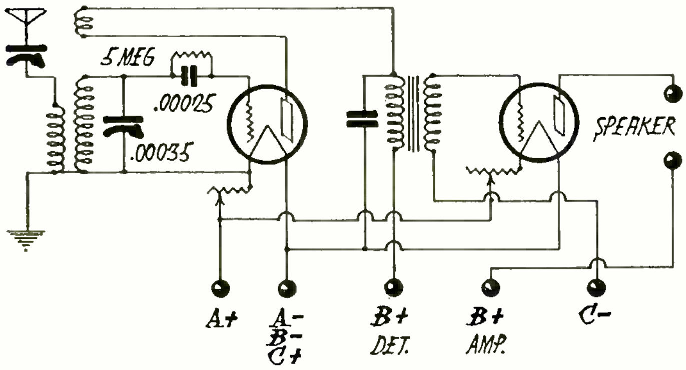


Fig. 1. American Version

The United States version (Fig. 1) speaks for itself.

Crossing the pond to England (Fig. 2) there is not much difference at first sight. Notice the larger tuning condensers, made desirable by the far wider range of wavelengths to be covered. Also the smaller grid condenser and resistance, this being standard British practice. And observe the graceful shape of of the *"valves"!* To judge by the symbol for the loudspeaker one would think that only horns are in use. Fortunately, however, this is not the case by any means, and, if anything, the general level of loudspeakers is higher in England than in America.

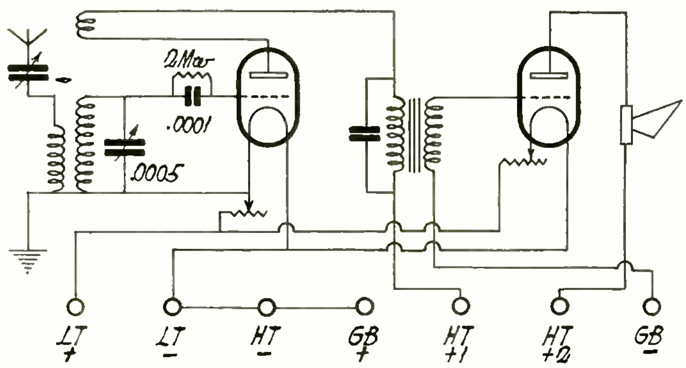


Fig. 2. English Version

The chief snag is the battery marking, though when one gets used to it, it is really simpler than the arbitrary *A, B, C,* since *High Tension, Low Tension,* and *Grid Bias* do exactly express the purposes of each battery. (This "high" and "low" business extends by the way, to frequencies also, radio frequency being "high frequency" and audio "low.")

The German diagram (Fig. 3) suggests at first sight an outbreak of resistances, but a comparison with the medieval battlements of the grid leak makes it clear that they are merely windings of sorts.

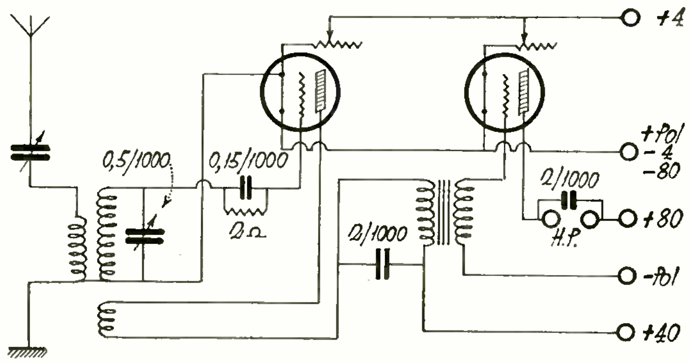


Fig. 4. French Version

Observe the umbrella antenna and the realistic *Earth;* also the loudspeaker looking like a microphone, to complicate things.

Here the tubes are an *Audion* and a *Low Frequency Amplifier,* the word audion having nothing to do with a particular circuit, but standing merely for detector tube. By the way, we are now back at "tubes," the German word meaning just that. And, talking of tubes, the mysterious "Durchgriff" so often quoted for German tubes, is merely the reciprocal of the factor of amplification ($1/\mu$): it may take the unfortunate amateur weeks to locate this fact, as

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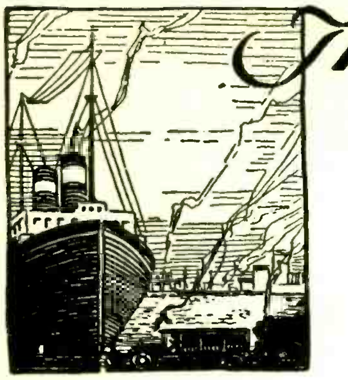
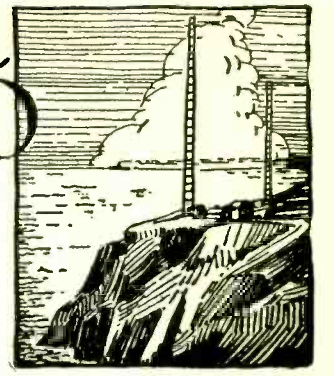


The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



Edited by P. S. LUCAS
R. O. COOK, *Assistant*

THE NEW WALLPAPER

IT HAS been our opinion that the requirements for a radio operator's license should be much more difficult, more severe, than heretofore. We have felt that the lamentable lack of dignity bestowed upon our profession is due to some extent to the ease with which the man "who has been found wanting in everything else" could secure a license. We have advocated that changes in the present methods of examination be radical enough to discourage all applicants other than those to whom radio was of vital interest, a chosen life work. Therefore we were a bit disappointed, upon studying the new regulations, to find that the requirements are no harder, if any, than they have always been.

The commercial extra first-class license is changed in the Continental code test only, code groups being sent instead of plain language at the same speed of 30 groups per minute. This code group business sounds dangerous at first but will probably prove to be a relief from the conglomeration of hash ordinarily used. We understand that plain language is still interpreted to mean the above mentioned conglomeration.

The new commercial first-class license replaces the old first-class first grade. The 12 month's experience required may be dug up out of the dim and dusty past, providing, of course, that only PG stations are counted. In addition to the 25 w.p.m. plain language test, the applicant must be able to copy 20 w.p.m. of code groups.

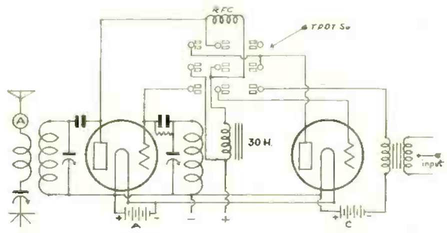
No experience is required for the second-class license which has replaced the old first-class second and third grades. Experience adds from 2 to 10% to the total percentage of the examination, however, making it possible to get as high as 110%. The subjects covered in the requirements for the theoretical examination remain the same, but the new question sheets are more comprehensive and up-to-date.

Renewals are much the same as before. All present licenses will be valid for the term indicated, but at any time during the term of the old license an operator may make application for and be issued a new license, providing he can meet the requirements therefor.

And so, although the changes were not drastic enough to satisfy us entirely, the situation is clearer and more concise than before, which is certainly a step forward. And the Department of Commerce, if it sees fit, has the power to publish new examination sheets at any time. A practical examination, although greatly to be desired, is more than can be expected for some time due to the fact that extra equipment and extra room for the examining offices is considered out of the question at present.

It might be possible, if agreeable, through a coöperative effort on the part of the supervisors' offices and the service companies, to have each man that is assigned to a new job questioned by the R. I. as to his ability to handle the particular equipment on that ship. If he passes this oral examination his ticket might be endorsed on the back, and he would be allowed to ship. If he failed another man would have to be supplied. Eventually the old-timer would have a long list of type numbers on his ticket, much as the skipper or mate sports a pile of pilot licenses. The examination, of course, would usually be given in the ship's radio shack.

A current fed antenna capable of operating on 40, 80 and 160 meters may be made by stretching one wire approximately 85 meters long, so that the center of it comes over the transmitter shack. Cut it in the center and separate the two halves 15 ft. with a 15 ft. spacer wire insulated at each end.



Scheme for Converting from CW to Phone

Run a lead-in from each end of the antenna adjacent to the spacer to the transmitter inductance, keeping them as far apart as practicable. Measuring from the transmitter inductance place a S.P.S.T. switch at 33 and 85 ft. points on both halves of the system. With all switches open, it operates in the 40-meter band, first switch on each side of center closed, it operates in the 80 meter band, and with all switches closed operates in the 160 meter band.

When using phone, the modulator tube can be placed in parallel with the oscillator tube, when you wish to use CW, by means of a T.P.D.T. switch, as shown in the accompanying illustration. The 30 henry choke is shorted when both tubes are operating in parallel for CW. Leaving it in the circuit while working CW would result in a chirpy note, due to the fact that each time the key is pressed it requires an instant for the choke to build up.

Difference Between Greenwich Mean Time and Standard Time

Greenwich mean time is the system of time in which noon occurs at the moment of passage of the mean sun over the meridian of Greenwich, England. Standard time is the time of a certain meridian adopted for local use over a large region in lieu of true local time. The meridian of Greenwich, England, was taken as a prime meridian, and there

(Continued on Page 42)

THE UNITED STATES COAST GUARD

By W. L. JEPSON, NGQ.

WITH the idea that commercial operators are not informed as to the organization of the Coast Guard so far as radio is concerned, I am submitting such scraps of information as occur to me, an operator still retaining the viewpoint of the commercial man, though now at NGQ, the Coast Guard station at San Pedro.

Regular vigils on my home receiving station in Brooklyn had made the calls of such cutters as the Gresham, NRG, and the Seneca, NRE, familiar to me in their work with old NAH in distress work on 600 meters around New York and down to the Capes. Then with the start of commercial work in May, 1923, on a Standard Oil barge, KSAA, I began to hear them oftener on closer acquaintance with their Navy Standard 5 k.w. spark sets, sometimes right abeam! Then running across the North Atlantic I had reason to know of the activities of the Ice Patrol, NIDK, as the captain of my ship sent and received reports from them at all times when in the ice and fog zones.

To this extent then, the average operator is acquainted with the Coast Guard, but no more—and there is more! The well-known prohibition business has resulted in the force being considerably augmented in both men and ships. With the enlargement of the service came the present conditions of reorganization and development of personnel and equipment.

The radio communication end is modeled after that of the Navy. The regulations governing manner of operating and rating of operators are the same. The difference between the days of 1923 and now is that these regulations are in force instead of just being on the books! The normal channels for inter-fleet work and ship-to-shore work over distances, varying with conditions, up to 300 miles day and more at night—are 110 meters to 130 meters. The usual wave used is 121 meters, on which I have communicated successfully with the Tamaroa, NIVR, up to 500 miles at sea, noon hours. This is unusual. However, contact is very satisfactory at 150 miles over land or sea. In addition, the Coast Guard has the use of such Navy intermediate channels as 355 kilocycles, and 275 kilocycles. The transmitters equipped for these waves, of course, have the commercial channels such as 500 kilocycles, for one important function of this service is the guarding of the distress frequency, 500 kilocycles.

The standard transmitter for the low waves is a 50-watt oscillator, 50-watt modulator, 5-watt speech amplifier combination with switching arrangement for CW, ICW or phone, and three available waves, for either system of transmission. As will be seen this is low power, only 50 watts—but the sets are

(Continued on Page 37)

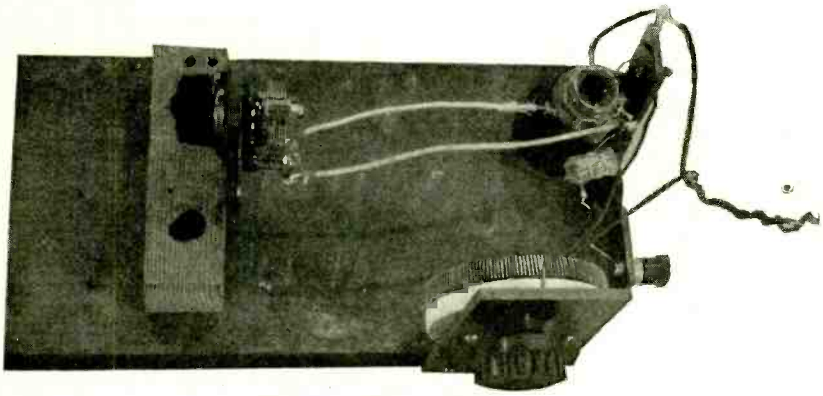
With the Amateur Operators

A 1½ METER OSCILLATOR FOR THE ¾ METER AMPLIFIER

By A. Binneweg, Jr.

With the present small power tubes, it is better to use the master-oscillator power-amplifier scheme, which gives a steady wave and is comparatively simple to operate. The CG-1162 will oscillate easily at 1½ meters and with quite a little inductance outside the tube, as shown in the illustration. All ordinary small power tubes will not oscillate below about 1.2 meters at best, as the capacity between the leads through the glass causes enough loss to prevent oscillations.

Chokes for operation in this vicinity may be tuned or untuned; tests show that results are about the same for anything above six turns on a one-half inch form. It will be found that somewhat higher plate voltages are necessary for proper oscillations than at lower frequencies. The arrangements which oscillate with the lowest plate voltages will usually be the most efficient, this depending on several factors such as the chokes, and the tube used, especially. If one uses a "double-end" tube or one in which the leads through the glass are well-spaced, oscillations can be produced directly at ¾ of a meter.



1½ Meter Master-Oscillator

At these frequencies, operation is often improved by disconnecting the grid leak. Since the external "shunt condenser" in the oscillating circuit is in series with the tube-capacity, beyond a certain value, this condenser has relatively little effect upon the frequency so that the leads must be shortened to lower the wave. For each length of leads, best oscillations are produced with some definite value of shunt capacity. With the tube shown in the illustration of the 1½ meter set, approximate value of shunt capacity and corresponding operating wavelengths were the following:

Length of leads (centimeters)	External Condenser Capacity. (mmfd.)	Wave-length (meters)
40	25	2.6
37	25	2.48
31	25	2.20
25	10	1.94
21	25	2.00
14	10	1.5

For experimental work, the 1½-meter set arrangement shown is quite convenient. To change the wave, simply move the condenser supporting block along the baseboard and change the leads. The base of the tube is removed and the bulb is secured to a bakelite upright by means of a length of tape. A plate or grid-meter is used to indicate resonance or oscillations. The tube is usually oscillating if, when the hand is brought near, the meter readings change.

For wavelengths of the order of 1 meter, a pair of Lecher wires can be arranged on a portable support, provided with a meter stick, and thus serve as a direct-reading wavemeter.

For ¾-meter operation, the "coupling line" is coupled to the oscillating circuit of the 1½-meter set. This line feeds the amplifier, the adjustment of which was described in October, 1928 Radio.

JAPANESE AMATEUR STATIONS

Through the courtesy of J3CH it is possible to publish the following list of members of J. A. R. L. (Japanese Amateur Radio Ligo):

J1CW—H. Takeuchi, 419 Ikebukuro, near Tokyo.

J1CX—H. Horikita, 597 Shimohebikubo, Ebara-machi, near Tokyo.

J1CZ—N. Eimura, care Mr. Sayama, 3495 Magome-machi, near Tokyo.

J1DA—T. Semba, 680 Shimonumabe, Denen-Chofu, Tokyo.

J1DB—M. Sumi, 85 Mukoyama, Shibuya-machi, near Tokyo.

J1DC—T. Seki, 33 Sakusabe, near Chiba.

J3CB—K. Kusama, 1581 Mikage-cho, near Kobe.

J3CC—K. Kajii, 100 Torishima-cho, Osaka.

J3CD—Y. Tanigawa, 4 Yamamoto-dori, Kobe.

J3CE—M. Takebe, 396 Sakuragi-cho, Tonodan, Kyoto.

J3CF—Y. Kikuchi, 35 Naka—2, Dojima, Osaka.

J3CG—G. Kikuchi, 2249 Koroen-hama, near Kobe.

J3CH—T. Hayashi, Hibarigaoka, Kawabe-gun, Hyogo-ken, (38 meters).

J3DD—K. Kasahara, 880 Tennoji-cho, Osaka.

K. Yamaguchi, 44 Minami-machi, Yokkaichi, Mie-ken. (Fone only).

The League's QSL service is in charge of J3DD.

Included in the membership also are the high power experimental stations:

J1AG—Hiraiso Radio Laboratory, Ibaragi-ken.

J1CT—Tokyo Electric Co. Radio Laboratory, Kawasaki.

JOAK—Toyko Central Broadcasting Station, Tokyo.

SPREADING THE BANDS WITH AN AUXILIARY TUNING CONDENSER

By G. S. Corpe

Now that all amateur signals are presumed to be tuned to the n^{th} degree of sharpness and that the boundary lines of each band contain all the signals that were crammed into the much wider bands of 1928, it is necessary to spread each band over the whole dial of the tuning condenser. When a receiver is used for more than one band, employing plug-in coils, a different maximum capacity is required in each case.

The two methods ordinarily in use today rely first upon plug-in tuning condensers which are somewhat bothersome to keep in accurate calibration and are slow to change; and second, upon plug-in fixed condensers shunted across the tuning condenser, which also, in the case of the average home-made fixed air condensers, will show the effects of handling.

The method of solving these difficulties here described has been in use with great satisfaction at W6UJ for some time and can be recommended as sure-fire to every short wave operator, either for handling traffic or listening to broadcast. It consists of paralleling the small tuning condenser with a large variable condenser, and providing a simple mechanical means for resuming the original position when shifting settings.

Instead of mounting a dial on the large auxiliary condenser, C_2, fit the shaft with a rectangular piece of bakelite 2 in. long and ⅝ in. wide. On the panel about 3 in. below the shaft and a little to the right of it mount another strip of bakelite, being sure that it

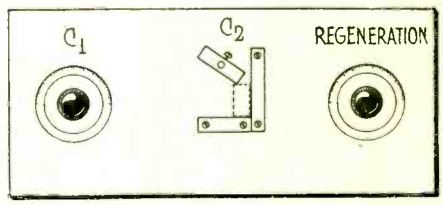


Fig. 1. Panel Mounting of the Strip Holder

is horizontal, and at the right of this mount a vertical strip of any handy length, as shown in Fig. 1. Now cut a dozen or more pieces of bakelite ⅜ in. wide, the shortest of which will, when fitted into place as shown on dotted lines (Fig. 1), stop the right hand end of the strip on the condenser shaft at the lowest point possible. Set the adjusting screw which holds the strip to the shaft, making the condenser at this point give a minimum of capacity, and mark the short strip No. 1. Then let each of the other strips be 1/16 in. longer than its preceding one so that the rotating strip will be stopped a little higher up in each case. This, of course, causes an increase in the capacity of condenser C_2. To insure the proper insertion of the removable bakelite strip it would be well to engrave an arrow near one end as shown in Fig. 2.

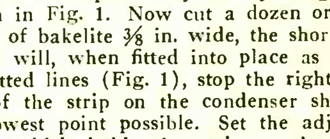


Fig. 2. Removable Bakelite Strip

(Continued on Page 33)

Inside Stories of Factory Built Receivers

THE EDISON RECEIVERS

All of the four new Edison receivers employ the same circuit, consisting of three stages of tuned r.f., detector and two stages of audio. Type '26 tubes are used throughout except for a '27 tube as detector and a '50 tube in the last audio stage. Plate voltage is supplied by an '81 rectifier tube and associated filter. Dynamic speakers are used in all models, the C-1 having two speakers, two '50 tubes and two '81 tubes. A phonograph is also incorporated with the latter model. The non-combination models are equipped with a jack between the detector and audio amplifier for a pickup plug. The pickups supplied with the combination sets reproduce both the needle type, lateral cut, and the Edison "hill and dale" records; an arm projecting from the side of the ordinary pickup and holding the Edison diamond point is used for the latter type of record.

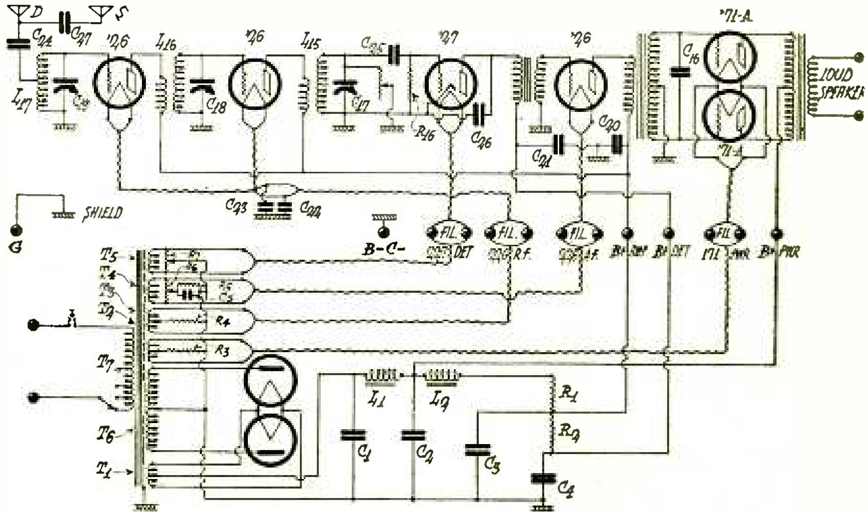
All three stages of r.f. amplification are tuned, a "fore and aft" four-unit condenser gang doing the work. A 600-ohm grid suppressor is used in each r.f. stage in order to eliminate oscillation in this part of the circuit. The volume control is a 2000-ohm variable resistor across the primary of the second r.f. transformer; i. e., in the plate circuit of the first r.f. tube. The grids are connected to ground and obtain their bias voltage from the drop through a 600-ohm resistor connecting them to the center taps of the 20-ohm resistances across their filaments. These two resistances as well as the 12-ohm resistance across the detector filament are used as hum adjusters and can be changed with a screw driver.

The detector operates upon the principle of grid rectification, employing a grid condenser and leak. Switch SW_1 throws the .002 mfd. regeneration condenser into the circuit along with a 3000-ohm variable resistor for regenerative control. This control switch is mounted on the tuning shaft and extends just below the knob. The detector is switched into oscillation when distance reception is required.

FEDERAL ORTHO-SONIC TYPE H RECEIVER

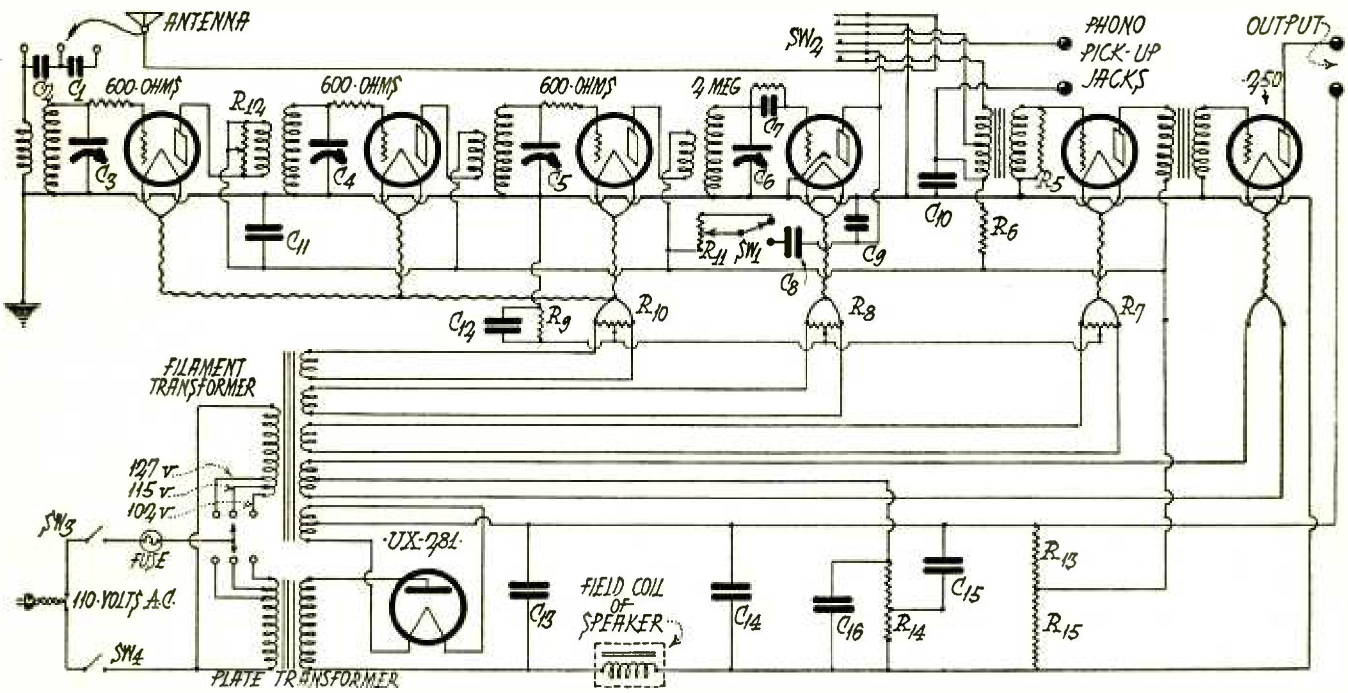
THIS set uses six tubes, two '26's for r.f. amplification, one '27 for detector, one '26 for the first audio and two '71-A power tubes in push-pull for the second audio

(Continued on Page 43)



Circuit Diagram of Federal Type H Ortho-Sonic Receiver

C_{16}=.0002 mfd.
C_{17}=.0003 mfd.
C_{18}=.0003 mfd.
C_{19}=.0003 mfd.
C_{20}=½ mfd.
C_{21}=½ mfd.
C_{22}=1/10 mfd.
C_{23}=1/10 mfd.
C_{24}=.0001 mfd.
C_{25}=.0002 mfd.
C_{26}—.001 mfd.
C_{27}=50/35 mmfd.
L_{15}=262 mh.
L_{16}=262 mh.
L_{17}=262 mh.
R_{15}=500,000 ohms.
R_{16}=2 megohms.



Edison Circuit Diagram

R5—Loading Resistor 0.5 Meg.
R6—Det. Plate Resistor 50,000 ohms
R7—1st A.F. Hum Adjuster 20 ohms
R8—Det. Hum Adjuster, 20 ohms
R9—226 Grid Bias Resist., 600 ohms
R10—R.F. Hum Resist., 12 ohms
R11—Regener. Control, 3000 ohms
R12—Volume Control, 2000 ohms
R13—R.F. and First Audio Plate Resistor, 12,500 ohms
R14—250 Grid Bias Resist., 1500 ohms
R15—Loss Current Resist., 25,000 ohms
C1, C2—Ant. Cond., .00025 mfd.
C3, 4, 5, 6—Tuning Condenser
C7—Grid Con., .00025 mfd.
C8—Regen. Cond. .002 mfd.
C9—Det. Bypass .00025 mfd.
C10—A.F. Bypass, 1.5 mfd.
C11—R.F. Plate Bypass 3.0 mfd.
C12—Bias Bypass 1.5 mfd.
C13—Filter Cond. 2 mfd.
C14—Filter Cond. 1 mfd.
C15—Filter Cond. 1 mfd.
C16—250 Bias Bypass 3.0 mfd.
SW1—Regen. Switch
SW2—Phono. Switch
SW3—Panel Starting Switch
SW4—Safety Switch

List of Standard Radio Receiver Models

(Furnished by courtesy General Contract Purchase Corporation, New York City)

Under "Cb.," "T" denotes table cabinet, "C," console, "P," phonograph radio.

Prices are based on Eastern delivery and are approximate in some cases.

MOHAWK-AMERICAN

Model	Price	Cb.	Pwr.	Tubes
60	$ 93	T	AC	1-'71A, 2-'27, 3-'26, 1-'80
61	145	C	AC	1-'71A, 2-'27, 3-'26, 1-'80
62	145	C	AC	1-'71A, 2-'27, 3-'26, 1-'80
65	138	C	AC	1-'71A, 2-'27, 3-'26, 1-'80
66	245	P	AC	1-'71A, 2-'27, 3-'26, 1-'80
606	65	T	Batt	
616	117	C	Batt	
626	117	C	Batt	
656	110	C	Batt	
80	128	T	AC	2-'71A, 2-'27, 4-'26, 1-'80
83	195	C	AC	2-'71A, 2-'27, 4-'26, 1-'80
84	295	C	AC	2-'71A, 2-'27, 4-'26, 1-'80
85	195	C	AC	2-'71A, 2-'27, 4-'26, 1-'80
86	235	C	AC	2-'71A, 2-'27, 4-'26, 1-'80
88	425	P	AC	2-'71A, 2-'27, 4-'26, 1-'80
808	95	T	Batt	
838	162	C	Batt	
848	263	C	Batt	
858	163	C	Batt	
868	203	C	Batt	
70	150	T	AC	4-'22, 2-'27, 1-'50, 1-'80
73	158	C	AC	4-'22, 2-'27, 1-'50, 1-'80
75	185	C	AC	4-'22, 2-'27, 1-'50, 1-'80

BOSCH

Model	Price	Cb.	Pwr.	Tubes
28	$133	T	AC	2-'71, 4-'26, 1-'27
28A	198	C	AC	2-'71, 4-'26, 1-'27
29B	295	C	AC	4-'26, 1-'27, 1-'10
28C	238	C	AC	2-'71, 4-'26, 1-'27
29D	260	C	AC	4-'26, 1-'27, 1-'10

AMRAD

Model	Price	Cb.	Pwr.	Tubes
Noct.	$295	C	AC	4-'26, 1-'27, 1-'10 or '50, 2-'81
Conc.	320	C	AC	4-'26, 1-'27, 1-'10 or '50, 2-'81
Son.	475	C	AC	4-'26, 1-'27, 1-'10 or '50, 2-'81
Op.	875	C	AC	4-'26, 1-'27, 1-'10 or '50, 2-'81

FADA

Model	Price	Cb.	Pwr.	Tubes
16	$110	T	AC	5-'27, 2-'71A, 1-'80
17	135	T	AC	5-'27, 2-'71A, 1-'80
32	225	C	AC	5-'27, 2-'71A, 1-'80
50	245	T	AC	6-'27, 2-'10A, 1-'81
70	360	C	AC	6-'27, 2-'10, 1-'81
18	120	T	DC	5-'12A, 2-'71A
72	890	P	AC	6-'27, 2-'10, 1-'81

APEX

Model	Price	Cb.	Pwr.	Tubes
36	$85	T	AC	4-'26, 1-'27, 1-'71A, 1-'80

ARBORPHONE

Model	Price	Cb.	Pwr.	Tubes
45	$ 75	T	AC	4-'26, 1-'27, 2-'71
55	185	T	AC	4-'26, 1-'27, 2-'71

ATWATER-KENT

Model	Price	Cb.	Pwr.	Tubes
46	$ 83	T	AC	4-'26, 1-'27, 2-'71, 1-'80
45	94	T	AC	5-'26, 1-'71, 1-'27, 1-'80
56	97	C	AC	4-'26, 1-'71, 1-'80, 1-'27
57	105	C	AC	4-'26, 1-'71, 1-'80, 1-'27
53	117	C	AC	4-'26, 1-'27, 2-'71, 1-'80

BREMER TULLY

Model	Price	Cb.	Pwr.	Tubes
6-40	$115	T	AC	4-'26, 1-'27, 1-'71-'80
7-70	150	T	AC	4-'26, 1-'27, 2-'71-'80
7-17M	245	C	AC	4-'26, 1-'27, 2-'71-'80
7-71D	280	C	AC	4-'26, 1-'27, 2-'71-'80
8-20	230	T	AC	4-'26, 2-'27, 2-'10-'81
8-21	375	C	AC	4-'26, 2-'27, 2-'10-'81
8-22	490	P	AC	4-'26, 2-'27, 2-'10-'81

BRUNSWICK

Model	Price	Cb.	Pwr.	Tubes
5 KR	$95	T	AC	4-'26, 1-'27, 1-71A, 1-'80
5 NO	147	T	AC	7-'27, 1-'71A, 1-'80
5 KRO	195	C	AC	1-'71A, 4-'26, 1-'27, 1-'80
5 NC8	375	C	AC	7-'27, 1-'71A, 1-'80
*3 KRO	395	P	AC	4-'26, 1-'27, 1-'71A, 1-'80
*3 NC8	700	C	AC	7-'27, 1-'71A, 1-'80
*3 KR8	675	C	AC	4-'26, 1-'27, 1-'50, 2-'81
*3 KR6	450	P	AC	4-'26, 1-'27, 1-71A, 1-'80
*5 KR6	240	C	AC	4-'26, 1-'27, 1-'71A, 1-'80
*3 NW8	995	P	AC	8-'27, 1-'50, 1-'81
*PR-138-C	945	P	AC	7-'99, 1-'10, 2-'81, 1-886
	995	P	DC	
*PR-148-C	995	P	AC	7-'99, 1-'10, 2-'81, 1-886
	1045	P	DC	

* Complete with tubes.

BUCKINGHAM

Model	Price	Cb.	Pwr.	Tubes
1	$79	C	AC	4-'26, 1-'27, 1-'71, 1-'80
11	95	C	AC	4-'26, 1-'27, 1-'71, 1-'80
61	98	C	AC	4-'26, 1-'27, 1-'71, 1-'80
41	98	C	AC	4-'26, 1-'27, 1-'71, 1-'80
25	125	C	AC	4-'26, 1-'27, 1-'71, 1-'80
55	125	C	AC	4-'26, 1-'27, 1-'71, 1-'80
	63	T	AC	4-'26, 1-'27, 1-'71, 1-'80
61	85	C	DC	
55	110	C	DC	

BUSH & LANE

Model	Price	Cb.	Pwr.	Tubes
4-A	$150	C	AC	1-'27, 4-'26, 2-'71, 1-'80
4-C	180	C	AC	1-'27, 4-'26, 2-'71, 1-'80
4-D	160	C	AC	1-'27, 5-'26, 1-'71, 1-'80
4-F	190	C	AC	1-'27, 5-'26, 1-'71, 1-'80
4-G	175	C	AC	1-'27, 5-'26, 2-'71, 1-'80
4-H	205	C	AC	1-'27, 5-'26, 2-'71, 1-'80
8-A	170	C	AC	1-'27, 4-'26, 2-'71, 1-'80
8-C	200	C	AC	1-'27, 4-'26, 2-'71, 1-'80
8-D	180	C	AC	1-'27, 5-'26, 1-'71, 1-'80
8-F	210	C	AC	1-'27, 5-'26, 1-'71, 1-'80
8-G	195	C	AC	1-'27, 5-'26, 2-'71, 1-'80
8-H	225	C	AC	1-'27, 5-'26, 2-'71, 1-'80
9-G	225	C	AC	1-'27, 5-'26, 2-'71, 1-'80
9-H	255	C	AC	1-'27, 5-'26, 2-'71, 1-'80
10-G	275	C	AC	1-'27, 5-'26, 2-'71, 1-'80
10-H	305	C	AC	1-'27, 5-'26, 2-'71, 1-'80
11-H	350	C	AC	1-'27, 5-'26, 2-'71, 1-'80
12-H	375	C	AC	1-'27, 5-'26, 2-'71, 1-'80
2	110	T	AC	1-'27, 4-'26, 2-'71, 1-'80

COLONIAL

Model	Price	Cb.	Pwr.	Tubes
31-AC	$268	C	AC	2-'26, 2-'27, 2-'71A, 1-'80
31-AC	278	C	AC	2-'26, 2-'27, 2-'71A, 1-'80
31-DC	288	C	DC	5-'26, 2-'71A
31-DC	298	C	DC	5-'26, 2-'71A

COLUMBIA-KOLSTER

Model	Price	Cb.	Pwr.	Tubes
C-1	$140	T	AC	1-'71A, 4-'26, 1-'27, 1-'80
C-2	160	T	AC	1-'71A, 5-'26, 1-'27, 1-'80
C-3	200	C	AC	1-'71A, 4-'26, 1-'27, 1-'80
C-4	285	C	AC	1-'71A 5-'26, 1-'27, 1-'80, 1-'81
C-5	350	C	AC	1-'10, 5-'26, 1-'27, 2-'81
C-6	140	T	DC	5-'01A, 1-71A
C-7	200	C	DC	5-'01A, 1-71A
C-1-25	140	T	AC	1-'71A, 4-'26, 1-'27, 1-'80
C-4-25	285	C	AC	1-'71A 5-'26, 1-'27, 1-'80, 1-'81

SLAGLE

Model	Price	Cb.	Pwr.	Tubes
Nine	$360	C	AC	7-'27, 2-'71A, push pull
Ten 29-A	500	C	AC	8-'27, 2-'71A, push pull
Ten 29-B	600	C	AC	8-'27, 2-'71A, push pull
Ten 29-C	750	P	AC	8-'27, 2-'71A, push pull
Ten 29-D	850	P	AC	8-'27, 2-'50, push pull

CROSLEY

Model	Price	Cb.	Pwr.	Tubes
804	$105	T	AC	5-'27, 2-'71A
706	80	T	AC	4-'26, 1-'27, 2-'71A
708	114	C	AC	4-'26, 1-'27, 2-'71A
609	99	C	AC	3-'26, 1-'27, 2-'71A
608	65	T	AC	3-'26, 1-'27, 2-'71A
601	55	T	Batt.	5-'01A, 1-'71A
401	35	T	Batt.	4-'99, 1-'20

DAY-FAN

Model	Price	Cb.	Pwr.	Tubes
25-mag.	$150	T	AC	5-'26, 1-'27, 2-'71A
48-dyn.	150	T	AC	5-'26, 1-'27, 2-'71A
26-mag.	295	C	AC	5-'26, 1-'27, 2-'71A
43-dyn.	295	C	AC	5-'26, 1-'27, 2-'71A
35	80	T	Batt.	6-'01A, 1-'12A

EDISON

Model	Price	Cb.	Pwr.	Tubes
R-2	$260	C	AC	4-'26, 1-'27, 1-'50, 1-'81
R-1	315	C	AC	4-'26, 1-'27, 1-'50, 1-'81
C-2	495	P	AC	4-'26, 1-'27, 1-'50, 1-'81
C-1	1100	P	AC	4-'26, 1-'27, 2-'50, 2-'81

Prices include Dynamic Speaker

ERLA

Model	Price	Cb.	Pwr.	Tubes
BM	$125	T	AC	2-'71A, 1-'80, 4-'26, 1-'27
BM	215	C	AC	2-'71A, 1-'80, 4-'26, 1-'27
BM	240	C	AC	2-'71A, 1-'80, 4-'26, 1-'27
BJ	265	C	AC	4-'26, 1'27, 2-'50, 2-'81
AJ	280	C	AC	5-'26, 1-'27, 2-'50, 2-'81
BM	325	P	AC	4-'26, 1-'27, 2-'71A, 1-'80
AJ	425	P	AC	5-'26, 1-'27, 2-'50, 2-'81

BALKITE

Model	Price	Cb.	Pwr.	Tubes
A-3	$125	T	AC	5-'27, 2-112A
A-5	140	T	AC	5-'27, 2-112A
A-7	375	C	AC	5-'27, 2-112A
B-7	475	C	AC	5-'01A, 1-'10, 1-'50, 2-'81
B-9	950	C	AC	5-'01A, 1-'10, 1-'50, 2-'81

FEDERAL ORTHO-SONIC

Model	Price	Cb.	Pwr.	Tubes
E	$95-$340	T-C	DC-AC	5-'01A, 1-'71A, 1-BA Rayth.
F	145- 925	T-C	DC-AC	6-'01A, 1-'71A, 1-BA Rayth.
H	110- 223	T-C	AC	3-'26, 1-'27, 2-'71A, 1-'80
K	128- 228	T-C	AC	1-'22, 3-'27, 2-'71A, 1-'80

FREED EISEMANN

Model	Price	Cb.	Pwr.	Tubes
NR-80	$125	T	AC	5-'26, 1-'27, 1-'71A, 1-'80
NR-80W	135	T	AC	5-'26, 1-'27, 1-'71A, 1-'80
NR-80	125	T	DC	6-'01A, 2-'71A
NR-80W	135	T	DC	6-'01A, 2-'71A
NR-80	135	T	AC-25	5-'26, 1-'27, 1-'71A, 1-'80
NR-80W	145	T	AC-25	5-'26, 1-'27, 1-'71A, 1-'80
NR-85	160	T	AC	5-'26, 1-'50, 1-'81, 1-'27

FRESHMAN

Model	Price	Cb.	Pwr.	Tubes
M-11	$85	T	AC	1-'80, 4-'26, 1-'27, 1-'71A
N-11	115	T	AC	1-'81, 4-'26, 1-'27, 1-'50
N-12	195	C	AC	1-'81, 4-'26, 1-'27, 1-'50
N-14	195	C	AC	1-'81, 4-'26, 1-'27, 1-'50
N-17	250	C	AC	1-'81, 4-'26, 1-'27, 1-'50
Q-15	69	T	AC	1-'80, 1-'22, 1-'27, 1-'26, 1-'71A
Q-16	129	C	AC	1-'80, 1-'22, 1-'27, 1-'26, 1-'71A
Q-D-16	150	C	AC	1-'80, 1-'22, 1-'27, 1-'26, 1-'71A

PRESIDENT

Model	Price	Cb.	Pwr.	Tubes
	$60	T	AC	2-'71, 1-'27, 4-'26, 1-'80
	150	C	AC	2-'71, 1-'27, 4-'26, 1-'80

GILLFILLAN

Model	Price	Cb.	Pwr.	Tubes
33	$318	C	AC	5-'27, 2-'10, 2-'81
44	388	C	AC	5-'27, 2-'10, 2-'81
66	388	C	AC	5-'27, 2-'10, 2-'81
77	490	P	AC	5-'27, 2-'10, 2-'81
100		C	AC	5-'27, 2-'71A, 1-'80

GRAYBAR

Model	Price	Cb.	Pwr.	Tubes
300	$ 83	T	Batt	5-'01A, 1-112A
310	115	T	AC	4-'66, 1-'27, 1-'71A, 1-'80
320	195	C	AC	4-'26, 1-'27, 1-'71A, 1-'80
330	182	T	AC	7-'27, 1-'71A, 1-'80
340	410	C	AC	7-'27, 1-'71A, 1-'80

SYNCHROPHASE

Model	Price	Cb.	Pwr.	Tubes
5	$105	T	DC	4-'01A, 1-112A or '71A
7	145	T	DC	6-'01A, 1-'71A
AC-6	198	T	AC	4-'26, 1-'27, 1-'71A
AC-7	195	T	AC	5-'26, 1-'27, 1-'71A
AC-6	510	C	AC	4-'26, 1-'27, 2-'50*
CR-18	110	T	AC	(Short wave)

* Push pull

MAJESTIC

Model	Price	Cb.	Pwr.	Tubes
71	$138	C	AC	4-'26, 1-'27, 2-'71A, 1-'80
72	168	C	AC	4-'26, 1-'27, 2-'71A, 1-'80
81	265	P	AC	5-'27, 2-'81, 2-'50

HOWARD

Model	Price	Cb.	Pwr.	Tubes
675	$675	C	AC	4-'26, 1-'27, 2-'10, 2-'81
750	750	C	AC	4-'26, 1-'27, 2-'10, 2-'81
1500	1500	C	AC	4-'26, 1-'27, 2-'10, 2-'81
395	395	C	AC	4-'26, 1-'27, 1-'10, 2-'81
445	445	C	AC	4-'26, 1-'27, 1-'10, 2-'81
495	495	C	AC	4-'26, 1-'27, 1-'10, 2-'81

KELLOGG

Model	Price	Cb.	Pwr.	Tubes
516	$375	C	AC	6-401, 1-403, 1-'80
514	495	C	AC	6-401, 1-403, 1-'80
520	115	T	AC	4-401, 1-403, 1-'80
521	200	C	AC	4-401, 1-403, 1-'80

KING

Model	Price	Cb.	Pwr.	Tubes
FK	$55	T	Batt	3-'01A, 1-'00A, 1-112A
GK	73	T	Batt	4-'01A, 1-'00A, 1-112A
HK	110	T	AC60	4-'26, 1-'27, 1-'71A
JK	130	T	AC60	4-'26, 1-'27, 2-'71A
HW	115	T	AC	4-'26, 1-'27, 1-'71A
JW	135	T	AC	4-'26, 1-'27, 2-'71A

KOLSTER

Model	Price	Cb.	Pwr.	Tubes
K-20	$135	T	AC	4-'26, 1-'27, 1-'71A
K-21	160	T	AC	5-'66, 1-'27, 1-'71A
K-22	200	C	AC	4-'66, 1-'27, 1-'71A
K-23	285	C	AC	5-'26, 1-'27, 1-'71A, 1-'81
K-24	350	C	AC	5-'26, 1-'27, 1-'71A, 1-'81
K-5	175	C	AC	2-'81, 1-'10, 1-874
6-D	90	T	DC	5-'01A, 1-112, Batt.
6-H	295	C	AC	6-'01A, 1-'10, 1-874, 2-'81
K-30	135	T	DC	5-'01A, 1-'71A
K-32	200	C	DC	5-'01A, 1-'71A

EVEREADY

Model	Price	Cb.	Pwr.	Tubes
1	$110	T	AC	4-'26, 1-'27, 2-'71A
2	110	T	AC	4-'26, 1-'27, 2-'71A
3	130	T	AC	4-'26, 1-'27, 2-'71A
20	55	T	AC	5-'40, 1-112A or 1-'71A
21	55	T	AC	5-'40, 1-112A or 1-'71A

PHILCO

Model	Price	Cb.	Pwr.	Tubes
511	115	T	AC	4-'26, 1-'27, 1-'71A
521	125	T	AC	4-'26, 1-'27, 1-'71A
512-3-4-5	125	T	AC	4-'26, 1-'27, 1-'71A
522-3-4-5	135	T	AC	4-'26, 1-'27, 1-'71A
531	200	C	AC	4-'26, 1-'27, 1-'71A
541	210	C	AC	4-'26, 1-'27, 1-'71A
551	275	C	AC	4-'26, 1-'27, 1-'71A
561	285	C	AC	4-'26, 1-'27, 1-'71A
571		P	AC	4-'26, 1-'27, 1-'71A
581		P	AC	4-'26, 1-'27, 1-'71A

(Continued on Page 44)

Radio Kit Reviews

"A", "B" AND "C" UNIT

This outfit is designed to supply *A, B* and *C* voltages for a radio set previously operated with wet and dry batteries. Filament current at 6 volts is furnished by a Tobe Model 26 *A* unit. The maximum *B* voltage from the rectifier-filter unit is 180 volts when the *C* supply is 40 volts. Very little wiring is involved in the assembly of the several units which constitute the assembly, which is designed to utilize a 110-volt a.c. supply.

Fig. 1 shows the wiring diagram. The transformer T_1 and choke coils *CK* are included in the Thordarson Compact type R-280. All but one of the condensers are included in the Tobe condenser block. An extra condenser C_3 is used to bypass the intermediate *C* bias voltage. All resistances of the voltage divider circuit are included in the Electrad Truvolt Divider *D*. This unique unit also provides a control panel and binding posts for the various *B* and *C* voltages. The five knobs are used to adjust *B* and *C* voltages and since the divider is calibrated, proper operating voltages can be obtained for any conventional type receiver. The booklet supplied with the divider gives complete information and the voltage adjustment is extremely simple.

Completed Current Supply Unit

The *A* supply is a complete unit that contains a stepdown transformer, rectifier and filter system. There is an adjustment provided that provides proper filament voltage for any conventional receiver. There is also a receptacle into which the supply plug of the R-280 compact must be inserted. In this way, one power switch operates all supply voltages to receiver.

Fig. 2 clearly shows the placement of parts. It will be noticed that no connection is made from *B* post to either of the *A* supply binding posts as this is usually incorporated in the set. If this connection is not provided in the set, the *A* binding post should be connected to the *B* post of the voltage divider.

If the set to be used with this power supply does not make use of a power tube in the last audio stage, much improvement of tone quality will be obtained by incorporating a 171-A type tube. An extra filament winding for the power tube is provided in the R-280 compact, but it need only be used for this purpose in case the receiver has a total of more than six tubes. Otherwise the *A* unit can supply all *A* voltage and the wiring is thereby simplified.

PARTS LIST

1—Electrad Truvolt Divider
1—Thordarson Power Compact type R-280
1—Tobe B Block type 280
1—Tobe Bypass condenser 2 mfd. 200 volts
1—T-1 A Supply Model A-26
1—UX Type Socket
1—Baseboard 11 x 14 x ½ in.

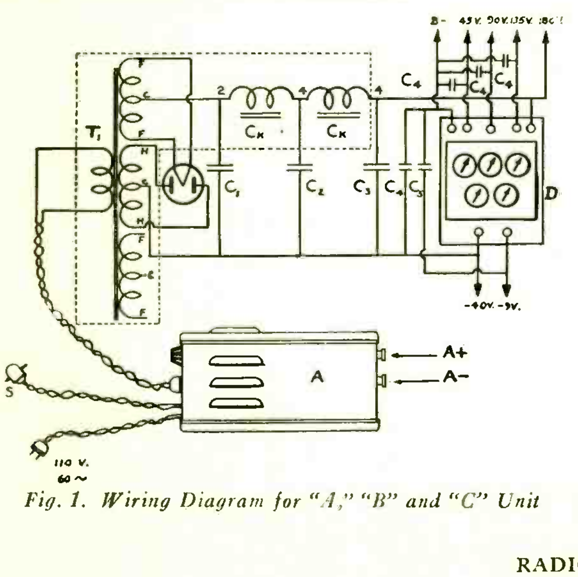


Fig. 1. Wiring Diagram for "A," "B" and "C" Unit

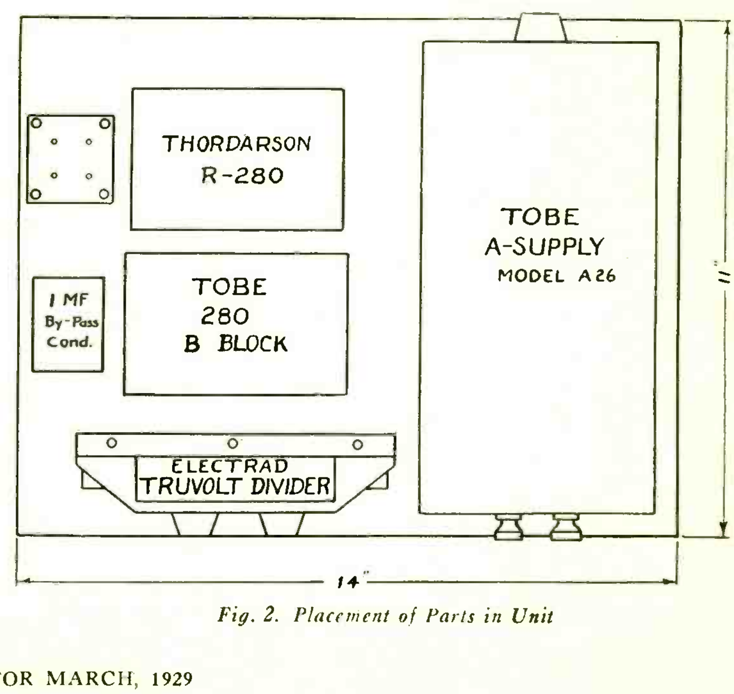


Fig. 2. Placement of Parts in Unit

NEW RADIO CATALOGS

Supreme Instruments Corporation of Greenwood, Mississippi, have issued interesting circulars regarding their models 99-A and 400-A. The former contains a three-scale d.c. voltmeter (1000 ohms per volt, 600-volt max.), a three-scale a.c. voltmeter (150 volts max.), a two-scale milliammeter (0-125 m.a. and 0-2½ amps), and a high-frequency oscillator, together with instructions for making all service tests on any radio set. The latter is similarly equipped and also contains all necessary tools, from screwdrivers to soldering iron. Both are furnished in convenient carrying cases.

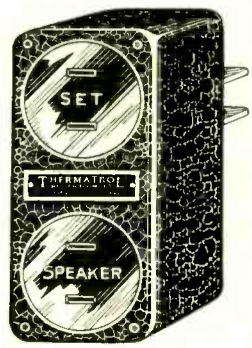
Bulletin PE-14 from G-M Laboratories, Inc., of Chicago, Ill., is a complete treatise on theory and use of photoelectric cells. It includes characteristics and specifications of several types of Visitron cells for radio picture transmission and reception.

Catalog 33 R-1 from Chicago-Jefferson Fuse & Electric Co., of Chicago, Ill., illustrates and describes audio transformers, tube rejuvenators and checkers, and fuses for radio use.

The Thermatrol interference filter is designed for connection between a 110-volt a.c. circuit and any small electrical device that may be causing interference to radio reception. It may also be plugged in ahead of an

a.c. set so as to reduce interference coming over an a.c. line, including the "snap" that is caused by turning electric lights on and off.

The Thermatrol dynamic speaker control switch is designed to automatically turn on or off the AC supply for the field of a dynamic speaker simultaneously with the receiver. Most dynamic speakers are equipped with an on-off switch, necessitating turning on or off two separate controls when the set is brought into play. With the use of this automatic switch the operation is accomplished by the snap of the receiver switch.



The Y-227 AC Sonatron is a new heater type vacuum tube which will heat up so as to give full reception within seven seconds after the current is turned on. It employs a mica bridge construction. Sonatron also announces production of a 171 AC tube with a heavy filament for reducing a.c. hum.


CROSLEY
announces:
3 optional colors
Mandarin Red
Nanking Green
Manchu Black
Attach to antenna and add tubes
The AC Electric
Gemchest
$99.
To radio's great *value* Crosley now adds STYLE. To perfection of radio reception Crosley introduces FASHION. Chinese Chippendale is the motif. Three popular, smart, stylish colors afford your trade a splendid choice. Mandarin Red, Nanking Green and Manchu Black. All gold trimmed.
The size of this chest a stylishly right. Not too big. Just enough color to complete the furnishing of any room.
In it is built the famous Crosley AC Electric GEMBOX and the Crosley dynamic type power speaker DYNACONE.
The same cabinet with the Crosley 8 tube SHOWBOX built in sells for $114. Prices quoted do not include tubes.
Radio excellence! Decorative smartness! Color harmony! See other side of this announcement for complete line.
See price correction
side this sheet

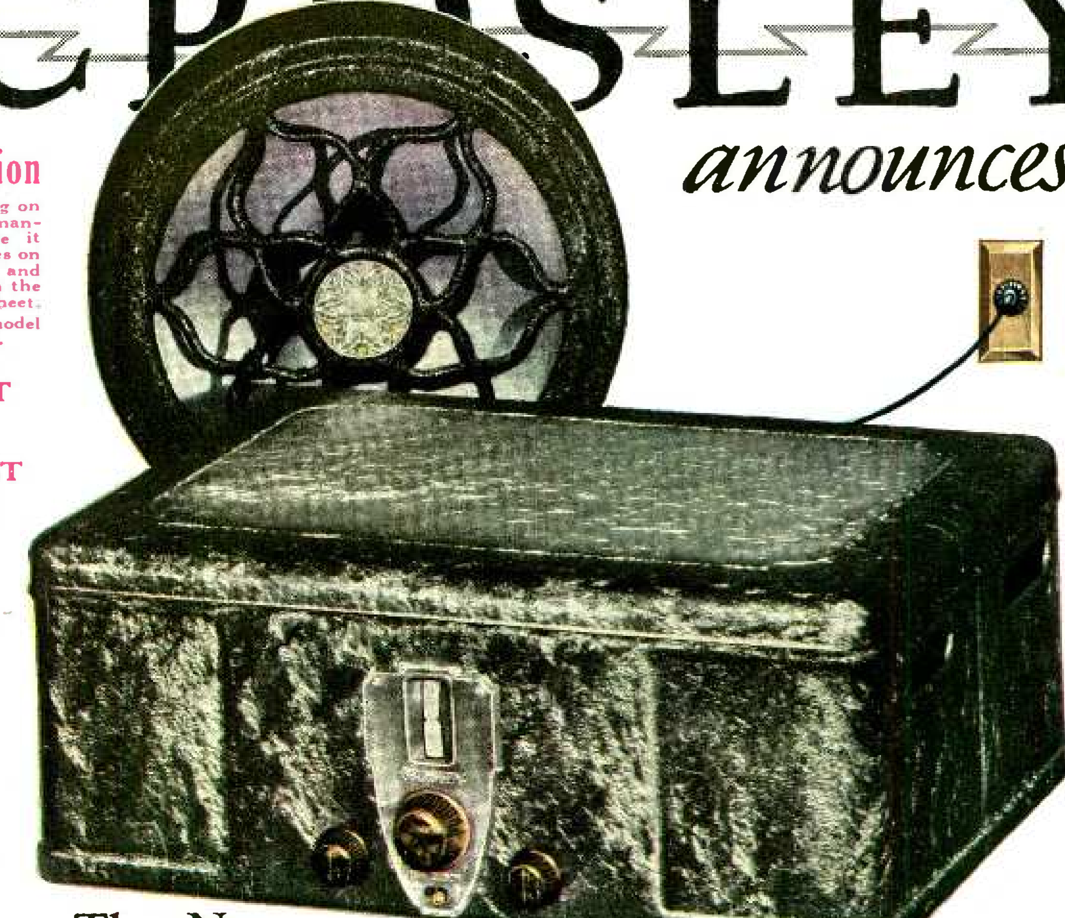
CROSLEY

announces:

Price Correction

After the black printing on this sheet, analysis of manufacturing costs made it possible to reduce prices on the Crosley Gemchest and Showchest described on the reverse side of this sheet. The price on each model has been reduced $5.00.

NEW PRICES
GEMCHEST
$94
SHOWCHEST
$109



The New

8 tube JEWELBOX $105

Power detector, tuned antenna circuit, UY-227 tubes in all sockets except output and rectifying.

"The finest radio money can buy."

Power detector makes use of plate rectification instead of grid rectification as commonly used in radio. Result: *over-loading prevented* and tone improved.

Tuned antenna circuit creates selectivity and sensitivity to a degree of quality never before attained.

By use of UY-227 type tubes, except in output, filtering of circuits is improved.

Add to these features other improvements such as NEW volume control, improved audio system, full voltage supply, no power pack trouble and genuine neutrodyne balancing.

Sell this great value—be in radio *profitably* in 1929.

Write us for address of nearest Crosley jobber.

CROSLEY 8 Tube SHOWBOX $80

This famous, finely balanced neutrodyne receiver—sensitive and selective to a marked degree is also available in a new black wrinkle finish brushed with white gold as well as the popular brown and gold finish.

Features of the SHOWBOX are FULL VOLTAGE on audio plates—perfected MERSHON Electrolytic condenser in power pack which will *not* break down—push-pull amplification — modern illuminated dial and many others found in sets at twice its price.

Crosley dynamic type power DYNACONE $25

THE CROSLEY RADIO CORPORATION, CINCINNATI, OHIO
Powel Crosley, Jr., Pres.
Montana, Wyoming, Colorado, New Mexico and West prices slightly higher.
Prices quoted are without tubes

CROSLEY Line for 1929 Strongest in the Industry

Lowest priced FIRST CLASS AC electric radio on the market — The GEMBOX at $65. Unusually sensitive and selective. Genuine neutrodyne and operates power speaker.

Crosley battery type sets are same superior neutrodyne circuits as found in Crosley AC Electric sets.

6 tube BANDBOX—operates power speaker—$55.

5 tube Dry Cell BANDBOX, Jr., for places where battery recharging is impossible—operates loud speaker—$35.

SPREADING THE BANDS

(Continued from Page 29)

Now take the bunch of various sized strips and place them in the holder, one at a time, checking for minimum and maximum wave reading on the tuning dial. When a strip is found that will spread the band in question over most of the dial, mark it for use on that band. It may be necessary to file 1/32 in. or thereabouts off the end of a strip in order to obtain this result.

The tuning condenser C_1 should have a maximum capacity of about 40 mmf, while any well built 13, 17 or 23 plate condenser may be used as an auxiliary condenser C_2.

One especially desirable feature of this method of spreading the bands is that any standard set of factory-built coils may be

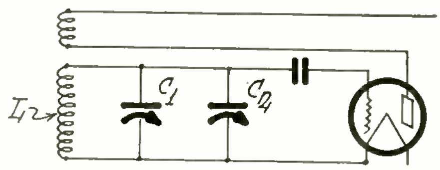


Fig. 3. The Tuning Condenser and the Auxiliary Condenser Are Paralleled

used; and by proper adjustment of the auxiliary condenser any desired wave may be quickly reached. It is quicker and easier to shift a small bakelite strip on the front of the panel than to change plug-in variable or fixed condensers. Of course a different coil may be desirable for changing from 20 to 40 or from 40 to 80, although in the tuners built at W6UJ good 20-meter signals from the 10-meter coil, good 40-meter signals from the 20-meter coil and good 80-meter signals from the 40-meter coil are obtained just by adding enough capacity with the auxiliary condenser. The $L:C$ ratio seems to have very little effect upon the signal strength. But most operators will desire to have at least 4 coils (10-20, 40 and 80), arriving at the approximate desired wave by setting the auxiliary condenser at a pre-determined point with the proper bakelite strip, and doing the final, accurate tuning with the regular small tuning condenser.

VACUUM TUBE VOLTMETER

(Continued from Page 24)

voltmeter are all that is required for the 60 cycle calibration, whereas audio and radio frequency oscillators, thermocouple meter standards, and more or less involved measuring circuits are required for higher frequency work.

In constructing a duplicate the base-mounted style of Fig. 1 need not be followed. The parts can be panel-mounted for cabinet use as long as the essential arrangement is preserved, the hook-up of Fig. 5 followed, and the instruments duplicated. The instrument shown was designed for laboratory measurement of radio-frequency receiver gain and was thus made of low range and small input capacitance (199 tube used). Its zero frequency error makes it useful for all measurements of a few volts, however, and of great convenience in many other cases.

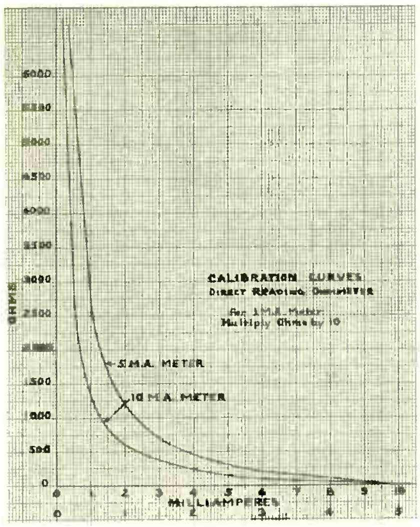
DIRECT READING OHMMETER

(Continued from Page 16)

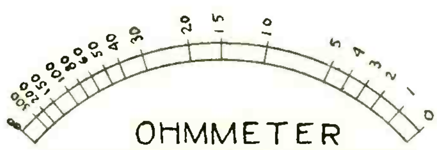
merely being adjusted for a lower resistance.

The range may be decreased by shunting the meter.

The arrangement of the writer's instrument is shown in the picture. The details of construction for such a simple device would be superfluous, the arrangement of convenient clips for holding the dry cell (or cells), etc., being a matter for each maker's fancy and facilities.



To obtain a calibration curve, values of *i* are chosen, which are scale divisions of the meter, and these values are inserted in the equation. A number of points are thus obtained from which a curve may be plotted. A handier method than a calibration chart is to make a new scale for the meter with the resistance values on it so the instrument is direct reading. A reproduction of the



Typical Meter Scale

scale for a Western 0-1 m.a. meter is shown herewith.

To use, short the terminals *X* and adjust the variable resistor for full scale reading, thus obtaining a zero and insuring correct readings. The value of a resistance inserted at *X* is then given directly in ohms.

For convenience in use the meter and resistance should be mounted on a small bakelite panel, which in turn is mounted on a small box in which the dry cell is kept. Flexible leads with spring clips or prods also increase the usefulness of the instrument.

PHOTO-RADIO OPERATION

(Continued from Page 20)

terval during which the gear stands still becomes shorter and shorter, but as soon as there is evidence of irregularity in the click of the trip magnet, the critical point of close adjustment has been passed and by advancing the regulator control slightly the correct operating speed will be found.

In the meantime, the photographic paper has been placed on the cylinder and the room in which reception is taking place is sufficiently darkened in order that the paper be not exposed to light. The corona needle is placed on the paper and the control R_1 is turned to the extreme left so that the synchronizing signal will not trip the relay while the adjustment of the corona discharge, the second important step, takes place. While the drum is stationary, slowly increase the gain control R_2 until the ultra-violet ray is about the size of a pencil point whenever a loud signal comes through the loudspeaker.

It may be necessary to adjust the condenser VC_1, but if the previous instructions regarding this have been followed, this will require only a moment to obtain a satisfactory corona discharge. With any variation in the volume of the audible signal there should be a corresponding fluctuation in the corona discharge, so that on faintly heard signals the corona is barely visible and on louder ones it will attain the greatest brilliancy. Now restore the corona stylus to its first position at the extreme left of the cylinder.

By this time the last warning signal should be heard from the transmitting station. This has a peculiar burring sound and lasts only four or five seconds. After this the actual picture signals are being sent and, for the 4 by 5 picture, lasts about three minutes.

The photographic papers used for the Cooley pictures are Azo No. 1 and Azo No. 2. The first is very sensitive to light and is likely to be spoiled by daylight, but it is also most sensitive to weak corona and, which amounts to the same thing, weak picture signals. Azo No. 2 is less sensitive, but more convenient to handle and most often used for ordinary reception.

The chemicals for developing have been placed on the market in a convenient tube with full directions for mixing. In the upper section of the tube is a powder which is poured in a tray containing six ounces of water. When it has been thoroughly mixed push down the second cork and pour off the remaining chemical in the same tray. The fixing solution calls for four tablespoons of "hypo" in 8 ounces of water. After this is thoroughly mixed, add the acidifier, using the lid of the box in which it comes as a measure. Three-quarters of a lidful is the correct amount. The fixer must be mixed fresh every three or four hours. This developing and fixing should be done in dim light, a shaded 32-watt lamp will be sufficient in which to work as long as the direct rays do not fall upon the paper.

After the paper has been exposed by the corona discharge, it is immersed in the developer solution and is kept there until the proper contrast of black to white appears. This process usually takes less than half a minute. The developer is then washed off with water and the paper placed in the fixing solution, where it is left for fifteen minutes and is finally given a fifteen-minute bath in running water.

It is natural that the operator who has some photographic experience will be most successful.

NOTE: Only a brief account of the construction and operation of the picture receiver has been attempted in this series of brief articles. Should any difficulties arise, readers may refer their questions to this department and the answers will be given in subsequent issues of the magazine.

FOREIGN CIRCUIT DIAGRAMS

(Continued from Page 27)

everyone is assumed to know it. The use of the grid leak in shunt from the grid to the filament is very common, not only in German practice, but throughout Europe.

The values of the condensers are here given in "Centimeters," a "cm." of capacity being 9/10 of a micromicrofarad (picofarad); but for all practical purposes in circuits a "cm." replaces a "pfd." so that the British .0005 condenser (500 picofarads) is here represented by one of 500 centimeters.

The real fun is with the batteries, since the *A* battery is called *H* (Heating), the *B* battery is marked *A* (Anode), and the *C* battery is *G* (Grid).

Finally, with the French diagram (Fig. 4), everything is turned sideways, backwards, and inside out. Here the condensers are given in thousandths of a microfarad, a thoroughly confusing practice: notice also the comma for the decimal point (and, vice versa, "20,000" is written as "20.000"). The battery voltages mean little or nothing—it is merely a habit to use "40" for *B Det*, and "80" for *B Amp*. Voltages higher than 80 are only just beginning to be used in France. *Pol.* is for "Polarisation," of course.

Above all, note the condenser shunt to the "High Talker." In a few years, French amateurs will begin to demand a few of the high notes, but for the moment it is "low notes or nothing," with the result that never an *S* gets through the shunted loudspeaker. And so, as Radio Paris is made to announce nightly, *"Bon 'oir mesdames, bon 'oir mesdemoi'elles, bon 'oir me'ieurs."*

COMMERCIAL BRASSPOUNDER

(Continued from Page 28)

extremely efficient, employing a Colpitts oscillator with capacitive coupling to the antenna, thus making for very stable output. This transmitter, minus the wave change switch, is installed on the great fleet of 75-ft. patrol boats employed in short-run patrols. The operating is done by non-operator personnel, mostly on voice, though ICW is used at slow speeds, too, over longer distances or under conditions preventing phone work.

The standard receiver used with the above transmitter is an eight-tube superheterodyne covering from 100 to 200 meters. This set is more or less conventional, employing peanut tubes; first detector, oscillator, three stages of intermediate amplification on 47 kilocycles, followed by detector and one stage of audio, and separate 47 k.c. heterodyne for CW reception.

The above described sets are the ones used on the 110-130-meter band. Higher power transmitters are used on the lower frequencies mentioned above, in conjunction with receivers identical with the Navy type SE-1420, which is familiar to most commercial ops.

The standard low-frequency set used on the smaller cutters and destroyers is a 200-watt master oscillator, power amplifier set, made by G. E. There is one 50-watt oscillator followed by three 50-watters as power amplifiers. This is similar to the three-tube set made for the RMCA, which is, of course, of lower power. One principal difference is in the method of securing ICW. The C. G. set uses a system of impressing 500-cycle a.c. on the grid through a transformer, which results in a sinusoidal modulated wave. The RMCA set uses the customary chopper, which has the advantage of giving a louder ICW signal for close work, though it doesn't carry as well as the other, for distance.

The bigger cutters have higher power sets for the low frequencies, which run from 500 watts to 2 k.w. The Ice Patrol boats have high power, high frequency transmitters.

Mr. Lahey, now of the Steamship Mongolia, reports regular winter work on 315 kilocycles (952 meters) with the above described 200-watter from the C. G. Destroyer Patterson off Nantucket Light, to NPG, San Francisco, and NPM, Honolulu, the latter giving R-4-5. They are good sets all right, being good for 500 miles daytime.

Most shore stations and cutters are equipped to keep watch on two frequencies at once so that they are in touch with both commercial and Coast Guard traffic.

This station, NGQ, which is a typical base station, has three receivers for low waves, the 121-meter band, and from 250 meters to 7000 meters, with split headsets for continuous watch on two of them, 500 kilocycles and 2465 kilocycles. The transmitter is the standard 121-meter set mentioned previously, with which work is done with patrol boats, cutters and with the world-wide naval communication system, through the station at San Diego, NPL. NPL works NGQ on 120 kilocycles, their normal working wave for the NPG-NPL circuit, NGQ responding on 2315 kilocycles (129.5 meters). The distance is 100 miles or so overland, and communication is perfect day or night, any season, so that there is no excuse for breaking.

All bases have but the 50-watt set for those frequencies, though the cutters often answer on 275 kilocycles with their higher power sets, which makes for good break-in work; that is, due to the wide difference in transmitting frequencies. The 50-watter on 121 meters carries about equally well with the high powers on 1000 meters or so, at night, especially if there is static, which handicaps the reception on the long waves more than the short ones; but in daytime the 500, 1000-meter waves are better than the short ones around 120 meters by far. Very often during the winter nights, signals are exchanged with base stations on the East Coast.

The described transmitters and receivers were designed with the idea in mind that they would be installed on these 75-footers for operation by non-radio personnel; and communication is very satisfactory as a rule. Phone work is done from this station regularly in daytime up to 100 miles or so. Most of the stuff handled is in code, so that it is found expedient to resort to ICW work when static is bad or there are dead spots encountered. This means that telegraphing must be done at the speedy rate of 5 or 6 words per minute, which is the source of much mental and physical anguish to the experienced telegrapher.

The cutter Tamaroa, based at San Pedro, besides her activities with the rumrunners, has figured in such incidents as the towing of the Grace Dollar when she lost her propeller September, 1927, off Lower California. The Tamaroa's 200-watt set on 600 meters, by the way, put a better signal into KOK, where I was operating at the time, than the 5 k.w. spark of the Dollar boat.

Well, such times as that, intermixed with shooting affrays with Limey rummies, go to make for a bit less monotony, common to "Spark's" life. . . . T I S . . . SK.

A LETTER from Dudley Owens contains some suggestions for the improvement of operating conditions at sea. They are on a somewhat new and dangerous tack and we hope none of our readers will take offense. If anyone does, it would seem to be an indication of a guilty conscience, which should be looked into. Anyway, this exposé of no one in particular may give someone a new slant on himself and start up a brand new line of thought. Owens lists a few things which he believes are detrimental to the advancement of the profession. Quote.

If you want the respect due an operator:

1. Why not clean up the old shack and keep it that way? Cigarette stubs, paper, old wire, matches, breezy pictures, etc., do not look very good.

2. Why not get into the habit of keeping enough of the 'old jack' to last from one payday to the next? The fellow who is always drawing is rather small.

3. Why not get acquainted with some of the officials of your S. S. company on all the docks? No wonder you get so little consideration; they don't know you from Adam.

4. Keep yourself cleaned up. A slouchy, unshaven sleepyhead doesn't make much impression even on the old tramp steamer.

5. Why be afraid you will 'spoil the job' by getting a little weather and press for the gang. It's what you're paid to do and if you fall down on the job don't kick if you're not liked.

6. If you have to take on liquid nourishment and lead a high life, do it ashore; not on the job, where you may cheapen the profession as a whole.

A lot of brasspounders blame the service companies and steamship companies for the poor treatment meted out to them when often it is the fault of the operators themselves. Unquote.

And that's that.

VPS

By CHARLES M. BENNETT

THE transmitters of VPS are located at Cape D'Aguilhar, about fifteen miles from the receivers at Kowloon. The main 600-meter transmitter is a 5 k.w. Marconi spark (Sync. 500 cycles) radiating 10 to 15 amperes into a six-wire cage suspended vertically from one of the towers. The long-wave transmitter is a Marconi 6-k.w. tube

(Continued on Page 40)

VPS

(Continued from Page 38)

set, using tube rectifiers. ICW is produced by cutting the filter out of the circuit. It operates on 2800 and 2000 meters, sending time on 2000 meters, through a connection with the Kowloon observatory. It works French Indo-China, Canton, and many others daily. A "T" aerial is used for the long-wave set, and the ground for both sets consists of plates buried in the sea earth extending radially for 100 feet.

The receivers are located at Kowloon observatory, where five picked Asiatic operators maintain the 600-meter watch with a white supervisor. Watch is observed on 2400 meters at the following times: (Hongkong time), 5:30 a. m. to 7:30 a. m., 2:30 to 3:30 p. m., 8 to 8:40 p. m., and 9:30 to 11:40 p. m.; listening on 2400 meters and answering 2800 meters i.c.w.

The station was built by the Navy in 1916, and taken over by the local government in 1921. Australia is worked frequently and ships are worked well into the Indian Ocean. The 600-meter receiver is the latest type of Marconi seven-tube superheterodyne.

VPS also is doing a great deal of work on short wave. The whole station is being remodeled and will eventually have a tube set on 600 meters with PG-N watch on both 600 and 2400 meters. A short-wave transmitter is also being installed for communication with England. The engineer in charge, Mr. Warrenton, told me that over a million dollars is being spent in remodeling the station. Another interesting feature is that every transmitter is in duplicate with emergency power supply, enabling continuous service at all times.

TIME SIGNALS OF THE WORLD

Herbert M. Stiles, S. S. *California*

G. M. T.	Call	Wave	Location
00.01	POT	34.4	Rio de Janeiro
00.25	XORT	44.0	Tsingtao, China
00.58	PKX	7700.	Malabar, Java
01.56	VPS	600.	Hongkong
01.56	JJS	600.	Funabashi
01.56	LIH	1000.	Buenos Aires
01.56	JCS	600.	Chosen. Japan
02.00	VIM	600.	Melbourne
02.30	VIA	600.	Adelaide
02.55	NAA	2677.	Arlington
02.55	NAA	37.4	Arlington
02.55	NSS	17,000.	Annapolis
02.55	VAE	600.	Vancouver, B. C.
02.55	NPO	2677.	Manila
02.55	NPO	5250.	Manila
02.55	FFZ	730.	Shanghai, China
03.55	NBA	18,000.	Balboa, C. Z.
03.55	NBA	2300.	Balboa, C. Z.
04.56	ICX	3500.	Massawa
07.55	NAA	37.4	Arlington
07.55	NAA	2677.	Arlington
07.55	NSS	17,000.	Annapolis
07.55	FL	32.0	Eiffel Tower
07.55	LY	18,900.	Bordeaux, France
09.00	VLY	600.	Wellington, N. Z.
09.25	FL	2650.	Eiffel Tower
09.55	GBR	18,740.	Rugby, England
09.55	NBA	2300.	Balboa, C. Z.
09.55	NBA	6663.	Balboa, C. Z.
10.25	XORT	44.0	Tsingtao, China
10.55	XPK	1400.	Peking
11.58	POZ	18,050.	Nauen, Germany
11.58	POZ	3100.	Nauen, Germany
11.59	JJC	7700.	Funabashi
12.56	VPS	600.	Hongkong
12.56	EBY	2000.	San Fernando, Spain
13.55	NPO	2677.	Manila
13.55	NPO	5250.	Manila
14.00	VIM	600.	Melbourne
14.00	LIH	1000.	Buenos Aires
14.00	PPY	650.	Rio de Janeiro
16.55	NAJ	2300.	Great Lakes, Illinois
16.55	NAT	2850.	New Orleans
16.55	NAA	2655.	Arlington
16.55	NAA	37.4	Arlington
16.55	NSS	17,000.	Annapolis
16.55	NAR	2670.	Key West, Florida
16.55	NPL	950.	San Diego, Calif.
16.55	NPL	9800.	San Diego. Calif.
16.57	VPB	600.	Colombo, Ceylon
17.55	GBR	18.740.	Rugby, England
17.55	NBA	6663.	Balboa, C. Z.
17.55	NBA	18,000.	Balboa, C. Z.
18.55	RET	7100.	Petrograd
18.55	XDA	2660.	Mexico City
18.55	HZA	15,800.	Saigon, Indo China

19.00	HZA.	25.	Saigon, Indo China
19.55	NPG	2275.	San Francisco
19.55	NPG	7005.	San Francisco
19.55	NPW	3156.	Eureka, Calif.
19.55	NPE	2726.	North Head, Wash.
19.55	FL	32.	Eiffel Tower
20.27	VWC	2000.	Calcutta
20.56	VNC	600.	Cape Town
22.25	FL	2650.	Eiffel Tower
23.55	PPC	800.	Caero, Brazil
23.55	NPM	26,245.	Honolulu, T. H.
23.55	NPM	2800.	Honolulu, T. H.
23.58	POZ	18,050.	Nauen, Germany
23.58	POZ	3100.	Nauen, Germany

FROM A GERMAN STANDPOINT

Here's a letter that we are publishing just as we received it. We have to hand it to the operator who tries to do his best under the handicap of having to use a foreign language. We only wish we had made as much use of our two years of foreign language in high school as did Mr. Pilz.

We cannot refrain from comparing the two foreign operators who got tangled up in this little spat over the air. One who had not taken the trouble to equip himself with a knowledge of English, making himself a burden upon the other who had. One was so anxious to rid his shoulders of a little work that he didn't even bother to interpret what he received. The other was so conscienscious that he spent several hours in correcting the other's mistake.

We have noticed that some American operators are just as shiftless as TNY, while others are as conscientious as DHC. If we could just shift the balance toward those who take their profession seriously the game would be improved for all hands.

Dear Wireless Operators:

Concerning the December issue of RADIO, I must say Mr. Lucas is perfectly right, when he writes that we operators, specially on a cargo vessel, are so lonesome. *(?)* We have plenty of time to write some articles. Certainly we do not always recognize the opportunity of a story, but there are so many things which people on shore would read with great interest, while we are accustomed to the life at sea.

This kind of English writing is a very difficult task for me, being a German. I only learned your language for two years, when I was at high school in Germany, and the sole occasion to learn more about it is, to have a big correspondence. In spite of this fact I will try to give you a picture of a communication I shortly had with a Spanish steamer about 100 miles away from PQG station of the Azores. I'll write it as it really happened.

One afternoon I was called by some ship for tr. Because of the terrible QSC I couldn't make out the call. It was given in the kind that you were able to change the dots against the dashes. I answered, QSQ? de DHC QRV K.

After ten mintues I got at last the tr as SS CABO STA MARIA fm SEVILLA bnd NY. Afterwards I found the call as TNY in my station book.

Now I gave QSL QSU AR.

Back came: pse QSO PQB or EAL?

Naturally I had no QSO, being not more than 100 miles from PQG, so that I could not work with full power.

TNY de DHC—hr QSN now QSO PQB only in darkness and EAL always QSN QSU later.

Then a few minutes later: DHC de TNY pse rpt will u QSR msg to EAL and PQB?

TNY de DHC sry om hr QSR impossible QSN will try PQB in darkness QSU ge.

DHC de TNY esta bien hr msg nr 1. Follows text of msg nr 1, 2, 3.

TNY de DHC pse QSK hr QSN nw QSU when QSO PQB.

DHC de TNY rrr esta bien hr rpt.

He repeats now his messages, forgetting to give date and time.

across two of the secondaries are adjusted at the factory to eliminate hum.

The output of the rectifier tube feeds into the filter system which consists of the usual two filter chokes and filter condensers. Fixed resistors are used to secure the proper plate voltages for the detector and amplifier tube. *C* biases are secured by causing the plate currents of the respective tubes to flow through resistors inserted in the center tap leads. Thus the frame of the receiver is both at *—B* and at *—C* potential and all grid returns are simply grounded to get the proper bias.

Because of the two power tubes and the use of generous size push-pull audio transformers, the model H receiver is able to deliver 1½ watts of undistorted power to the loud speaker and so only the better grades of the exponential, dynamic cone and dynamic speakers should be used. The dynamic is the best for true frequency response, but is not quite as sensitive on weak signals as the other two types.

RADIO RECEIVERS

(Continued from Page 31)

RCA

Model	Price	Cb.	Pwr.	Tubes
16	$ 83	T	Batt	5-'01A, 1-112A
18	115	T	AC	4-'26, 1-'27, 1-'71A, 1-'80
18	110	T	DC	5-112A, 1-'71A
30-A	285	C	AC	7-'99, 1-'71A, 2-'81, 1-876
41	241	C	AC	4-'26, 1-'27, 1-'10, 1-'80
41	230	C	DC	6-112A, 4-'71A
51	195	C	AC	4-'26, 1-'27, 1-'71A, 1-'80
51	190	C	DC	5-112A, 1-'71A
60	182	T	AC	7-'27, 1-'71A, 1-'80
62	410	C	AC	7-'27, 1-'71A, 1-'80
64	609	C	AC	8-'27, 1-'50, 2-'81

SLEEPER

72	$250	C	AC	4-'26, 2-'27, 1-'71A, 1-'80
71	225	C	AC	4-'26, 2-'27, 1-'71A, 1-'80
70	185	T	AC	4-'26, 2-'27, 1-'71A, 1-'80
78	180	C	AC	3-'26, 2-'27, 2-'71A, 1-'80
76A	150	C	AC	3-'26, 2-'27, 2-'71A, 1-'80
76	170	C	AC	3-'26, 2-'27, 2-'71A, 1-'80
80	100	C	AC	3-'26, 2-'27, 2-'71A, 1-'80
68	200	C	AC	3-'26, 1-'27, 1-'71A, 1-'80
67	175	C	AC	3-'26, 1-'27, 1-'71A, 1-'80
66	130	C	AC	3-'26, 1-'27, 1-'71A, 1-'80
60	110	T	AC	3-'26, 1-'27, 1-'71A, 1-'80

SONORA

A-46	$795	T	AC	4-RA1, 2-DE1, 2-SO2 2-RE2, 1 Ballast Lamp
A-44	695	C	AC	4-RA1, 2-DE1, 2-SO2 1 Ballast Lamp 2-RE2
A-40	495	C	AC	4-RA1, 1-DE1, 2-SO1 1 Ballast Lamp 1-RE1
A-20	455	C	AC	1-DE1, 2-SO2, 2-RE2 1 Ballast Lamp
A-36	470	C	AC	4-RA1, 1-DE1, 2-SO2, 2-RE2 1 DE1, 1 Ballast Lamp
A-32	345	C	AC	4-RA1, 1-DE1, 2-SO1 1-RE1, 1 Ballast Lamp
A-30	325	C	AC	4-RA1, 1-DE1, 2-SO1 1-RE1, 1 Ballast Lamp
A-50	155	C	DC	
A-12	95	M	DC	
A-12	115	C	DC	
A-14	140	H	DC	
A-14	160	C	DC	

STEINITE

261	$ 75	T	AC	4-'26, 1-'27, 1-'71A, 1-'80
263	115	C	AC	4-'26, 1-'27, 1-'71, 1-'80
265	130	C	AC	4-'26, 1-'27, 1-'71, 1-'80
266	150	C	AC	4-'26, 1-'27, 1-'71, 1-'80
102	250	P	AC	3-'26, 2-'27, 2-'50, 1-'80
50	185	C	AC	1-'81
40	130	C	AC	3-'26, 1-'27, 1-'26, 1-'71

STEWART-WARNER

801	$96	T	AC	4-'26, 1-'27, 2-112A
811	96	T	AC	4-'26, 1-'27, 2-112A
806	69	T	Batt	4-'01A, 1-'00A, 2-112A

STROMBERG-CARLSON

523	*$295	T	AC	4-'01A, 1-'71A, 2 tungars
635	185	T	AC	5-'27, 1-'71A, 1-'80
636	245	C	AC	5-'27, 1-'71A, 1-'80
633W	*365	T	AC	5-'01A, 1-'71A, 1-'80, 2 tung.
734B	*755	C	AC	6-'01A, 1-'10, 2-'16B, 2 tung.
744B	*1205	C	AC	6-'01A, 1-'10, 2-'16B, 2 tung.

* Complete with tubes.

CASE

73B	$175	T	AC	1-'27, 1-'71, 5-'26, 1-'80
90C	250	C	AC	1-'27, 5-'26, 2-'71, 1-'80

VICTOR

Model	Price	Cb.	Pwr.	Tubes
7-11	$285	P	AC	4-'26, 1-'27, 1-'71A, 1-'80
7-26	425	P	AC	4-'26, 1-'27, 1-'71A, 1-'80
9-16	750	P	AC	4-'26, 1-'27, 1-'50, 2-'81
9-18	925	P	AC	8-'27, 1-'50, 2-'81
9-54	1350	P	AC	8-'27, 1-'50, 1-'81
9-56	1750	P	AC	8-'27, 1-'50, 1-'81
10-69	850	P	AC	1-'26, 1-'50, 2-'81
11-50	950	P	AC	1-'26, 1-'50, 2-'81
12-15	550	P	AC	1-'26, 1-'50, 2-'81

ZENITH

Model	Price	Cb.	Pwr.	Tubes
31	$100	T	Batt	5-'01A, 1-'71A
32	180	C	Batt	5-'01A, 1-'71A
33	150	T	AC	5-'27, 1-'71A, 1-'80
33X	150	T	AC	5-'27, 1-'71A, 1-'80
333	150	T	DC	5-'01A, 2-'71A
333X	150	T	DC	5-'01A, 2-'71A
34	230	C	AC	5-'27, 1-'71A, 1-'80
34P	250	C	AC	5-'27, 2-'81, 1-'10
342	240	C	AC25	5-'27, 1-'71A, 1-'80
342P	260	C	AC25	5-'27, 2-'81, 1-'10
35	270	C	AC	5-'27, 1-'80, 1-'71A
35A	325	C	AC	5-'27, 1-'80, 1-'71A
35P	330	C	AC	5-'27, 1-'10, 2-'81
35AP	385	C	AC	5-'27, 1-'10, 2-'81
35APX	385	C	AC	5-'27, 2-'81, 1-'50, 1-'26
35PX	330	C	AC	5-'27, 2-'81, 1-'50, 1-'26
352	280	C	AC25	5-'27, 1-'71A, 1-'80
352A	335	C	AC25	5-'27, 1-'71A, 1-'80
352P	350	C	AC25	5-'27, 1-'10, 2-'81
352AP	405	C	AC25	5-'27, 1-'10, 2-'81
352APX	405	C	AC25	5-'27, 2-'81, 1-'50, 1-'26
352PX	350	C	AC25	5-'27, 2-'81, 1-'50, 1-'26
353AX	325	C	DC	2-'71A, 5-'01A
353A	325	C	DC	5-'01A, 2-'71A
362	165	T	AC25	5-'27, 1-'71A, 1-'80
362X	165	T	AC25	5-'27, 1-'71A, 1-'80
37A	625	C	AC	5-'27, 2-'81, 1-'50, 1-'26
39	450	C	AC	6-'27, 2-'81, 1-'10, 1-'26
39A	510	C	AC	6-'27, 2-'81, 1-'10, 1-'26
392	480	C	AC25	6-'27, 2-'81, 1-'10, 1-'26
392A	540	C	AC25	6-'27, 2-'81, 1-'10, 1-'26
40A	850	C	AC	6-'27, 2-'81, 1-'10, 1-'26
Colonial	650	C	AC	6-'26, 3-'27, 1-'10, 1-'81
English	800	C	AC	6-'26, 3-'27, 1-'10, 1-'81
Italian	1250	C	AC	6-'26, 3-'27, 1-'10, 1-'81
Chinese	1700	C	AC	6-'26, 3-'27, 1-'10, 1-'81
Spanish	2500	C	AC	6-'26, 3-'27, 1-'10, 1-'81

RADIOADS

A CLASSIFIED ADVERTISING SECTION READ BY BETTER BUYERS

The rate per word is eight cents net. Remittance must accompany all advertisements. Include name and address when counting words.

Ads for the April Issue Must Reach Us by March Fifth

BARGAIN FOR QUICK SALE—A complete Radio Receptor three stage power amplifier in steel case. Entirely AC operated. Uses two AC detector tubes, two 281 rectifier tubes in full wave rectifier, one 250 power tube in last stage. Has volume control, also load control. Volume can be controlled from a whisper to a roar. Rebuilt with latest oversize General Radio transformer in last stage. Faithful reproduction of all frequencies. Tremendous volume. Extremely quiet in operation. Has special voltage regulation switch. Must sell and will sacrifice at a fraction of original cost. Complete set of new tubes, including one Cunningham 350, two UX 281, two Arcturus AC Detector tubes for quiet operation, included with amplifier. Regular price, $225.00 with tubes. Will sell for $75.00 with tubes, f.o.b. San Francisco. Express or freight charges will amount to about $5.00. Guaranteed to be in perfect condition. Used only one week. Ideal for theatre or outdoor work as well as for the home. Also want to sell latest type Jensen Auditorium, 110 volt operation from light socket. No hum. Cost $75.00. Will sell for $40.00. Send money by telegraph for prompt action. P. Lucas, 1159 Glenn Ave., Berkeley, California.

IMAGINE AN ORGANIZATION with over 4,000 clients scattered throughout the world, all radiowise dealers, builders, experimenters, hams. Over $50,000.00 stock of high grade receiving and transmitting parts only, no sets. Spend $5,000.00 yearly on our own experimenting. Carry nothing until it passes our tests. 50c brings prepaid over four pounds catalog, circuits, data, etc. Weekly data (more than all radio magazines together)—20 weeks, $1.00; 52 weeks, $2.50. Sample "Over The Soldering Iron," 32-page experimenter's magazine, 25c. Full trade discounts to licensed hams and radiowise builders. We carry approved items advertised in RADIO. Kladag Radio Laboratories, Established 1920, Kent, Ohio.

FEBRUARY 10TH LOG BOOK—Just off the press. All the very latest changes for the entire U. S. and Canada. 32 pages, size 6 x 9. Logging chart for dial readings. All stations grouped two different ways for immediate checking. Plenty of station data. Everything you need. The most complete and most accurate log book yet published. Price only 25 cents per copy. Stamps accepted. When ordering be sure to ask for the 32-page February 10th, 1929 Book. Publishers of "RADIO," Pacific Building, San Francisco.

SPECIAL—this month only. A 12 month subscription to MOTION PICTURE MAGAZINE and a 12 month subscription to "RADIO," all for the price of one. $2.50 for a full year subscription to both. "RADIO," Pacific Bldg., San Francisco.

HERMANN SCHNITZEL, Der Perfesser Uf Der Ooniversity of Cincinnapolis, O-ho-ho, has prepared his radio lectures in the form of a complete booklet. 21 subjects in all. Interesting reading matter for humorous occasions. Thousands have been sold. These lectures were broadcast by radio on the Pacific Coast Network. Schnitzel's book will be sent to you upon receipt of 50 cents in stamps, coin or check. Publishers of "RADIO," Pacific Building, San Francisco, California.

AT LAST a flashlight with no battery. Product of five years' experiments. Neat, compact, and reliable. Produces good, strong light. Generator principle; fits neatly in hand; works by easy motion of three fingers. "Everlastingly Ready." Send for one. You will be delighted. C.O.D., check or money order. $5.50 (absolutely worth it). Factory Distributors Company, Box 1163, Denver, Colo.

DETECTOR TUBES—A.C.—Given free for a two-year subscription to "RADIO." The latest type Arcturus long life (2000 hour) 5 prong detector tube will improve reception. It is a remarkable tube. Hundreds of thousands in use. Send $5.00—get "RADIO" for 2 years and the Arcturus tube without a penny of extra cost. "RADIO," Pacific Building, San Francisco, California.

FOR SALE—Latest model Tyrman "50" screen-grid portable, complete with tubes, batteries, built in speaker and loop, $50.00. List price $90.00. Webster Bone-Dri "A" power unit, $15.00. Silver-Marshall Screen-Grid Five, in mahogany cabinet, slightly used but with new tubes, $35.00. Address owner, 6251 31st Ave. N. E., Seattle, Wash.

SALESMEN WANTED — Screw-holding screw driver! Amazing brand new patented invention! Retails $1.50. Factories, garages, electricians, auto, radio owners buy on sight! Exclusive state territory. Genuine opportunity earn big money. Free trial offer. Jiffy 1027, Winthrop Bldg., Boston.

ALFALFA SEEDS, hardy common varieties, $8.40, $10.20, $12.60 bushel; Grimm variety Alfalfa seed $18. Scarified sweet clover $3.90, $5.20; Alsike or red clover $15. Bags Free. Send for samples and catalogue. Kansas Seed Co., Salina, Kan.

"B" ELIMINATORS REPAIRED, New Condensers installed; Chokes, Transformers, etc., repaired; $2.00 to $4.00. Fast Service. Clark Brothers Radio Co., Albia, Iowa.

WANTED—Men to work with National Radio Service organization. No selling scheme. Radio Doctors, Inc., Dept. R., Essex St., Salem, Mass.

SPEAKERS REPAIRED, Rewound, Magnetized, Guaranteed, $1.50 to $2.50. Fast Service. Clark Brothers Radio Co., Albia, Iowa.

RADIO STATION stamps bought, sold and exchanged. Chas. A. Phildius, 510 East 120th St., New York, N. Y.

SOUTH AMERICA, WORK! American firms pay fare, expenses if accepted. Opportunities! Tropical Service Bureau, 14606 Alma, Detroit, Michigan.

POWERFUL, Shieldless, Loop, Antenna Circuit, $1.00. Archer. 617 Decatur St., Brooklyn, N.Y. (3T)

FREE!

MEN! Here's the dope you've been looking for

HOW TO GET INTO THE RADIO BUSINESS~

J.E.S.

Many Earn $50 to $250 a Week in Work That is Almost Romance

If you're earning a penny less than $50 a week, clip coupon now for FREE BOOK! New 64-page book pictures and tells all about the Radio business, hundreds of opportunities—in work that is almost romance! YOU can learn quickly and easily at home, through my tested, proved methods to take advantage of these great opportunities! Why go along at $25, $35, or $45 a week when you can pleasantly and in a short time learn how to hold the big-pay jobs?

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Don't envy the other fellow who's pulling down the big cash! My proven home-study training methods make it possible for you too to get ready for better jobs, to earn enough money so you can enjoy the good things of life. One of the most valuable books ever written on Radio tells how — interesting facts about this great field, and how I can prepare you in your spare time at home, to step into a big-pay Radio job. GET THIS BOOK. SEND COUPON TODAY.

J. E. SMITH, *Pres.*,
National Radio Institute
Dept. 9P75
Washington, D. C.

I Give You 6 Big Outfits of Radio Parts

With them you can build 100 different circuits—learn the "how" and "why" of practically every type of Radio set made. This kind of training fits you to step into the good jobs—sends you out an experienced Radio expert. When you complete, my Employment Department will help you get a real big Radio job like Graduate Edward Stanko, now Chief Operator of Station WGR, or Frank M. Jones, 922 Guadalupe St., San Angelo, Tex., builder and operator of Station KGFI and Manager of the best equipped Radio shop in the Southwest, or help you start a Radio business of your own like Richard Butler, 1419 No. 17th St., Phila, Pa., who made around $500 a month compared with a small-salaried, no-future job as motorman when he enrolled.

My Radio Training Is the Famous "Course That Pays for Itself"

Spare time earnings are easy in Radio almost from the time you enroll. G. W. Page, 1807 21st Ave. S., Nashville, Tenn., made $935 in his spare time while taking this course. Al. Johnson, 1409 Shelby St., Sandusky, O., $1,000 in four months, and he didn't know the difference between a condenser and a transformer when he enrolled. I'll give you a legal contract, backed by N. R. I., pioneer and largest home-study Radio school in the world, to refund every penny of your money if you are not satisfied, upon completing, with the lessons and instructions received. Find out what Radio offers you. get the facts. Mail coupon—RIGHT NOW.

I Have Trained Hundreds of Men at Home for Big Radio Jobs. My Book Proves I Can Do the Same for You.

RADIO NEEDS TRAINED MEN!

ACT NOW~COUPON BRINGS MY FREE BOOK

J. E. Smith,
President,
National Radio Institute
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Dear Mr. Smith: Without obligating me in any way, send me your big FREE BOOK, "Rich Rewards in Radio," and all information about your practical home-study Radio Course.

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Address ______________________

Town ______________________ *State* ______

Unquestionably~

the Most Complete Radio Testing Apparatus Ever Devised

THE *SUPREME* is sweeping the country by storm. Radiotricians and engineers everywhere are amazed at its performance, and its already long list of users are enthusiastically proclaiming its superiority. Truly an amazing instrument; it makes every test that can be made by all other testing devices combined and many that heretofore have not been available in any service instrument.

Complete, Handy Carrying Case

The case containing the instrument was designed after careful study by practical radiotricians of many years' experience in radio service. Its arrangement is most complete and convenient—a proper place for every tool, accessory, part, and material that a service man might need; even a swinging tube shelf that affords absolute protection to tubes. A complete set of tools, from electric soldering iron to screw driver, is furnished, and of course, all necessary adapters and accessories. Everything the service man requires—all in one case. And still, due to ingenious design, this case is only 18 x 10½ x 7 inches, and weighs complete only 25 pounds.

Send No Money

The SUPREME must sell itself to you on sheer merit and performance. We are willing to place it in your hands for actual use in your service work, and allow you to be the sole judge of its value. Fill out and sign the following request for six-day trial.

THREE WESTON METERS

Mounted in Bakelite cases.

1 Voltmeter, three scales of 0/10/100/600, 1000 ohms per volt.

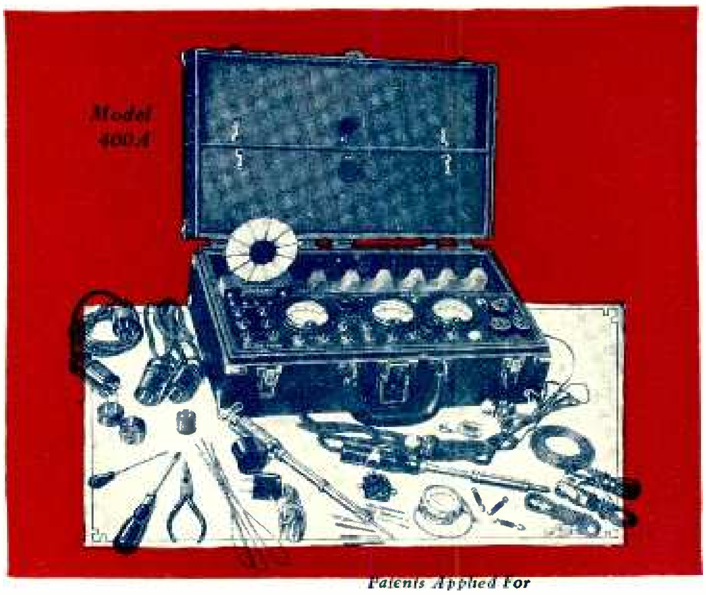
1 Milammeter, of 125 mils and 2½ amps.

1 A.C. Voltmeter, three large scales of 0/3/15/150.

All instruments are manufactured for 110 volts and 60 cycles. Instruments for other voltages or frequencies can be furnished special at slight increase in price.

PRICES AND TERMS

Under our time payment plan, the Model 400A SUPREME can be bought for $38.50 cash and 10 trade acceptances (installment notes) for $10 each, due monthly. Cash price, if preferred, $124.65. All prices are net and do not carry dealers' discounts.



Patents Applied For

6-Day Trial

Date ....

SUPREME INSTRUMENTS CORP.,
314 Supreme Building,
Greenwood, Miss.

Please ship me one Model 400A SUPREME. Upon delivery of the instrument I will deposit with the express agent either the cash price of $124.65 or $38.50 cash and 10 trade acceptances (installment notes) for $10 each, due monthly, at my option, subject to the following conditions:

It is agreed that the deposit made with the express agent shall be retained by him for six days. If, within that time, after testing the instrument I am not entirely satisfied, I have the privilege of returning the instrument to the express agent in good condition, with the seal unbroken (see note below) and all tools and parts intact. Upon such return and upon the prepayment of return express charges, the deposit I have made with the express agent will be promptly returned to me.

Signed ....

Firm Name ....

Address ....

City .... *State* ....

Please send three or more trade references, including at least one bank, with this coupon.

NOTE: The seal on the panel of the instrument covers the master screw in the assembly. It is never necessary to disturb this, and it does not in any way prevent or restrict the use of the instrument. Factory guarantee ceases with disturbance of seal.

Makes every conceivable test on any Radio Set—

You have waited long and patiently for an instrument such as the SUPREME. It is now here—at your command for greater accuracy and thoroughness, bigger profits and satisfied customers.

Tubes, power units, loads, breakdowns, voltages, all instantly analyzed, peaking condensers, also modulated radiator. Everything you have ever hoped for is there; all contained in one compact instrument.

The only self-rectifying oscillation tester in existence.

The exact working conditions of any tube from 1½ to 15 volts, including screen grid, heater type, and rectifier tubes, are shown by meter readings; the only service instrument that shows output of rectifier tubes on meter.

The oscillation tests from alternating current are made possible by the exclusive self-rectifying SUPREME Power Plant. Every radio engineer and service man will appreciate this feature.

The SUPREME radiator sends out a modulated wave. Simply plug into A.C. line. No more wasting valuable time on broadcast stations; always at your service and finer adjustment assured.

Condensers can be balanced or synchronized—not by the former tedious methods—but with both meter reading and audible click. Easy and much more accurate.

All continuity tests can be made from socket on either A.C. or D.C. sets, with independent cathode readings.

The SUPREME heavy duty rejuvenator provides scientific method of rejuvenation of any thoriated filament tube. Will reactivate up to 12 tubes at one time without removal from set. Push a plug—the SUPREME does the rest.

The SUPREME will give direct reading of amplifying power of tubes and will show actual working condition of all tubes.

The SUPREME will play radios with open transformers and will give condenser, choke coil output and capacity output on radios not wired for that purpose.

Access is provided to all apparatus through pin-jacks. Will test condensers for breakdown. Contains various fixed condensers from .001 to 2 mfd., a 30 ohm rheostat, a 500,000 ohm variable resistance, and an audio transformer, for instant use and various combinations.

It will give plate and filament voltage readings with or without load; will test voltage and current of all radios, including those using tubes such as 210 and 250. It will give grid circuit readings up to 100 volts: plate voltage readings up to 600 volts; will test output of trickle chargers, or any output up to 2½ amps.

Why wait longer? Share in the satisfaction and added profits that come with SUPREME ownership.

The Sign of Efficient Radio Service

Radio Owners: Look for this emblem in your radio shop or on the button worn or card carried by your service man. *It is your guarantee of dependable service.*

SUPREME SERVICE LEAGUE

SUPREME
Radio Diagnometer

START NOW
FOR 1929-30

ANNOUNCING THE FIRST BROWNING-DRAKE MODEL FOR THE COMING SEASON

More Volume-More Selectivity-More Power for 1930

Earlier than ever before, the next season will begin this spring. Dealer franchises will date from March 1st. The active, wide-awake dealer will line up NOW with those sets whose jump on the field will give them an outstanding position from the very beginning.

Your customers know Browning-Drake and how good it has always been. Dealer franchises with every sort of helpful manufacturer cooperation are now being granted. Get in on the proposition EARLY. Remember that profits in radio can be made in the spring and summer, and then you will be all set for the big rush in September.

Model 46 at left is a walnut consolette using our newly developed chassis. Tone quality which is practically perfection, through a resistance amplifier—selectivity adequate for modern needs—sensitivity which brings in the Pacific Coast from Boston. True single control, with panel switch and volume adjustment. Model 46A (Air-Chrome reproducer) $175.00; Model 46D (Dynamic) $195.00.

Browning-Drake has a million friends. You will be surprised how many of them are right around you. Write or wire today for franchise information.

BROWNING-DRAKE CORPORATION
CAMBRIDGE, MASS.

BROWNING-DRAKE

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