RADIO
WITH WHICH IS INCORPORATED "RADIO JOURNAL"
VOLUME VIII OCTOBER, 1926 No. 10

Radiotorial Comment

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Consequently it is most pleasing to note that most of the radio manufacturers have adopted the recommendations for radio selling standards prepared by the National Better Business Bureau. The basis of these standards is that the usual performance, and not the unusual, is to be advertised. They recommend that the facts be under-stated rather than over-stated.

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While it is not yet possible to define standards for satisfactory comparison as to the selectivity and sensitivity of various sets, it is possible not to make impossible claims. Nor is there any excuse for the improper rating of batteries or eliminators nor for false statements as to the tone range of loudspeakers. Reputable manufacturers have become most scrupulous in this respect.

The foregoing comments apply particularly to factory-built receivers. Similar protection is now accorded the man who buys parts for home-built sets. Condensers are sold with precise statement regarding capacity and loss. Coils can be bought with exact specification as to inductance and distributed capacity. The resistances of rheostats and potentiometers are specified and the frequency curves of transformers are published. Junk parts, except on the "five and ten" counters, are almost a thing of the past. And there are relatively few specified parts for which adequate substitutes cannot be found.

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Dollars from Radio Inventions

Why a Knowledge of Science is Essential to Success in Research

By Volney G. Mathison

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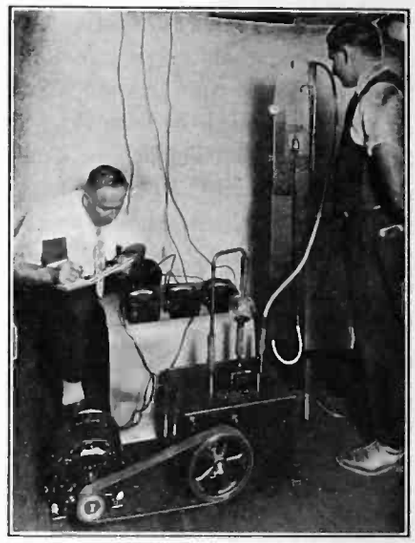
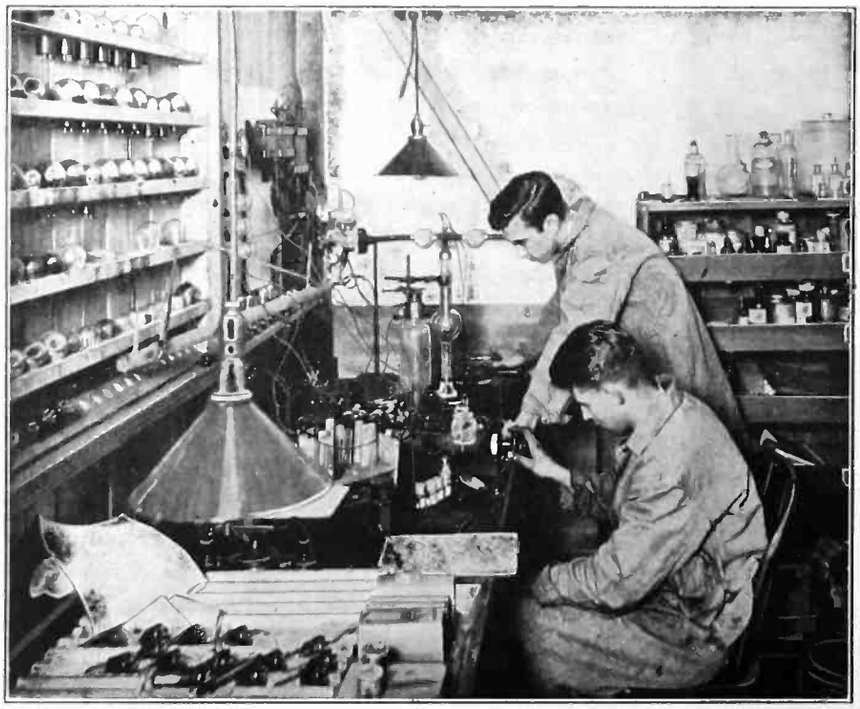


Testing Vacuum with a McCloud Gauge.



Developing a New Long-Life Filament for a Low-Temperature Power Tube.

To speak bluntly from the middle of the text, virtually all of the highly important and valuable radio, electric, and chemical inventions of today are not the result of half-haphazard, unscientific experiments, but are the products of highly-educated men co-operating closely in large laboratories. This statement, which does not deal with minor inventions, and which is subject to a rapidly diminishing number of exceptions, is not intended to dishearten any earnest radio experimenter. Rather, as amplified by what follows, it will, I hope, suggest to the serious amateur certain roads, all leading to the same Rome, that may save him days or years of fruitless and half-blind groping among the wonders of the hurtling electron.

Everybody likes the stories of the poor but determined young scientific genius struggling alone without money or encouragement in a gloomy cellar, his equipment an alcohol-torch, a rusty saw, and a bicycle-pump, who makes a discovery fated to bring about an industrial revolution; who is nearly robbed of his

The super-accuracy of parts required for research can be achieved only by machinists of remarkable skill.

precious invention by the hungry falcons of some grasping corporation; and who finally forges his way up to the ownership of a fifteen-hundred-acre face-powder factory, a silver-plated swimming-pool in his front yard stocked with gold-fish laden with diamond rings in their gills and bells on their tails, and a forty-thousand-dollar pane of stained glass in his home-town church.

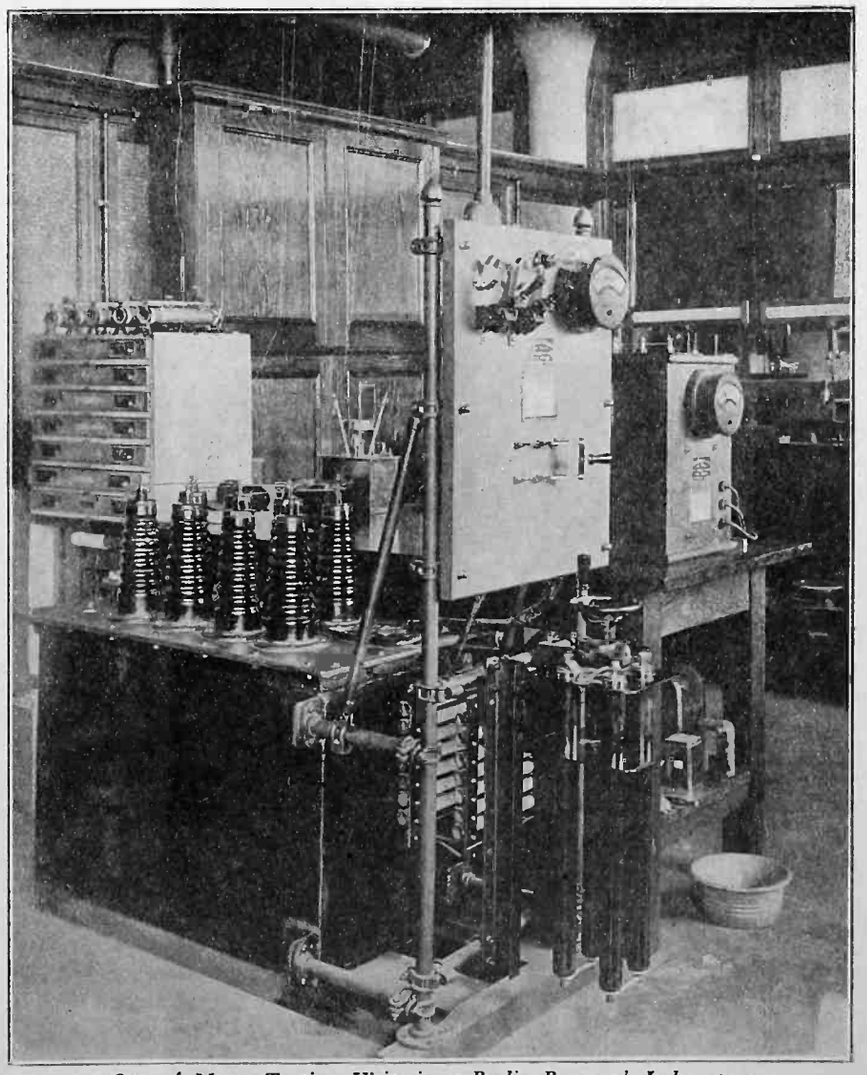
Folks love and are inspired by this kind of story; for it breathes of romance and invincible bravery. It is a true story, too; but true only of an age that is, I believe, swiftly passing away. We have many industrial inventors who have succeeded in the face of poor means and stupid or bigoted sneers in creating some thing of great value to the world; yet I venture to state that most of the rougher, ruder, and rather merely mechanical inventions have been more than adequately supplied by thousands of inventors, and that a new kind of man and product is the order of the present and future day.

Do not confuse this view with the tearful gibber of those blind, unimaginative clowns of twenty, fifty, and three-thousand years ago, who wrote discourses bewailing that there was nothing left in the world to invent. As long as man physically exists, there will probably be invention, in some meaning of the word. But everything is evoluting, is alternating, from year to year, from second to second; and in this process of change is included inevitably the art of inventing.

The faculties of primitive geniuses were exercised over the invention of fish-spears and fire-makers; later men advanced to ploughs and sphinxes; then came the wheel and the rail. These objects are accounted to be physical, solid, and heavy; they were produced by the co-operation of the hands and the physical senses, with the essential employment, of course, of no little brain. When our progenitors got to electricity, they encountered a totally new thing, a kind of force that did not seem to be in such gross contact with our physical body as iron and leather. To exploit the powers of electricity and the phenomena of chemistry called for the use of more abstract knowledge and less blind brawn than the inventions of the mind controlling the forging-hammer.

This, in brief, is the history of the evolution of the art of inventing: a progress toward the use of higher and higher mental powers and the employment of remarkable metaphysical processes in numbers, together with the co-operation of more and more delicate and highly-trained physical senses. This tendency, in the field of electricity, has been wondrously swift. In 1785 Benjamin Franklin and some of his contemporaries drew great crowds of people to gaze at experiments with static electricity which was generated by rubbing glass rods with silk—today these are minor demonstrations in any public school; while the scientist bursts asunder the atom and probes among the ultimate particles of matter. The earliest consciously scientific experiments began with apples and stones, and perhaps shall end with the almost, if not absolutely, spiritual electron. Persevering study of the latter promises to unfold the mysteries of all things.

An inseparable corollary of scientific progress is the accumulation and instant availability of enormous and swift-growing masses of technical knowledge of every conceivable kind; whereby the pre-



One of Many Testing Units in a Radio Research Laboratory.

cocious schoolboy is enabled to begin almost at the point where the most brilliant genius of a previous generation left off his labors.

And this is the miracle of right education; that by it the earnest student lives a thousand years in a twelve-month, by contact through books and works with the sincerest great labors and achievements of a host of immortals. Not that he is ever to worship their ideas in any field, and bury his mind fatally in the tombs of the past; he is to use those ideas as stepping-stones to far higher and better ones. Maxwell, Faraday, and Hertz, Volta, Ampere, and Ohm all got hold of about all the scientific knowledge that was going in their days, though sometimes with pain and difficulty.

It is tiresome to repeat the trite statement that we are on the mere threshold of invention in radio, or, speaking more generally, in the vast field of electricity; everybody conceives this to be true, but too few have definite ideas as to just how and where further advances are to be made. Yet the scientist, the Edison and the Burbank, can see labors ahead to occupy them through three lives, if they could live that many. The difference in outlook is owing to the difference between the knowledge and vision of these workers and that of the untrained layman.

Of course, many people are born without much gift of imagination, or vision; but, again, no matter how gifted you are, you cannot see very much from within a dark, narrow cave of ignorance, or when your mind is prisoned in a straight-jacket of slavish submission to old and dead ideas.

In radio, anything is possible for the trained engineer and scientist with imagination—and a laboratory. Truly adequate laboratories for radio research are pretty hard to find today outside of the property-lines of the great commercial corporations. I am not asserting that there are no others, for that would be untrue; yet few individuals or organizations other than those directly supported by industrial companies can afford to own or maintain them.

I have been through the plant of one company, not a very big one either, that is spending over $50,000 a year in salaries alone for engineers who do absolutely no other thing than study the actions of electrons in certain gases. The Western Electric Company uses $30,000 worth of apparatus to separate and accurately measure the a.c. and d.c. components of certain chokes it manufactures for radio purposes; and would be affronted at an offer of a million dollars for all its research equipment.

It is certainly something of a calamity that in the fields of radio, electricity, and chemistry we must go to private corporations for our super-laboratories. An engineer employed in such a laboratory suffers under an inevitable tendency to develop a bias, to see everything with an eye turned eternally toward financially satisfactory results to his own particular company, that is positively deplorable. Facts that might be of great value in other fields, if they were published, are overlooked or neglected; potentially priceless ideas may be let slip.

Then the work of each corporation laboratory is jealously kept as secret as possible, which is another disaster, for sometimes a prized secret of one corporation combined with another secret of another corporation would inspire a finer mind to the conception of a third "secret" worth a hundred times more than the other two by themselves. This crime is being ameliorated in certain cases in the radio field by the organization of gigantic interlocking combinations of corporations among which work is compared and exchanged; but outsiders are not only shut out by these combinations, but are menaced or ruined by the ruthless rapacity of their moneyed operators.

Much as we are doing in this country for science, it is to our shame that we are not doing more for it in a public way. The world should have national armies of thinkers instead of stabbers; great federal departments of astronomy, chemistry, geology, radio, and so forth, devoted to pure research on an immense scale—the unpatentable, unstealable results of these government works to be published broadcast over all the globe. I doubt that there are more than a dozen competent men working today on radio transmission of pictures; if a dozen hundred free and powerful minds co-operating generously under the thumb of no private corporation were focused upon the problems of radio-vision, what an acceleration of progress would result!

I should say that the photo-electric cell is a more precious thing than all the deadly guns and gases ever forged and compounded in the world's war-departments; within this cell and the electron-tube lies the possibility of tying all the continents and cities of the globe into one super-system of radio vision and audition that will go further toward establishing universal peace than all the studies of fiends to produce a bacterium capable of wiping out a nation in a week.

Aside from the danger of a biasing of the genius of the inventor employed in the private corporation laboratory, another objection made against such laboratories is that the discoveries of the engineer working therein are the sole property of his employing company. A corporation taking out a patent in the name of one of its inventing engineers commonly presents the inventor with the sum of one dollar, as a matter of legal form. He gets the rest of his pay in the shape of monthly salary, and in the equipment the corporation provides for his experiments and study.

The result of this arrangement is ordinarily more to the prejudice of all humanity than it is to the individual inventor. The corporation dictates what price the world shall pay for the use of an invention of one of its employees, fixing that price, naturally, on cool calculations as to what figure will yield the greatest return of shekels.

I confess that, like most folks, I feel for the inventor, as well as for the public; as it is evident that he sometimes stands in the position of making his employers billionaires for a comparatively

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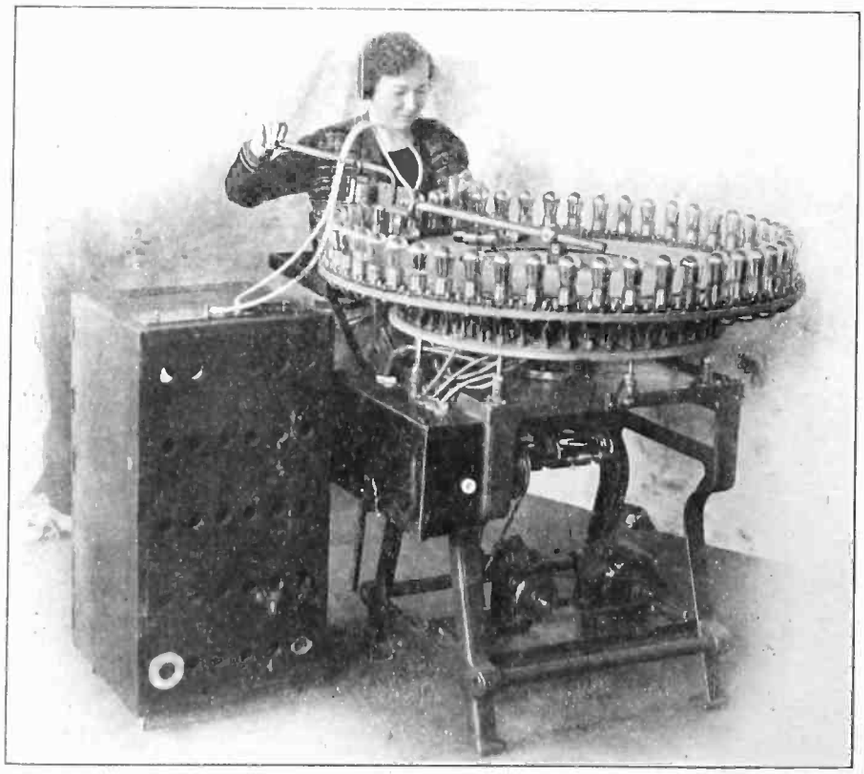


A Laboratory-Created Tube Ager and Bombarder Which Has Helped to Reduce the Manufacturing Cost of a 201A Tube to 28 Cents.

An Improved, Shielded Superheterodyne

Embodying All the Latest Approved Ideas But Intended Only for the Experienced Builder Who Wants the Best Possible Results

By H. W. Armstrong

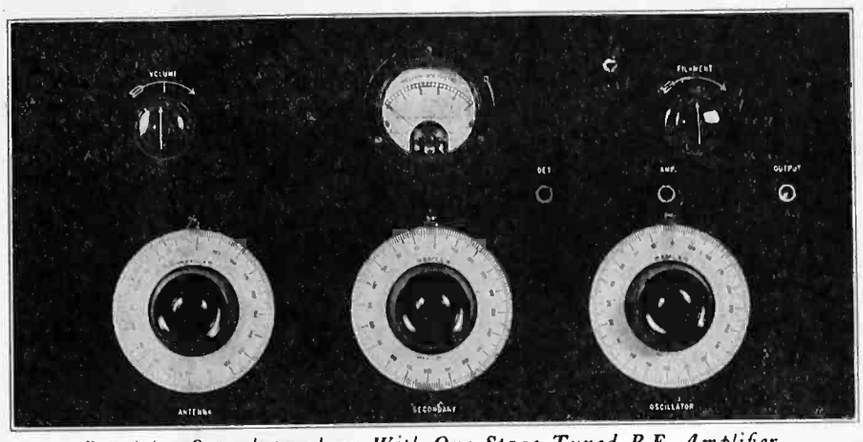
SINCE the publication of the description of the shielded model superheterodyne, covering all waves from 50 to 600 meters, by G. M. Best in August, 1925, RADIO, the writer has made a number of changes whereby he obtains even greater distance, selectivity and power output. This is secured primarily by adding one stage of tuned r.f. amplification, which also prevents radiation from the local oscillator, and one stage of power tube a.f. amplification.

These changes can be incorporated by a slight re-arrangement of parts without modifying the dimensions of the panel or supporting shelf, so that the nine tubes and associated equipment can be housed in the same cabinet which may be owned by many who built the original set. The set is adaptable to either antenna or loop connection by either plugging in or removing the antenna coil.

The set has eight dry battery 3 volt tubes and one 5 volt storage battery power tube. A set of plug-in coils for the antenna tuner, r.f. transformer and oscillator coupler enables it to cover the wide range from 40 to 600 meters. Any tendency toward oscillation is minimized by a new system of r.f. chokes.

As may be seen by the circuit diagram, the incoming signal first passes through an untuned primary whence it is transferred by induction to a tuned secondary and then amplified at radio frequency. The amplified r.f. signal and the locally generated oscillations then feed into the frequency changer or first detector which delivers a modulated intermediate frequency. This is amplified by three stages of I.F. amplification and then de-modulated in the second detector whence it is again amplified in two stages of a.f. amplification.

The general arrangement of parts is shown in the pictures, the r.f. amplifier, frequency changer and oscillator being



Panel for Superheterodyne With One Stage Tuned R.F. Amplifier.

underneath the shelf. Placing the first three tubes in individually shielded compartments improves the selectivity and prevents any interaction between the r.f. stage and the oscillator, a very important point. The r.f. amplifier unit is similar to that described by G. M. Best in June 1926 RADIO, the antenna secondary coil being tuned by a .0005 mfd. variable condenser instead of .00035 mfd., as specified normally for the plug-in coil used, as a loop antenna may be occasionally employed and most loops require the larger condenser. The other two variable condensers are each .0005 mfd.

The shelf is used to support the three intermediate frequency stages, the second detector and audio stages. The panel above the shelf supports a volt-meter, volume control, filament rheostat and three output jacks. The panel originally specified for this receiver may be retained, but those who wish to build the set for the first time will find the complete dimensions for the panel in Fig. 2.

No specific recommendations are made in the parts list, so that the panel dimensions show only the center holes for the variable condensers and rheostats. The supporting holes for the panel apparatus can be laid out from the templates generally furnished by the manufacturer. Directions for building the intermediate frequency transformers and filter were published in April 1926 RADIO. Mount the intermediates so that the cores are parallel with the shelf, and not perpendicular, as otherwise trouble may develop due to the metal shelf acting as a capacity to the windings of the transformers.

Fig. 3 shows the assembly of the shielding, which is absolutely necessary for a receiver of this type. All apparatus is mounted directly on the shield, which consists of the back panel plate, the shelf, and the partitions. The entire assembly is held in place by the screws supporting the panel apparatus, no baseboard being required. Fig. 1 shows the schematic wiring diagram, with all connections indicated. No pictorial wiring diagram is furnished, as anyone unable to read a schematic diagram should not attempt to build the set, as this is a job for only the experienced constructor.

The r.f. transformer, antenna tuner and oscillator coil are of the plug-in type, with a six terminal base. They may be purchased ready-made, or can be wound

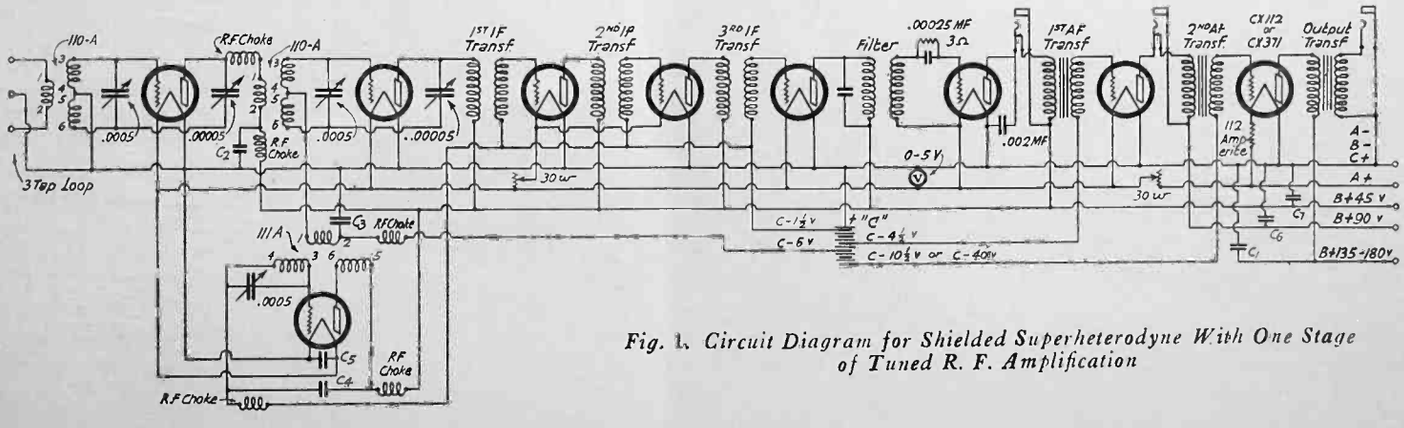
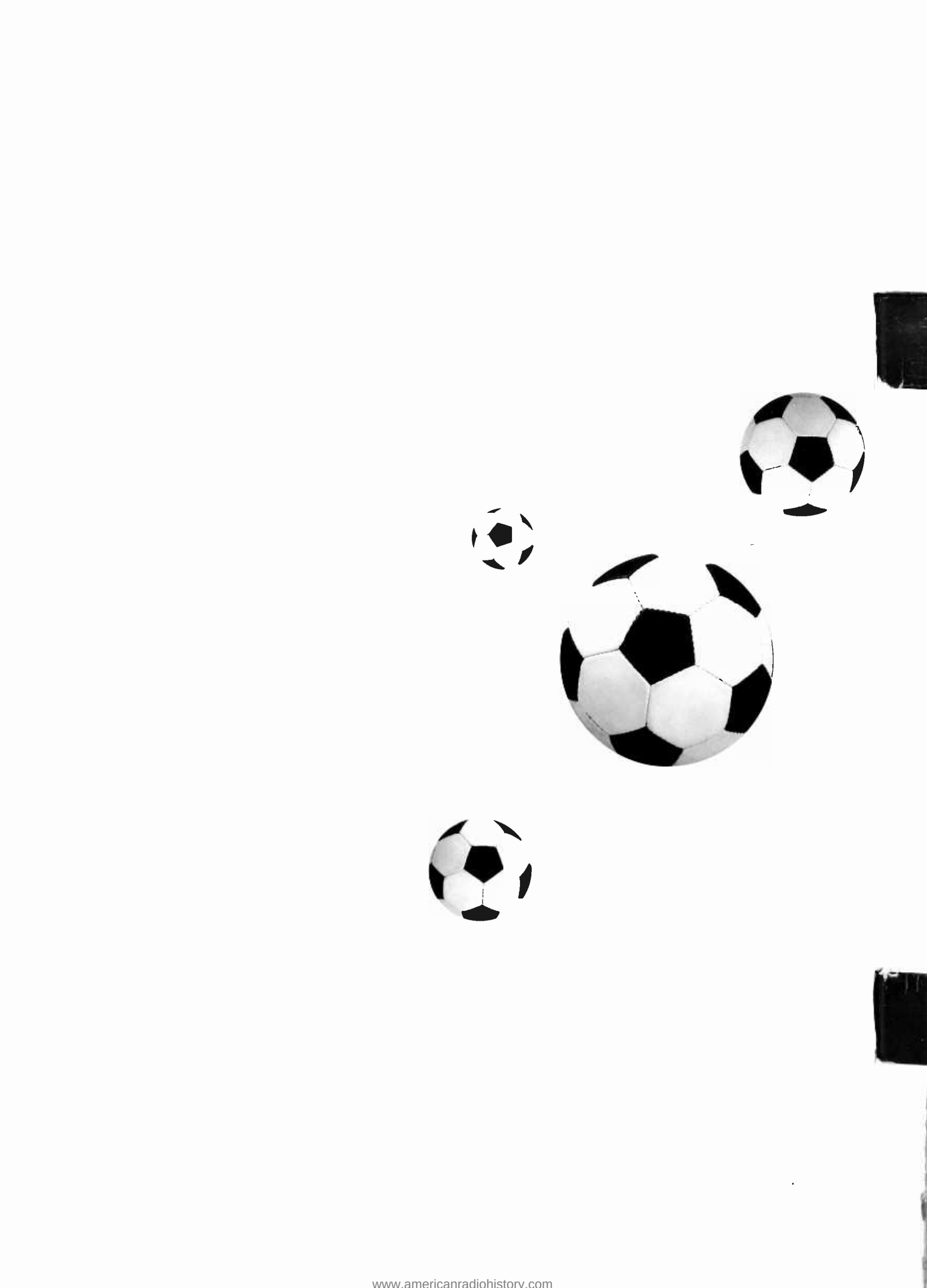


Fig. 1. Circuit Diagram for Shielded Superheterodyne With One Stage of Tuned R. F. Amplification



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Developing a New Long-Life Filament for a Low-Temperature Power Tube.

To speak bluntly from the middle of the text, virtually all of the highly important and valuable radio, electric, and chemical inventions of today are not the result of half-haphazard, unscientific experiments, but are the products of highly-educated men co-operating closely in large laboratories. This statement, which does not deal with minor inventions, and which is subject to a rapidly diminishing number of exceptions, is not intended to dishearten any earnest radio experimenter. Rather, as amplified by what follows, it will, I hope, suggest to the serious amateur certain roads, all leading to the same Rome, that may save him days or years of fruitless and half-blind groping among the wonders of the hurtling electron.

Everybody likes the stories of the poor but determined young scientific genius struggling alone without money or encouragement in a gloomy cellar, his equipment an alcohol-torch, a rusty saw, and a bicycle-pump, who makes a discovery fated to bring about an industrial revolution; who is nearly robbed of his

The super-accuracy of parts required for research can be achieved only by machinists of remarkable skill.

precious invention by the hungry falcons of some grasping corporation; and who finally forges his way up to the ownership of a fifteen-hundred-acre face-powder factory, a silver-plated swimming-pool in his front yard stocked with gold-fish laden with diamond rings in their gills and bells on their tails, and a forty-thousand-dollar pane of stained glass in his home-town church.

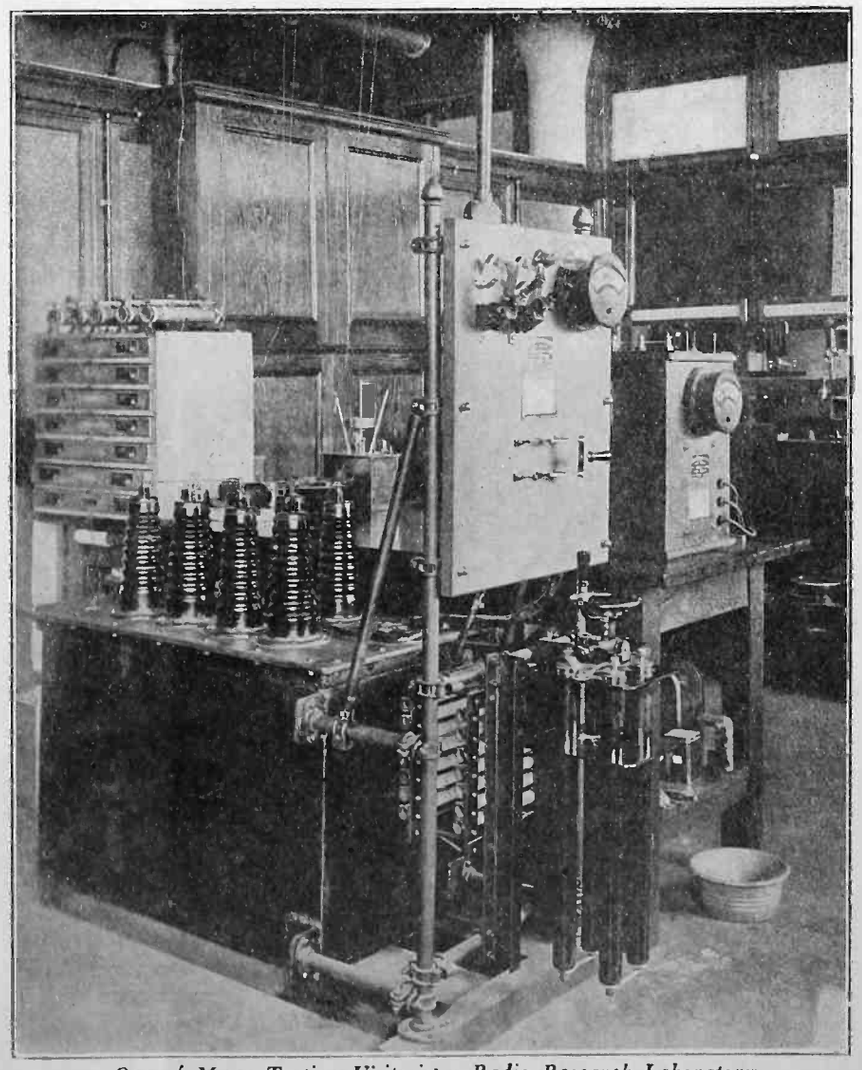
Folks love and are inspired by this kind of story; for it breathes of romance and invincible bravery. It is a true story, too; but true only of an age that is, I believe, swiftly passing away. We have many industrial inventors who have succeeded in the face of poor means and stupid or bigoted sneers in creating something of great value to the world; yet I venture to state that most of the rougher, ruder, and rather merely mechanical inventions have been more than adequately supplied by thousands of inventors, and that a new kind of man and product is the order of the present and future day.

Do not confuse this view with the tearful gibber of those blind, unimaginative clowns of twenty, fifty, and three-thousand years ago, who wrote discourses bewailing that there was nothing left in the world to invent. As long as man physically exists, there will probably be invention, in some meaning of the word. But everything is evoluting, is alternating, from year to year, from second to second; and in this process of change is included inevitably the art of inventing.

The faculties of primitive geniuses were exercised over the invention of fish-spears and fire-makers; later men advanced to ploughs and sphinxes; then came the wheel and the rail. These objects are accounted to be physical, solid, and heavy; they were produced by the co-operation of the hands and the physical senses, with the essential employment, of course, of no little brain. When our progenitors got to electricity, they encountered a totally new thing, a kind of force that did not seem to be in such gross contact with our physical body as iron and leather. To exploit the powers of electricity and the phenomena of chemistry called for the use of more abstract knowledge and less blind brawn than the inventions of the mind controlling the forging-hammer.

This, in brief, is the history of the evolution of the art of inventing: a progress toward the use of higher and higher mental powers and the employment of remarkable metaphysical processes in numbers, together with the co-operation of more and more delicate and highly-trained physical senses. This tendency, in the field of electricity, has been wondrously swift. In 1785 Benjamin Franklin and some of his contemporaries drew great crowds of people to gaze at experiments with static electricity which was generated by rubbing glass rods with silk —today these are minor demonstrations in any public school; while the scientist bursts asunder the atom and probes among the ultimate particles of matter. The earliest consciously scientific experiments began with apples and stones, and perhaps shall end with the almost, if not absolutely, spiritual electron. Persevering study of the latter promises to unfold the mysteries of all things.

An inseparable corollary of scientific progress is the accumulation and instant availability of enormous and swift-growing masses of technical knowledge of every conceivable kind; whereby the pre-



One of Many Testing Units in a Radio Research Laboratory.

cocious schoolboy is enabled to begin almost at the point where the most brilliant genius of a previous generation left off his labors.

And this is the miracle of right education; that by it the earnest student lives a thousand years in a twelve-month, by contact through books and works with the sincerest great labors and achievements of a host of immortals. Not that he is ever to worship their ideas in any field, and bury his mind fatally in the tombs of the past; he is to use those ideas as stepping-stones to far higher and better ones. Maxwell, Faraday, and Hertz, Volta, Ampere, and Ohm all got hold of about all the scientific knowledge that was going in their days, though sometimes with pain and difficulty.

It is tiresome to repeat the trite statement that we are on the mere threshold of invention in radio, or, speaking more generally, in the vast field of electricity; everybody conceives this to be true, but too few have definite ideas as to just how and where further advances are to be made. Yet the scientist, the Edison and the Burbank, can see labors ahead to occupy them through three lives, if they could live that many. The difference in outlook is owing to the difference between the knowledge and vision of these workers and that of the untrained layman.

Of course, many people are born without much gift of imagination, or vision; but, again, no matter how gifted you are, you cannot see very much from within a dark, narrow cave of ignorance, or when your mind is prisoned in a straight-jacket of slavish submission to old and dead ideas.

In radio, anything is possible for the trained engineer and scientist with imagination—and a laboratory. Truly adequate laboratories for radio research are pretty hard to find today outside of the property-lines of the great commercial corporations. I am not asserting that there are no others, for that would be untrue; yet few individuals or organizations other than those directly supported by industrial companies can afford to own or maintain them.

I have been through the plant of one company, not a very big one either, that is spending over $50,000 a year in salaries alone for engineers who do absolutely no other thing than study the actions of electrons in certain gases. The Western Electric Company uses $30,000 worth of apparatus to separate and accurately measure the a.c. and d.c. components of certain chokes it manufactures for radio purposes; and would be affronted at an offer of a million dollars for all its research equipment.

It is certainly something of a calamity that in the fields of radio, electricity, and chemistry we must go to private corporations for our super-laboratories. An engineer employed in such a laboratory suffers under an inevitable tendency to develop a bias, to see everything with an eye turned eternally toward financially satisfactory results to his own particular company, that is positively deplorable. Facts that might be of great value in other fields, if they were published, are overlooked or neglected; potentially priceless ideas may be let slip.

Then the work of each corporation laboratory is jealously kept as secret as possible, which is another disaster, for sometimes a prized secret of one corporation combined with another secret of another corporation would inspire a finer mind to the conception of a third "secret" worth a hundred times more than the other two by themselves. This crime is being ameliorated in certain cases in the radio field by the organization of gigantic interlocking combinations of corporations among which work is compared and exchanged; but outsiders are not only shut out by these combinations, but are menaced or ruined by the ruthless rapacity of their moneyed operators.

Much as we are doing in this country for science, it is to our shame that we are not doing more for it in a public way. The world should have national armies of thinkers instead of stabbers; great federal departments of astronomy, chemistry, geology, radio, and so forth, devoted to pure research on an immense scale—the unpatentable, unstealable results of these government works to be published broadcast over all the globe. I doubt that there are more than a dozen competent men working today on radio transmission of pictures; if a dozen hundred free and powerful minds co-operating generously under the thumb of no private corporation were focused upon the problems of radio-vision, what an acceleration of progress would result!

I should say that the photo-electric cell is a more precious thing than all the deadly guns and gases ever forged and compounded in the world's war-departments; within this cell and the electron-tube lies the possibility of tying all the continents and cities of the globe into one super-system of radio vision and audition that will go further toward establishing universal peace than all the studies of fiends to produce a bacterium capable of wiping out a nation in a week.

Aside from the danger of a biasing of the genius of the inventor employed in the private corporation laboratory, another objection made against such laboratories is that the discoveries of the engineer working therein are the sole property of his employing company. A corporation taking out a patent in the name of one of its inventing engineers commonly presents the inventor with the sum of one dollar, as a matter of legal form. He gets the rest of his pay in the shape of monthly salary, and in the equipment the corporation provides for his experiments and study.

The result of this arrangement is ordinarily more to the prejudice of all humanity than it is to the individual inventor. The corporation dictates what price the world shall pay for the use of an invention of one of its employees, fixing that price, naturally, on cool calculations as to what figure will yield the greatest return of shekels.

I confess that, like most folks, I feel for the inventor, as well as for the public; as it is evident that he sometimes stands in the position of making his employers billionaires for a comparatively

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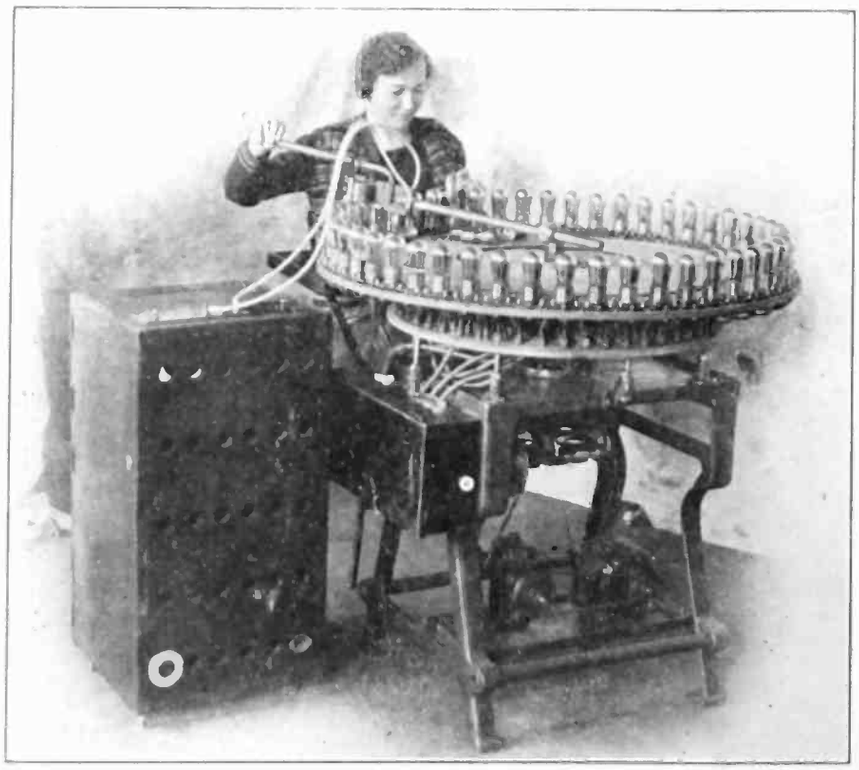


A Laboratory-Created Tube Ager and Bombarder Which Has Helped to Reduce the Manufacturing Cost of a 201A Tube to 28 Cents.

An Improved, Shielded Superheterodyne

Embodying All the Latest Approved Ideas But Intended Only for the Experienced Builder Who Wants the Best Possible Results

By H. W. Armstrong

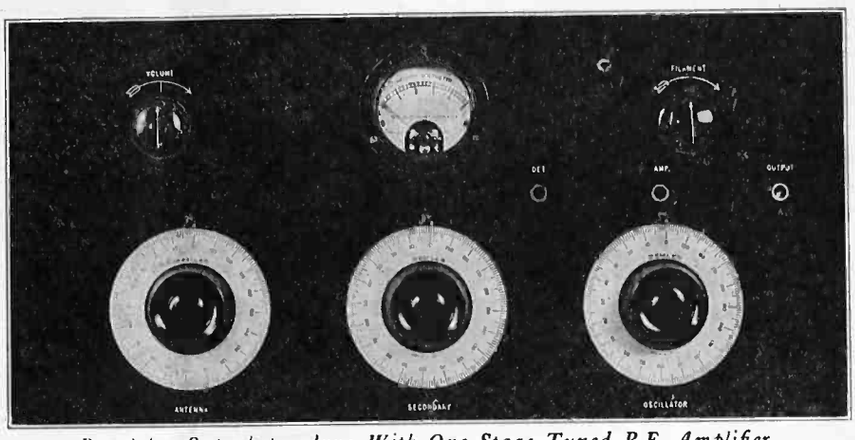
SINCE the publication of the description of the shielded model superheterodyne, covering all waves from 50 to 600 meters, by G. M. Best in August, 1925, RADIO, the writer has made a number of changes whereby he obtains even greater distance, selectivity and power output. This is secured primarily by adding one stage of tuned r.f. amplification, which also prevents radiation from the local oscillator, and one stage of power tube a.f. amplification.

These changes can be incorporated by a slight re-arrangement of parts without modifying the dimensions of the panel or supporting shelf, so that the nine tubes and associated equipment can be housed in the same cabinet which may be owned by many who built the original set. The set is adaptable to either antenna or loop connection by either plugging in or removing the antenna coil.

The set has eight dry battery 3 volt tubes and one 5 volt storage battery power tube. A set of plug-in coils for the antenna tuner, r.f. transformer and oscillator coupler enables it to cover the wide range from 40 to 600 meters. Any tendency toward oscillation is minimized by a new system of r.f. chokes.

As may be seen by the circuit diagram, the incoming signal first passes through an untuned primary whence it is transferred by induction to a tuned secondary and then amplified at radio frequency. The amplified r.f. signal and the locally generated oscillations then feed into the frequency changer or first detector which delivers a modulated intermediate frequency. This is amplified by three stages of I.F. amplification and then de-modulated in the second detector whence it is again amplified in two stages of a.f. amplification.

The general arrangement of parts is shown in the pictures, the r.f. amplifier, frequency changer and oscillator being



Panel for Superheterodyne With One Stage Tuned R.F. Amplifier.

underneath the shelf. Placing the first three tubes in individually shielded compartments improves the selectivity and prevents any interaction between the r.f. stage and the oscillator, a very important point. The r.f. amplifier unit is similar to that described by G. M. Best in June 1926 RADIO, the antenna secondary coil being tuned by a .0005 mfd. variable condenser instead of .00035 mfd., as specified normally for the plug-in coil used, as a loop antenna may be occasionally employed and most loops require the larger condenser. The other two variable condensers are each .0005 mfd.

The shelf is used to support the three intermediate frequency stages, the second detector and audio stages. The panel above the shelf supports a volt-meter, volume control, filament rheostat and three output jacks. The panel originally specified for this receiver may be retained, but those who wish to build the set for the first time will find the complete dimensions for the panel in Fig. 2.

No specific recommendations are made in the parts list, so that the panel dimensions show only the center holes for the variable condensers and rheostats. The supporting holes for the panel apparatus can be laid out from the templates generally furnished by the manufacturer. Directions for building the intermediate frequency transformers and filter were published in April 1926 RADIO. Mount the intermediates so that the cores are parallel with the shelf, and not perpendicular, as otherwise trouble may develop due to the metal shelf acting as a capacity to the windings of the transformers.

Fig. 3 shows the assembly of the shielding, which is absolutely necessary for a receiver of this type. All apparatus is mounted directly on the shield, which consists of the back panel plate, the shelf, and the partitions. The entire assembly is held in place by the screws supporting the panel apparatus, no baseboard being required. Fig. 1 shows the schematic wiring diagram, with all connections indicated. No pictorial wiring diagram is furnished, as anyone unable to read a schematic diagram should not attempt to build the set, as this is a job for only the experienced constructor.

The r.f. transformer, antenna tuner and oscillator coil are of the plug-in type, with a six terminal base. They may be purchased ready-made, or can be wound

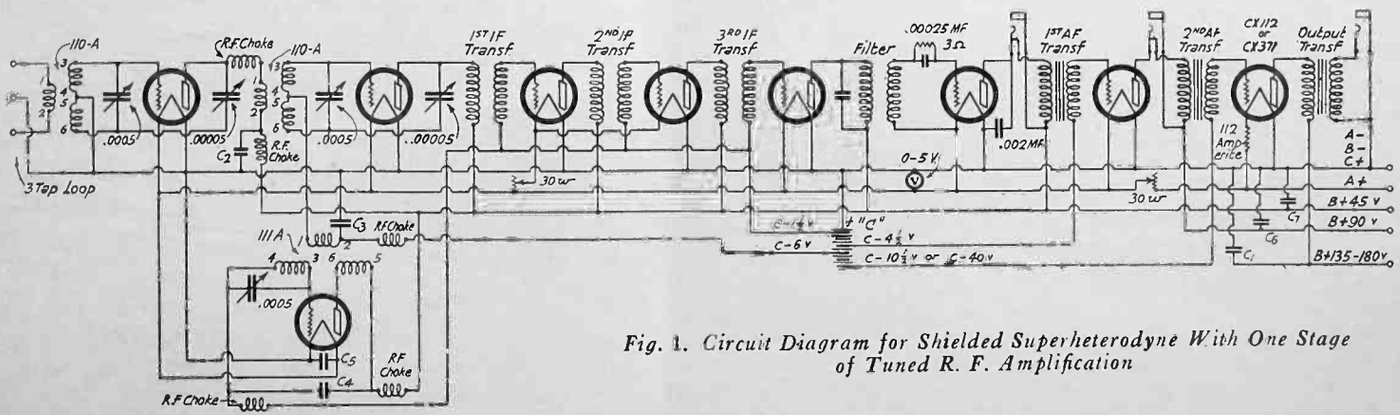


Fig. 1. Circuit Diagram for Shielded Superheterodyne With One Stage of Tuned R. F. Amplification

by hand if desired, so that the data for each coil are given in the following tables. The antenna tuner and r.f. transformer are identical, and consist of a stator form 2 in. wide by 2½ in. long, with a rotor mounted inside the stator, made of a piece of bakelite tubing 1 in. wide and ¾ in. long. Data are given for three different wavelength bands, so that any wave from 40 to 600 meters can be received.

Range in meters	Rotor Coil 1-2	Stator Coil 3-4	Stator Coil 5-6
40-100	6	6	6
100-300	14	16	16
200-600	30	45	45

The stator windings are wound with No. 26 enameled wire in the commercial article, but if the coils are homemade, they had best be wound with No. 26 single silk. The rotor is wound with No. 32 double silk wire in all three coils.

The oscillator coil data are contained in the following table:

Range in meters	Rotor Coil 1-2	Stator Coil 3-4	Stator Coil 5-6
40-100	6	14	10
100-300	10	32	14
200-600	30	84	25

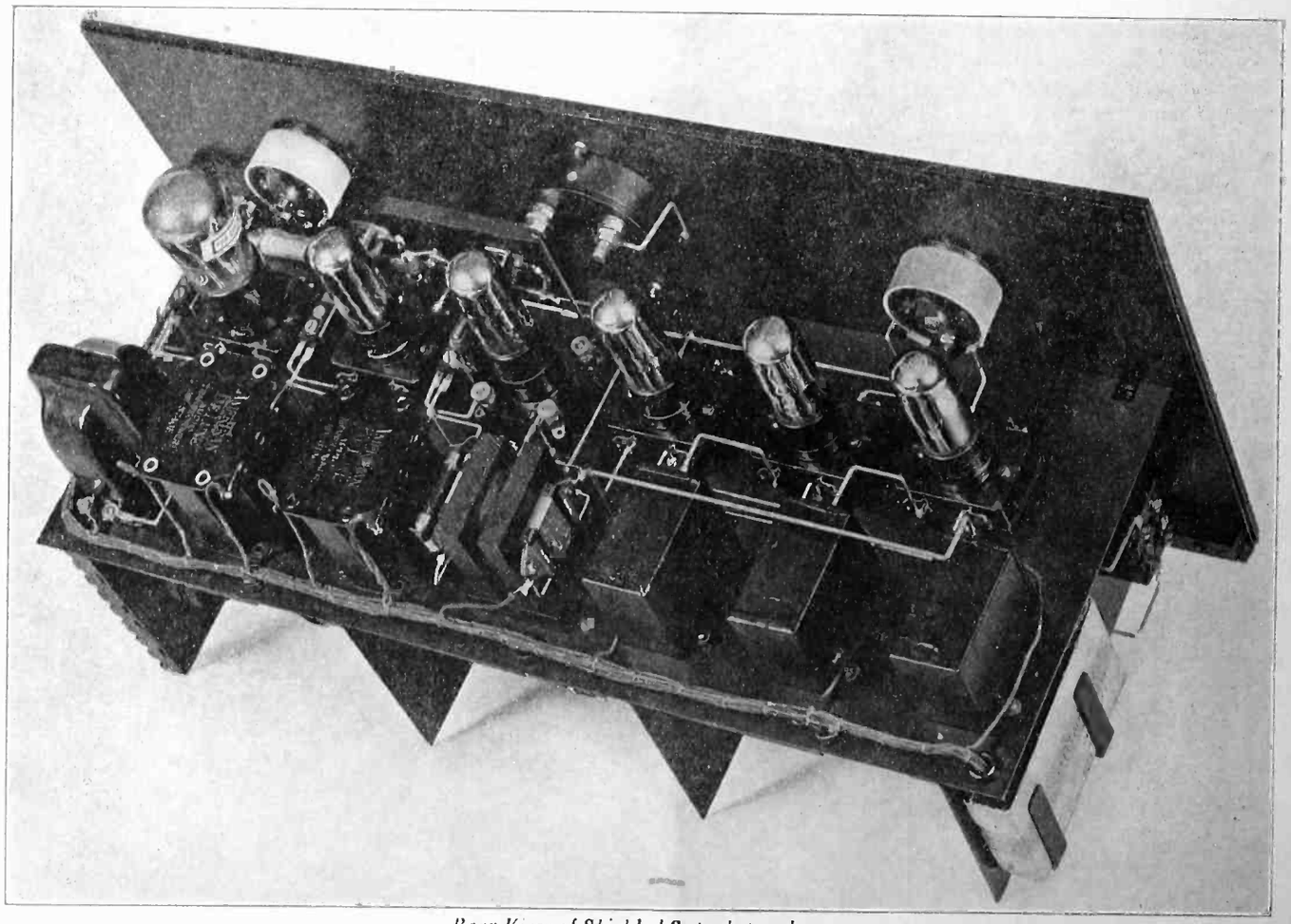
The tube sockets should be of the new UX base type, so that any of the new tubes may be used. The second detector socket should be of the spring base type, and all sockets except the cushioned one should be raised from the shelf by placing a piece of ⅛ or ¼ in. bakelite under each socket, as a support. This precaution should also be taken with the bases of the plug-in coils so as to reduce eddy current losses due to the shielding and to reduce the capacity to ground.

Shielded intermediate transformers were used, the metal cases being fastened directly to the shield, thus giving the same effect as though a shield was placed between each stage of the amplifier. The filter transformer, which is placed next the second detector, should be raised away from the shield at least ¾ in., so as to prevent broadening of the filter tuning. The audio transformers should be of high grade, with a frequency characteristic extending down to 50 cycles or below. For the best results the impedance of the output transformer primary should match the output impedance of the tube and the secondary impedance should match the impedance of the loudspeaker, at the lowest frequency which it is intended to reproduce.

Sheet brass, 1/16 in. thick is recommended for the shielding, as it is the smallest size which is really an effective shield, and is stiff enough to stay in place. It is fairly cheap, and easy to drill, so that the only tools necessary are a good set of machine drills, and a vise for bending the edges. The assembly of the shelf and the partitions is made by bending one edge of each partition at right angles and then drilling the bend, so made, to clear the supporting screws. Machine screws are used to fasten the shelf to the back panel shield and the partitions, ⅛ in. round head 4-36 brass machine screws being recommended. On the front edge of each partition, ½ in. from the bottom, and at three places on the front edge of the shelf, cuts are made with a hack saw. ⅜ in. apart and 5/16 in. deep. The small piece between the cuts is then bent at right angles to form a lip which is drilled to clear a 4-36 machine screw. Brass collars can be cut to a length of ¼ in. and drilled to clear, or some old nuts taken from dry cells can be used if they are handy. These collars or nuts should be placed under the lips which have been formed, and the assembled shelf and partitions can then be screwed to the back panel shield.

No special provision need be made for attaching this shield to the panel, there being enough screws for supporting the panel apparatus to provide a strong hold for the shield. Provision must be made in drilling the shield so that sufficient clearance is allowed for "hot" apparatus, which is any part having a positive potential with respect to the grounded shield. This applies to jack frames, rheostat shafts, condenser shafts, and the panel supports of the condensers.

Reference to the pictures will give a good idea of where each part is placed, but a few words of explanation will make the details clear. On the top of the shelf, looking at the set from the rear, from right to left, are the intermediate amplifier tubes and their transformers; then the filter transformer and the second detector tube and finally the audio amplifier tubes and their transformers. Looking at the picture of the under part of the shelf, from left to



Rear View of Shielded Superheterodyne.

right, on the first partition are mounted the three binding posts to which the loop or outdoor antenna and ground are connected. The *C* battery is also mounted here.

The left hand compartment houses the first plug-in coil and its associated condenser, the plate circuit choke, the amplifier tube, feedback condenser and a by-pass condenser. The center compartment contains the frequency changer tube, second plug-in coil and condenser, the second feedback condenser, the *B* battery choke for the r. f. amplifier tube, and another by-pass condenser. The right hand compartment contains this oscillator coupler, its condensers and tube, three r.f. chokes, and a by-pass condenser.

The two chokes in the oscillator grid and plate circuit are to localize the oscillator energy as much as possible, and to keep oscillator currents out of the *B* and *C* battery circuits. A 1-mfd. by-pass condenser shunted across the oscillator filament also helps in keeping the oscillator energy within the oscillator compartment. A choke placed in the grid return lead of the frequency changer tube prevents oscillator current from reaching the *C* battery, but it is optional with the builder. On the right side of the last partition is mounted the battery terminal strip and four by-pass condensers.

All the by-pass condensers must be at least 1 mfd., preferably 2 mfd. in the audio frequency end of the circuit. The condenser in the left hand compartment is C_1 on the diagram, the one in the center compartment is C_2, and in the right hand compartment the condenser is C_3. The four condensers on the extreme right are C_4, C_5, C_6 and C_7 in the diagram.

In wiring the set, insulated wire should be used for the filament, *C* battery, positive *B* battery and meter circuits. Annunciator wire or small

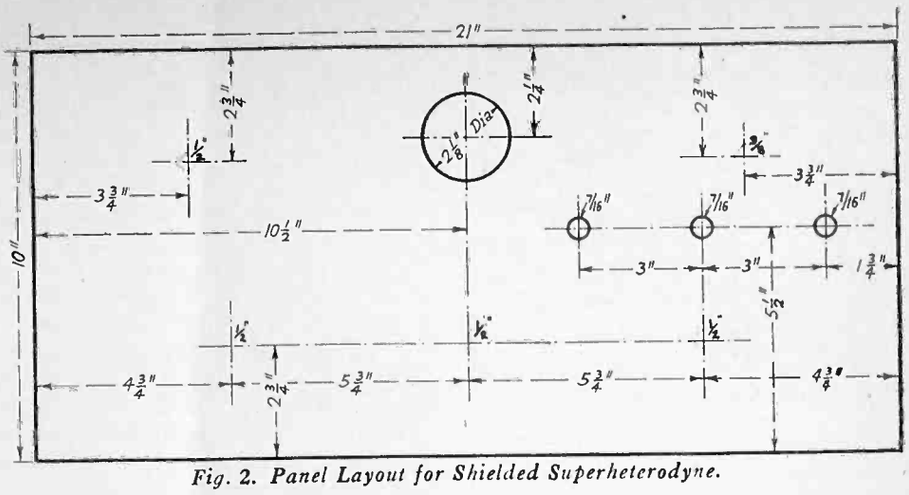


Fig. 2. Panel Layout for Shielded Superheterodyne.

stranded insulated wire may be used, and after all leads have been finished, they may be laced together with twine so as to form a harness, preserving the appearance of the set, and guarding the wires from injury. Bare wire is used for all high frequency leads; the less insulation used the better. Ordinary socket bushings and nuts were used where any of these wires passed through the shield, so as to prevent short circuits. The negative *A* and *B* batteries are connected together to a common terminal, which is grounded to the shield, so that no negative *A* or *B* wiring need be made in the set, all connections to these terminals from the tube sockets, by-pass condensers, etc., being made directly to the shielding. This procedure eliminates over 25 separate connecting wires, and greatly simplifies the job of wiring.

A slight departure from heretofore standard practice is made in the circuit

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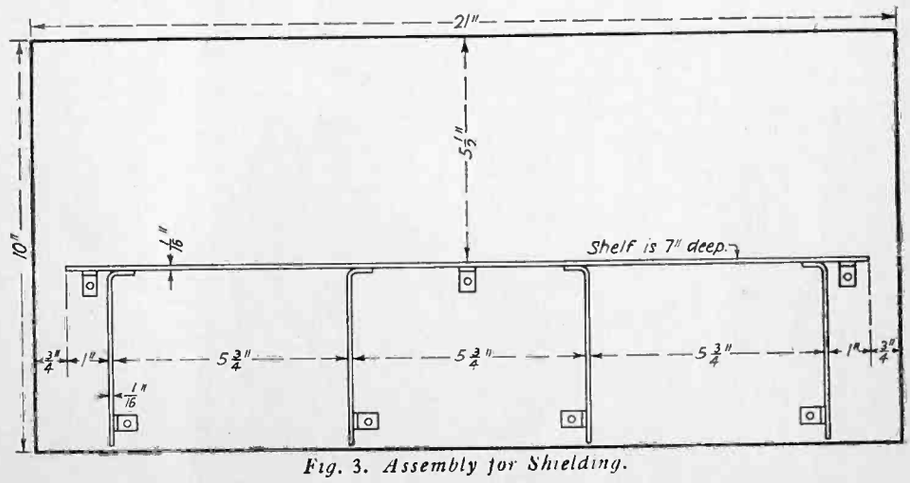
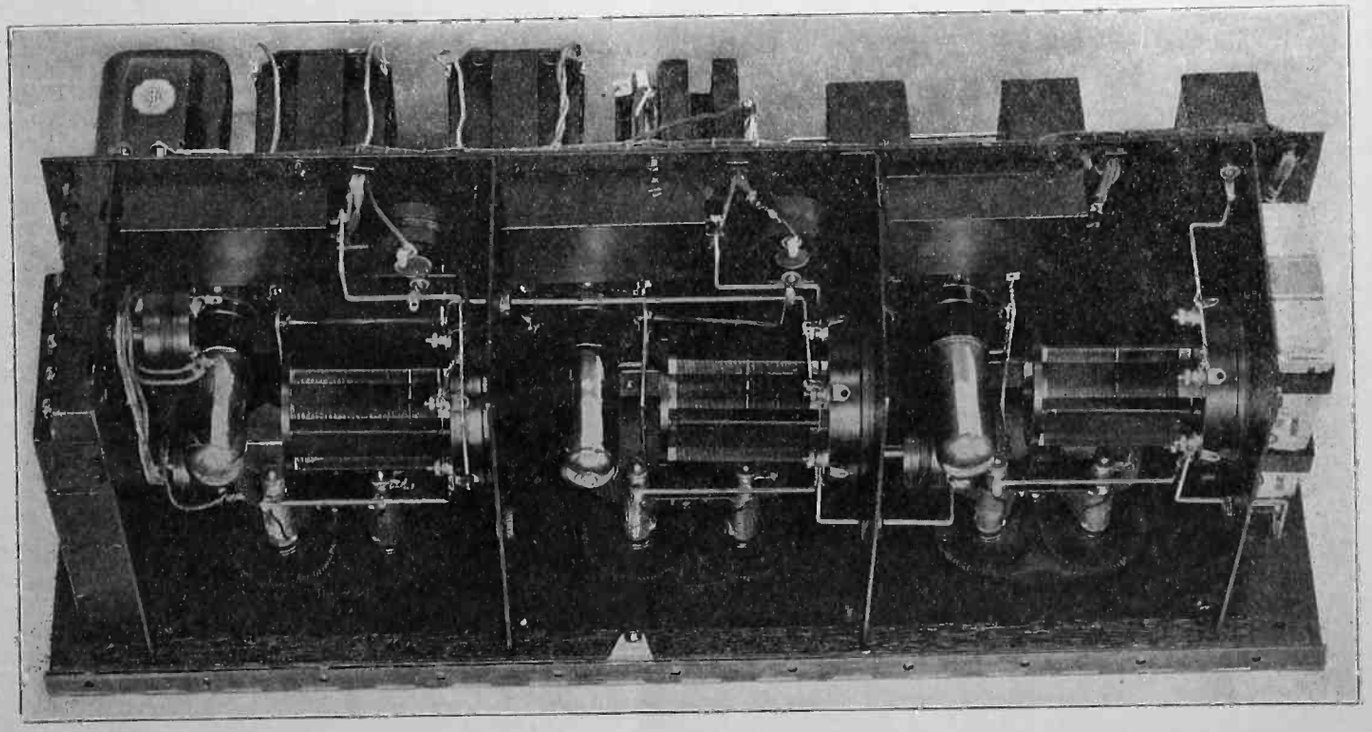


Fig. 3. Assembly for Shielding.



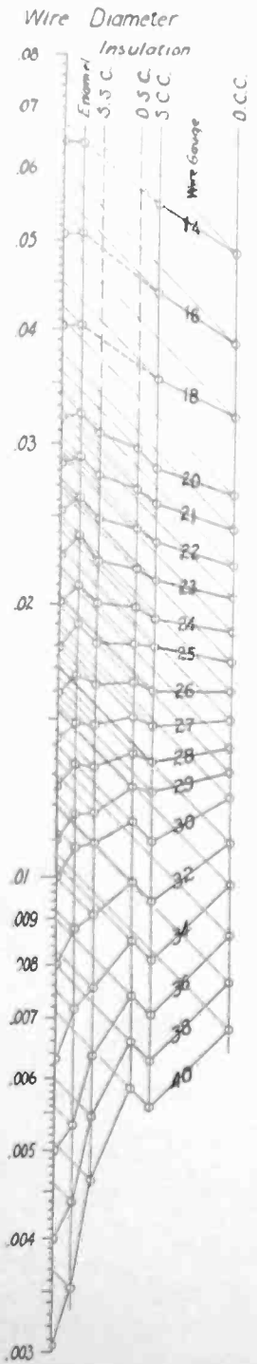
View of Under Part of Shelf.

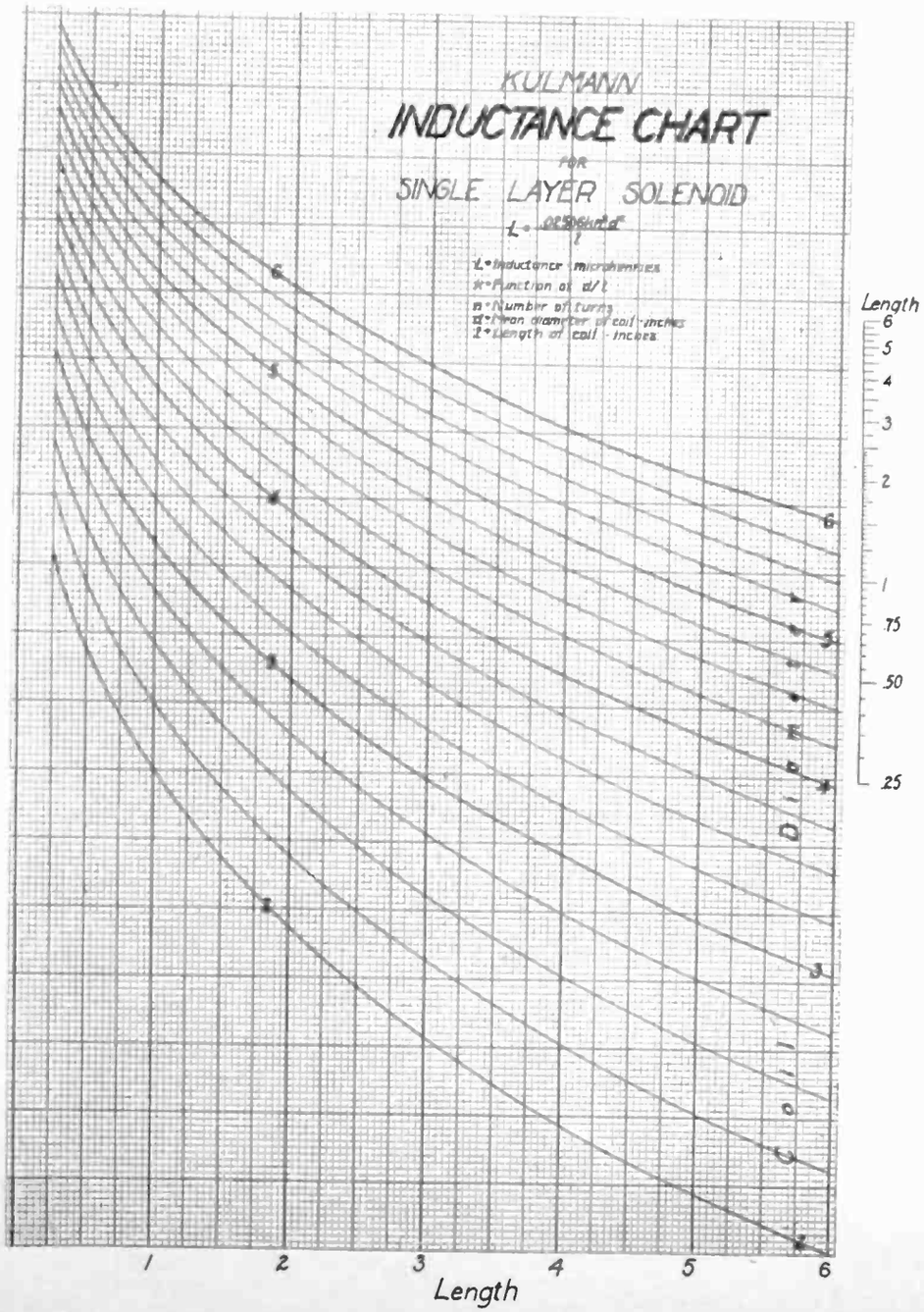
To find inductance of given number turns and size wire on coil of given diameter: 1st. On left scale find wire diameter by following oblique line upward from intersection of wire size and insulation. (Thus diameter No. 21 D. S. C. is .0325 in.)

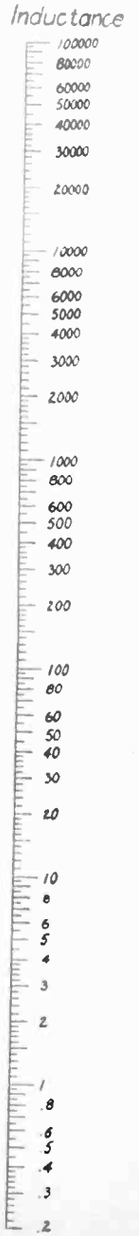
2nd. With straight edge connect this point to point showing number of turns in right hand scale and read length of coil on scale so designated. (Thus 44½ turns No. 22 D. S. C. wire are 1.47 in. long.)

3rd. Locate this length on lower scale of central chart. Follow vertical line upward to curve showing coil diameter. Follow horizontal line to heavy vertical line at left side of central chart.

4th. Connect point so located with number of turns on right hand scale and read inductance at point of intersection on scale so designated. (Thus 44½ turns No. 22 D. S. C. have inductance of 159 microhenries.)







Nonagram for Determining Inductance of Single Layer Solenoid Coils.

How to Analyze Radio Diagrams

A Simple Explanation Giving the Novice an Understanding of the Purpose and Meaning of Radio Symbols

By Lester I. Wiltse

MANY a person interested in radio can intelligently discuss the functions and purposes of the various parts in a radio receiving set without being able to read a circuit diagram. But such a person is handicapped. He may spend hours in studying an article explaining some circuit when a moment's glance at a diagram would tell him the entire story. To eliminate this handicap is the author's aim in here interpreting the various symbols which may be combined to make a circuit diagram.

The alphabet of this radio language is shown in Fig. 1, which should be learned by heart so that no future reference to it will be necessary. These symbols are standard, being used in Japanese, Russian, French, German, Spanish and English publications throughout the world. They constitute the elements of a universal radio language.

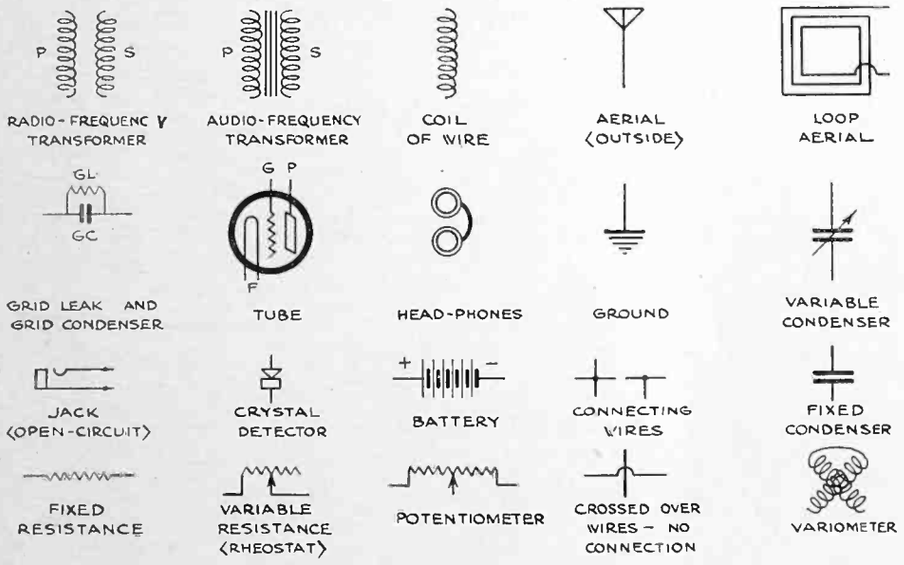


Fig. 1. Conventional Symbols Used in Radio Diagrams.

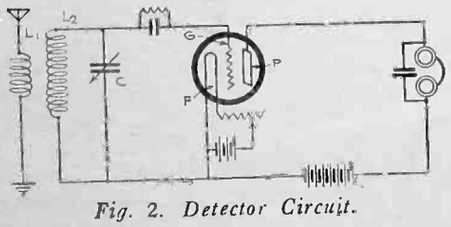


Fig. 2. Detector Circuit.

Fig. 2 is a typical simple circuit, so let us follow it through. First, we start at the extreme left with the aerial, as that is where the current from the broadcast station is picked up. The aerial, being insulated from surrounding objects, conveys this high frequency alternating current down the lead-in wire, through coil marked L_1 to the ground. Alternating current flows first in one direction then reverses itself and goes in the opposite direction, so this current is surging back and forth from aerial to ground very rapidly. We have now traced what is known as the primary or aerial circuit. Very easy, isn't it?

Coil L_2, termed the secondary coil, is pictured beside coil L_1. Notice that coil L_2 is not connected with the primary circuit. It is drawn that way because it actually is not connected with it in practice. Any diagram showing two coils drawn alongside of each other denotes that they are inductively coupled, which means this: When current flows through any coil of wire, another coil either inside or near it will have the current induced into itself. This phenomenon is found in all branches of electrical work. The closer the coils are to each other the more current will be transferred into the secondary coil (the coil that receives it).

So the current surging back and forth in the primary circuit induces a similar current in the secondary circuit coil L_2. We know then that this is a double-circuit hook-up, because the primary circuit is not physically connected with the grid G or plate P of the tube. This double-circuit feature also informs us that this circuit is more selective than one with only a primary coil, called a single-circuit set.

The coil L_2 is shunted by a variable condenser C. This is the tuning element in the circuit. For any given wavelength, or frequency, there is some setting of the condenser which, in combination with the coil L_2, offers a minimum opposition to the flow of the current of that frequency. Consequently that wavelength comes in strong and other wavelengths are shut out or subdued.

Following along the bottom line of Fig. 2 we next come to the filament connection to the circuit, together with the associated filament or A battery, and then to the plate or B battery. These battery connections are often omitted in diagrams or indicated by $+A$, $-A$, $+B$, $-B$, for the sake of simplicity.

We left our current in the secondary coil L_2, didn't we? Following the line from the top of coil L_2 towards the tube (see symbol in Fig. 1). Now we come to our symbol for the grid leak with a fixed condenser across it. We know that the grid leak is some sort of resistance by the symbol. Take particular notice of that grid leak and condenser combination because they are the parts that make the tube to whose grid they are connected act as a detector, (correctly called rectifier). In other words, the tube changes the current which we have traced so far from radio frequency to audio frequency. Radio frequency current is of such high frequency (vibrating so fast) that our eardrums do not respond to it, so we must have something to change it to permit it to actuate our headphone diaphragms or loud speaker. All frequencies above audibility are called radio frequencies; all audible to us are audio frequencies.

When no grid leak or condenser is pictured between the lead from the secondary coil to the tube's grid, that tube is acting as a radio-frequency amplifier. Remember that! In some diagrams the grid leak will be shown connected between the grid and filament lead, the condenser remaining as usual. The effect is the same, i. e., the tube is the detector when thus drawn. (A C battery between the lower end of the secondary coil and the filament lead would make the tube a detector also, but this is rarely used.)

Signals from distant stations are naturally weak when they reach our aerial, so in order to permit the detector tube to rectify them, radio-frequency amplifiers are used, between the aerial and detector; however, this circuit in Fig. 2

isn't designed for exceptional distance, as no radio-frequency amplifier is incorporated.

It is not necessary to describe the complicated action of the tube; all that need be said is that the grid *G* of the tube is where the signals come in, (input), and the plate *P* is the output (where they go out).

Now trace the lead from the plate (output) of the tube and we come to the phones; the current vibrates the diaphragms because the tube converted it to audio-frequency current, you will recall. This completes the circuit, as the filament and battery leads have already been explained.

We have now traced a simple one-tube detector circuit. Let us see what the difference is between the circuit just traced in Fig. 2 and the regenerative

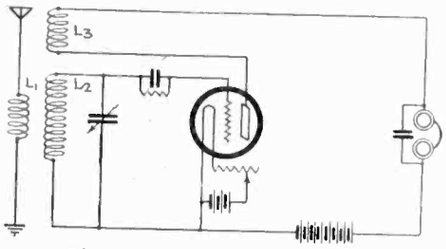


Fig. 3. Regenerative Circuit.

circuit in Fig. 3. We can tell it is a regenerative circuit by the coil L_3, termed the tickler, which you will perceive is drawn beside the secondary coil L_2 to show they are inductively coupled. The only difference between Figs. 2 and 3 is that the plate circuit (output) is tuned by the tickler coil. The signals after being detected by the tube have to go through the tickler (usually the rotor of a vario-coupler), are then induced into L_2, and re-detected by the tube-grid leak-condenser combination before the phones get them. The result

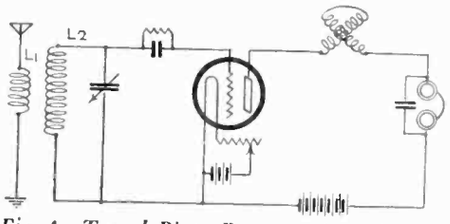


Fig. 4. Tuned Plate Regenerative Circuit.

is more sensitivity, louder signals and more selectivity than in Fig. 2. So remember this, when the plate circuit incorporates some form of variable tuning arrangement that circuit contains regeneration. Fig. 2 will not squeal while being operated, but Fig. 3 will, because of the tuned plate circuit.

Another form of tuned plate regenerative is shown in Fig. 4, a variometer being used for regeneration. Take it out and you have Fig. 2 again. Now we can tell just by the diagrams when the circuit is regenerative or non-regenerative.

The foregoing hookups are all one-tubers, suitable for headphone reception over moderate distances only. In order to actuate a loud speaker satisfactorily we must add two more tubes after the detector. Fig. 5 is a three-tube regenerative circuit. The first tube on the left is the detector because it has the grid leak and condenser connected to its grid, the next tube is first stage of audio-frequency amplification and last tube is the second stage; so we have a "detector and two audio." The method to determine whether the tube is acting as an audio-frequency amplifier is simple—start at grid of the tube in doubt and see if the wire goes to the secondary of an audio-frequency transformer. If so, it is one stage of audio (see symbol for the transformer in Fig. 1). The straight lines between primary and secondary coils represent layers of soft iron which comprise the core. The reason for the laminated iron core is that it helps pass currents at audio frequency more readily, therefore more will be inductively transferred to the secondary coil.

Take a peek at Fig. 6—a plain circuit, used with slight modifications in most five-tube sets.

First we'll count the tube symbols. Five is right. Remembering what we have learned in the foregoing paragraphs, we can see at a glance that the first two tubes on the left are serving as radio-frequency amplifiers, which means "2 stages of R.F. amplification." Then we pass on to the third tube and find our little friends, the grid leak and condenser, connected in the grid lead, so that tube is the detector. So far we know it has "2 R.F. and detector." Tube number four is next. Tracing from the grid we see it is connected to the secondary of an audio-frequency transformer,

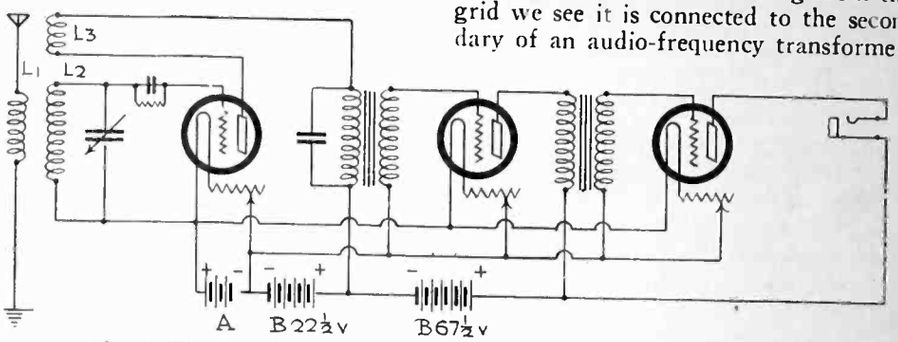


Fig. 5. Regenerative Circuit with Two Stages A.F. Amplification.

which means one stage of audio-frequency amplification. Tube five is connected similarly, so it is the second audio stage. The plate (output) is connected to the jack symbol, therefore that is the *output of the entire set.*

How can we tell the number of controls this set will have when made up? That's easy. *Any symbol with an arrow drawn obliquely through it, or the arrowhead connected with some part of it, indicates that apparatus is variable, or tunable.*

Starting on the left of the diagram in Fig. 6 again, we see variable condensers connected across the secondaries of each radio-frequency transformer. That means three tuning dials or controls. Any more arrows in the diagram? Sure, five more! Under each tube is a symbol for a resistance connected to one side of the filament lead. It is not a fixed resistance like the grid leak of this circuit because the arrow denotes it should be variable. So a rheostat is used, the size depending upon the type of tube employed. Now we know we have three tuning controls, and five rheostats to vary to light their respective tubes. Of course, fixed filament resistances, usually called "ballast resistances" can be utilized for the last two tubes if desired, or one rheostat of the correct size connected in parallel will control several tubes.

Just suppose we should build a set from the diagram in Fig. 6, because we "like five-tube sets." What would be the result? Well, being novices, we surely would have a great time keeping

(*Continued on Page 70*)

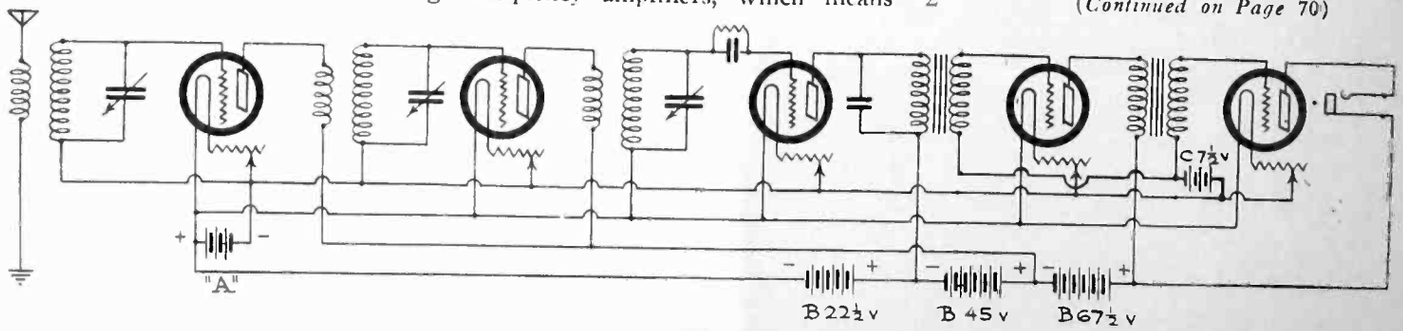


Fig. 6. Two Stages R.F., Detector and Two Stages A.F.

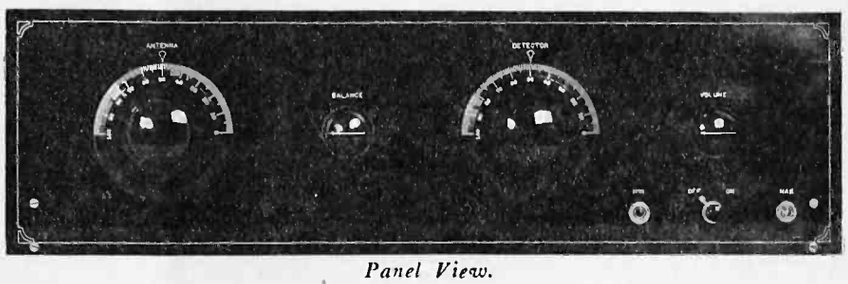
An Easily Built Five-Tube Receiver

Full Constructional Details for an All-Wave Set Combining Sensitivity and Selectivity With Tone Quality and Simplicity

By Elmore B. Lyford

TO meet the needs of the novice builder, who wants an easily-assembled set that will give unusually fine results, we have selected a number of standard parts whose various characteristics may be combined as a harmonious whole in the Henry-Lyford receiver. This fact, together with the detailed directions given in this article will enable even the inexperienced constructor to turn out a job of which he can justly be proud.

The requisite simplicity is embodied not only in the construction of the set but also in its operation, there being but two tuning dials and no rheostat, as may be seen from the panel view. The sensitivity is controlled by a panel-operated

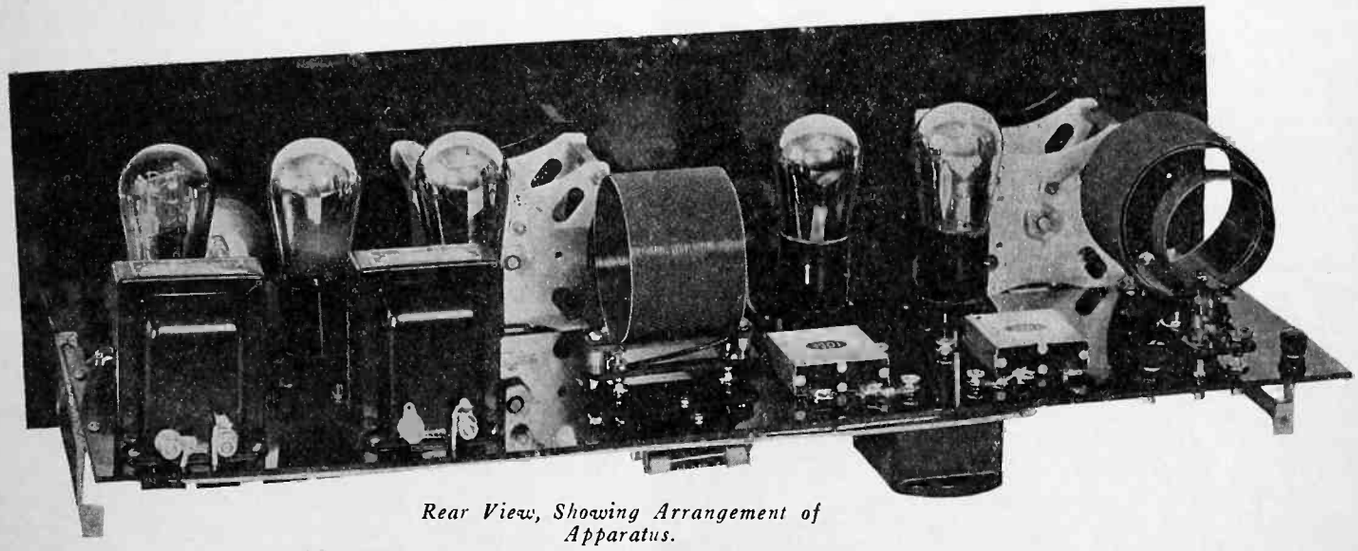


Panel View.

volume and by using high grade a. f. transformers and the special by-pass condensers shown in the circuit diagram. This latter feature keeps the audio component from passing through the batteries and battery leads, a cause of distortion frequently overlooked.

thus checking oscillations and giving the higher gain that comes from using proper grid biasing voltage.

Each of the two radio frequency tubes, as well as the detector, has a grid bias of 1½ volts for use with 90 volts and 22½ volts *B* battery respectively. Greater se-



Rear View, Showing Arrangement of Apparatus.

balancing condenser and the volume by a variable resistance in the audio amplifier, these adjustments having no effect on the settings of the tuning dials.

The circuit consists of two stages of radio frequency amplification (one untuned), tuned detector, and two stages of transformer-coupled audio frequency amplification with a power tube in the last stage. This gives great loudspeaker

The two stages of r. f. amplification, with their low-loss inductances and condensers and short leads, give unusual sensitivity. Neutralization is accomplished by the balancing condenser, oscillation being thus controlled by the highly-efficient "reversed e. m. f." principle. The untuned r. f. stage, after the first tuned stage, uses a transformer having very low impedance in its primary,

lectivity, with some decrease in sensitivity, may be secured by increasing this *C* bias to 4½ volts and changing the detector *B* to 45 volts. The first audio tube is biased with 4½, and the second, UX-112 type, with 7½ volts with 135 volts on the plate. One 5540 Burgess battery suffices for all *C* voltages.

Complete coverage of the present broadcast range is given by the plug-in

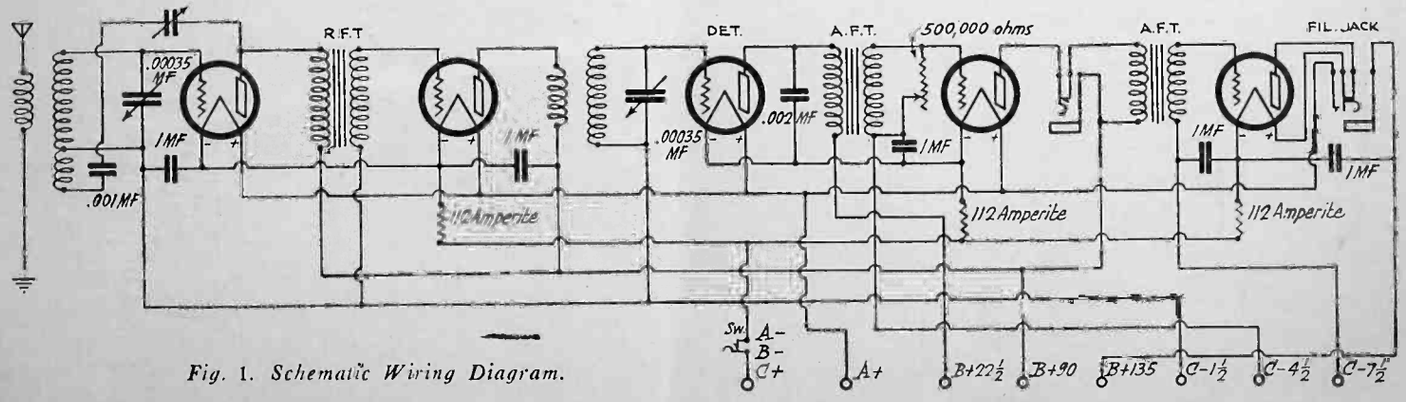
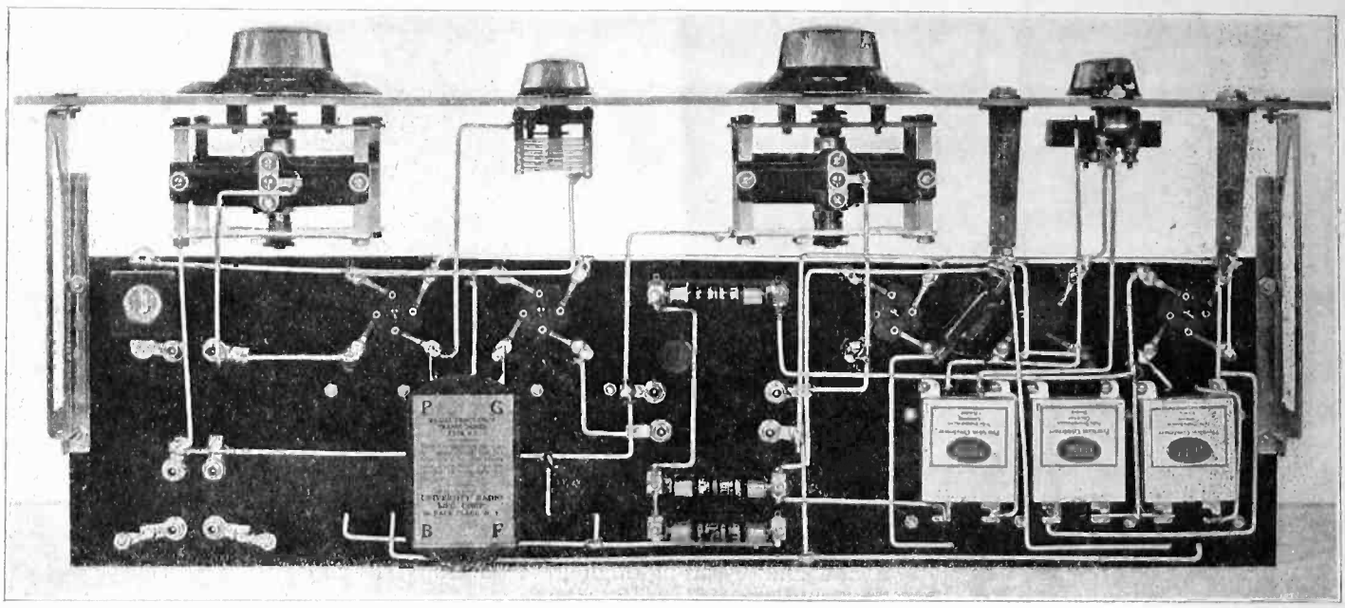


Fig. 1. Schematic Wiring Diagram.



Lower Side of Sub-Panel.

coils specified. Separate coils for the higher and lower wavelengths are obtainable.

The parts actually used in the construction of this receiver were carefully selected for the purpose. While there are others which will do as well, it is definately known that those listed are satisfactory and will fit together as planned. Assuming that the builder has the entire set of parts before him, the procedure is as follows:

Mounting the Apparatus

FIRST mount the 10 coil jacks as shown in the picture wiring diagram, Fig. 2, with the lugs placed as indicated in the drawing. Then mount the antenna and ground binding posts in their correct positions with a soldering lug on each stud overlapping their respective coil jack lugs. Refer to the picture wiring diagram for the proper position of each part and their soldering lugs if any are needed.

Mount the Benjamin brackets as shown with the screws furnished with each pair. Then mount the single post in the center of the sub-panel with the long screw provided for that purpose.

LIST OF PARTS USED

1 Micarta Panel, 7x24, drilled and engraved.
1 Micarta Subpanel, drilled, with Benjamin cushion sockets mounted.
2 Precise 350 mmfd. variable condensers, Type 845.
1 Precise 55 mmfd. variable condenser, Type 940.
1 Centralab modulator, 500,000 ohms.
1 Carter "Imp" filament switch.
1 Carter 102-A jack.
1 Carter 103 jack.
1 University antenna coupling transformer, Type B-1.
1 University radio frequency transformer, Type B-2.
1 University tuned radio frequency transformer, Type B-3.
2 Thordarson Audio transformers, Type R-200.
5 Tobe-Deutschmann 1 mfd. fixed Condenser, No. 201.
1 Micamold .002 mfd. permanent condenser.
1 Micamold .001 mfd. permanent condenser.
3 Amperites, No. 112.
10 Coil mounting jacks.
1 Pair Benjamin brackets, Type 8629.
1 Bakelite post.
2 Eby binding posts, antenna and ground.
2 4-in. Kurz-Kasch dials.
1 Battery cable, 8 wire.
1 25 foot coil, Belden hook-up wire.
1 Complete set of hardware,—lugs, machine screws, etc.

Before mounting the audio frequency transformer No. 2, slip the mounting bolts for the by-pass condenser No. 5 into the proper holes. Then mount the transformer No. 2 so that the *G* and *F* posts are toward the front panel. We are now ready to mount audio frequency transformer No. 1, but before doing this slip the mounting bolts for by-pass condenser No. 3 into place. Take care that the *G* and *F* posts of this transformer are also toward the front panel.

Now turn the sub-panel upside down, and start mounting the by-pass condenser No. 5, which should be mounted between the four bolts that hold audio frequency transformer No. 2 to the sub-panel. By-pass No. 4 mounts directly next to No. 5 as shown in the illustration. By-pass condenser No. 3 should be mounted next by means of the holes provided in the sub-panel. Next mount the three Amperite holders, in the three holes which are directly in line near the middle of the sub-panel. Two go near the back edge of the sub-panel, and one near the front edge, as shown.

(*Continued on Page* 54)

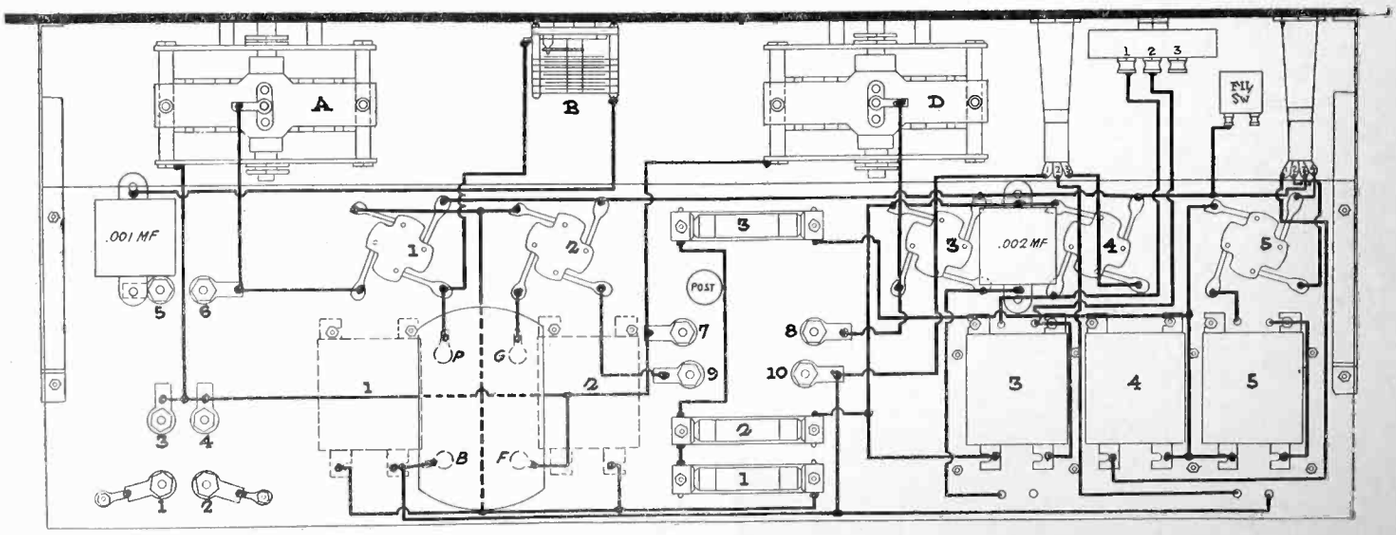


Fig. 2. Pictorial Wiring Diagram Showing Connections as Actually Made.

She could peer into the private chamber of Edisi, the inventor.

The Fatal L-Ray

By Earl Ennis

THE King of Uvala awaited the arrival of his prime minister with ill-concealed impatience. The day seemed perfect and yet on the horizon of national affairs there lurked a cloud no bigger than the spot on the spat of the British Ambassador. It was because of this cloud that the King was worried.

On the balcony rail, the Princess Katerina Eloise Eclypta Tasselhaupt, called "Tassie" for short, perched with graceful ease and swung a silk-clad ankle in careless abandon. She cocked a canny eye at His Majesty.

"What's eating on papa, now?' she demanded in flute-like tones. The King shook his head.

"G'wan," he replied. "Don't bother papa when he's thinking."

"Papa mustn't think," said the Princess Tassie calmly. "Every time papa thinks, papa gums the works."

The King glared at his darling daughter.

"Who said that?" he demanded.

"The Duke of Ork in whom papa has the highest confidence," the darling replied.

"Huh!" grunted the King. "That owl-faced old cow! What knows he about it?"

"Well," said Tassie, checking off the score on her fingers, "He says you gummed the Lissonian treaty, and the naval appropriation, and the ambassador's luncheon, and that's pretty near par, papa!"

"Enough!" The King's voice was stern. "Stop blatting so loud."

"Well, then stop trying to applesauce me," said the Princess sweetly. "I'm not the prime minister, you know."

The King sighed. How could one be Uberalles in the bosom of one's own family? Inasmuch as he knew the answer, he changed the subject.

"Hast seen Rorick the day?"

"Nope," said the Princess easily. "Hast not. Where ist supposed to be?" She liked to take liberties with the vocative because it annoyed the King greatly.

"He was to ask today for the hand of Marie of Eluria." The King spoke heavily. "That is an alliance we would fain discourage. It is not to the best interests of Uvala."

The Princess chuckled.

"You would," she said. "But if it was Elaine of Bagonia you'd order out the Velvet Pant boys and declare a holiday. What do you care who Rorick marries?"

The King stiffened in his chair.

"The responsibility is mine," he snapped.

"Yeah—and Rorick's the boy that has to live with 'em," snapped the Princess. "Be yourself, papa, be yourself. Throw him in the arena and let the girls fight it out between 'em. It'll be a real scrap then."

The King shook his head.

"You don't understand. With Elaine we annex a strip of much needed territory that links us to the sea. With Maria, we gain only more forests to patrol. Uvala needs the sea. There is too much at stake for puppy love to interfere."

He rose and paced to and fro, his brow wrinkled in thought. The Princess regarded him silently. She was not as dumb as she looked, a fact which was a source of constant surprise to the folks in Uvala. Beneath her nifty sport bob, ideas were twinkling in and out like sand through a bathing suit, but on her beautiful face there was not the slightest sign of intelligence.

"Papa," she said after a bit, "perhaps I might interest Rorick in Elaine and

win the route to the sea for Uvala."

This suggestion from the Princess who had never taken even the most casual interest in affairs political nearly dropped His Majesty in his tracks. He stared at his off-spring open-mouthed.

"You have an—idea?"

Princess Tassie beamed brightly.

"Yes, but don't tell mamma," she said. "She would think it coarse of me. This is just between us—father and daughter stuff—you know. Tell me—how stands the royal treasury?"

The King groaned. There was always a catch in the thing somewhere.

"Bitterly low," he declared. "Only this morning, Nollie, of the Exchequer called my attention to the fact that this year's campaign contributions are devilishly behind. For some reason the usual announcement of administration policies has failed to bring the customary financial return. There seems to be a strange apathy abroad."

"Well," said the Princess, "that cramps my style a whole lot. You can't arrange true love affairs without coin of the realm. I've noticed that Rorick has a tendency to cast his affection where the bonus runs highest."

"Cease girl," commanded the King. "Rorick is thy mother's half brother, and thou shouldst speak with more respect."

"Oh, shouldst I?" jeered the Princess. "Say—I know that half-portion better than you do. I've been riding with him!"

The King removed his crown and mopped his brow. The younger generation kept him hard put for replies at times. At that moment, as if in response to an unspoken wish, the prime minister Blannerhassett stepped through the palace window onto the porch. He hardly ever used the door for fear of assassination.

"Ha!" exclaimed the King. "What luck with Edisi the inventor?"

The prime minister bowed from the waist and spread his hands with the gesture of a gentleman caught in a Pullman car without a towel.

"Your Majesty, that low-down, scumdullioned. . ." he began, but the King raised a hand.

"Tut! Tut! The Princess."

"Your Highness' pardon," said the Prime Minister, turning to the Princess. "In the heat of emotion I didst forget myself."

"Let her roll," said Tassie, "as long as you don't repeat. I hate a man who can't cuss without doubling back."

The King rapped sharply on the balcony with his knuckle.

"This is private business," he announced. "Beat it."

The Princess bowed sardonically.

"Anything to please papa," she replied and strolled off down the balcony, followed by the prime minister's slightly protuberant and watery eyes.

"What did the old bilk say?" demanded the King, jerking back his second in command to affairs of state.

The prime minister returned to his interrupted stream of profanity. After a bit he mentioned a sum of money. The King's jaw dropped.

"Sacred Camels," he exclaimed, "but he drives a hard bargain. Did he show it you—his deadly L-ray, I mean?"

The prime minister lowered his voice.

"Your Majesty," he said. "He took us to a device in the middle of a wide field. Before our eyes he pressed a lever and a tree which but a moment before had been growing, dissolved, faded away, passed into mist and was gone. I myself examined the ground afterward. Sire—there was nothing—absolutely nothing."

The King bent forward and sniffed at the minister's breath. Then he leaned back seemingly much relieved.

"You don't say," he remarked. "Gone, eh? How'd he work it?"

The other shook his head.

"That is not for me to say, sire. Edisi is a strange person. He says what he has done with a standing tree he can do with a standing army. If this be true . . . . ."

"Can he do it with a standing debt?" asked the King eagerly.

"I am afraid not," said the prime minister. "Such a debt as ours is beyond even Edisi."

There was a long pause, while each did his own thinking. Finally the King smashed his hand down on the veranda rail.

"Blannerhassett," he said. "Uvala must have that ray even if we have to mortgage the palace to get it."

The prime minister shook his head dubiously.

"There are already four mortgages on the palace, sire, three on the museum of natural mistakes, three on the navy and two on the arsenal. I doubt if the Royal bank would lend on such security."

The King frowned.

"Then we'll sell the navy," he declared. "What good is it anyhow?"

The prime minister turned a shocked face toward the King.

"Sire," he protested, "where in all Uvala are those who can compare with our admirals in the mixing of cocktails? And our commissioned rank stand alone in social persiflage. Your pardon, sire, but our navy provides a most essential society background . . . . "

"Floating cabarets!" snapped the King. "That's what they are. Umpah, umpah instead of boom, boom! In a real battle the Uvalian navy would be about as much use as a knife and fork to a one-armed plumber. We'll sell the navy, I tell you, and buy this L-Ray. With that on our side, we can defy the world!"

The prime minister held up a deprecating hand.

"Your pardon, sire, but it would be better to defy only a portion of the world at first and see how it goes. If you recall, the late Kaiser made a serious mistake of that kind . . . . a few small nations at first, sire, and then some of the larger ones."

"Quite right," said the King heartily. "No use overdoing the thing. You know, Blanny, you have a level head—a damned level head."

"Your Majesty flatters," said the prime minister flushing to his dew-laps.

"No I don't," said the King graciously. "But, if I do say it myself, I can dish the applesauce where it does the most good."

He stood for a moment and contemplated himself mentally,—every inch a King, by golly! Abruptly he turned.

"Have Edisi here for an audience at 10 tomorrow. We will have the bureau chiefs attend also. There is no use asking Jeeks of the War department. He'll be against whatever we do."

"And the press, your Majesty?"

"Let 'em in. That's the only way we can muzzle 'em."

The prime minister bowed. Verily the King was playing into his hands—his and Edisi's. Very shortly now the country would be his and the haughty Princess Tassie with the salmon-silk legs and the rapier tongue . . . . He shook himself. This would never do. There was work yet to be done!

While these epochal events were taking place, Edisi the inventor sat in the workshop of his exclusive castle, Cinder-on-the-hearth, and plotted against the peace and prosperity of the Kingdom of Uvala. Edisi was, by nature, a born conspirator. He was tall and thin. He bent his knees like a deacon when he walked. His voice was soft and unctuous like a mortician's. His eyes were deep set and he smelled gently of rose-water.

At the moment he had fifteen separate and distinct plans for seizing the kingdom of Uvala from its fat, complacent and somewhat near-sighted ruler. He had gone over each and every one of these plans in his mind and Plans Nos. 3 and 9 seemed to him to be the most feasible. In fact, the only difference between Plan No. 3 and Plan No. 9 was that in No. 3 the King was thrown into the sea while in No. 9 he was kicked into the sea.

A less careful conspirator would have said: "What difference makes it how the King gets into the sea, so long as he is drowned?" Not so with Edisi. He was most particular about such details. He always worked out such matters with delicate attention and then, if, by any chance, the plan failed, he knew it was not due to his calculations but to Fate or chance—a most comforting compensation when one conspires for a living.

Take the L-Ray for instance! It had been perfected by a bookkeeper in his

(*Continued on Page 59*)

The Equamatic Tuned R. F. Receiver

A Non-oscillating Five-Tube Receiver with a Unique System of Stabilization.

By G. M. Best

ONE of the principal drawbacks of the popular tuned radio frequency receiver is its tendency to oscillate when the r. f. amplifiers are operating at greatest amplification. To overcome this, various methods are employed, including neutralization by balancing condensers, "lossers" of different types such as resistance in the grid or plate circuits, and decreased filament current. The first mentioned method is often difficult for the home set constructor to accomplish, due to lack of skill in balancing the circuits; the "losser" method materially reduces the sensitivity of the set, as does also the method of filament current reduction.

None of these methods take into consideration the change in the degree of coupling between primary and secondary circuits, which is necessary in order to obtain an equal transfer of energy at any given frequency. Nearly all tuned r. f. receivers are most efficient at the higher frequencies and more and more insensitive as the frequency decreases. This difficulty can be overcome, however, by varying the coupling between the primary and secondary windings of the r. f. transformers in such a manner that the sensitivity of the set remains constant at all frequencies, and oscillation troubles are entirely absent. Such a set is shown in the pictures, and data for its construction are given in the accompanying text and diagrams.

Before describing the actual construction of the set, let us consider the theory of the improved circuit, which is known as the King Equamatic System of oscillation control. Assume for a moment that a secondary coil is tuned with a variable condenser to a wavelength of 200 meters. Assume a primary coil fitted inside the secondary winding, making a complete r. f. transformer. If there is too much wire on this primary coil, the tubes to which the transformer is connected will oscillate, and it will be necessary to remove some of the turns from the primary in order to stop the oscillations. Let us say for example that we have to remove all except four turns from the primary before the oscillations cease.

Now tune the secondary coil to a wavelength of 300 meters, and we find that in order to make the tubes oscillate, it is necessary to increase the primary turns to five. As the wavelength increases, assuming a constant degree of coupling between primary and secondary windings, we can thus add more and more turns to the primary without causing oscillation, and if an equal transfer of energy from primary to secondary is maintained, it is necessary to add these extra turns.

Assuming that it requires fourteen turns on the primary to cause oscillation when the secondary is tuned to 600 meters, if the coupling between the primary and secondary is loosened, the same effect has been attained as though a certain number of turns had been removed from the primary coil. This coupling could therefore be changed to just such a degree as would be right for 300 meters, or loosened still more so that the primary with fourteen turns would have the same effect at 200 meters that a four turn primary would have with the original coupling scheme. In other words, with a primary winding having sufficient turns to operate the tube just under its oscillating point when the secondary winding is tuned to 600 meters, if the coupling can be changed just the proper degree as the variable condenser changes the tuning of the secondary, the tubes can be kept just under the oscillating point, regardless of frequency, thus transferring the same energy to the secondary over the entire range. This is, in effect, the application of the old variocoupler principle to a transformer.

The King System accomplishes this. Fig. 1 shows the primary mounted on the end of the secondary condenser shaft. As the condenser is varied, the primary is also twisted so as to vary the coupling. By also adjusting the secondary to an angle of 58 degrees the coupling between the primary and secondary is reduced in the same proportion as the capacity of the condenser as it is rotated, which is just sufficient to keep the tube from oscillating.

Another factor which has to be considered is the fundamental wavelength of the antenna used with the set. By using the variable coupling between antenna and the r. f. amplifier, you are not limited in any way as to the length of the antenna. The coupling may be varied to suit individual conditions, so that if an extremely long antenna is used, with a fundamental of say 600 meters, minimum coupling would be needed at this point, and greater coupling for all lower wavelengths. If an antenna had a fundamental of 350 meters, minimum coupling would be required at that point and correspondingly greater coupling on either higher or lower wavelengths.

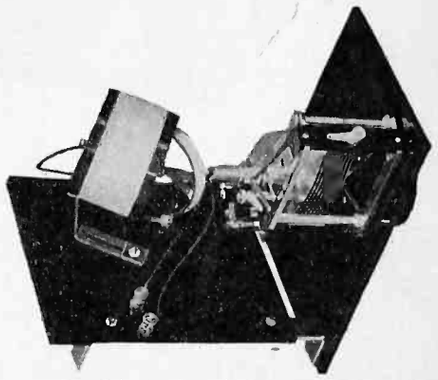
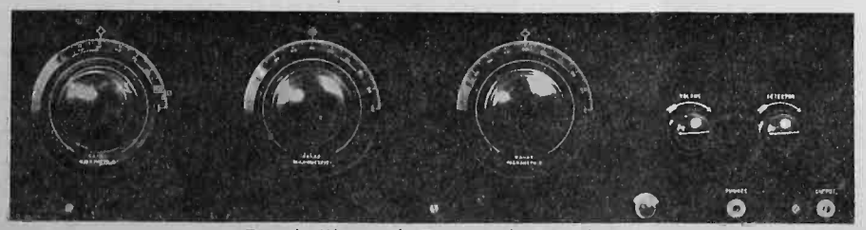


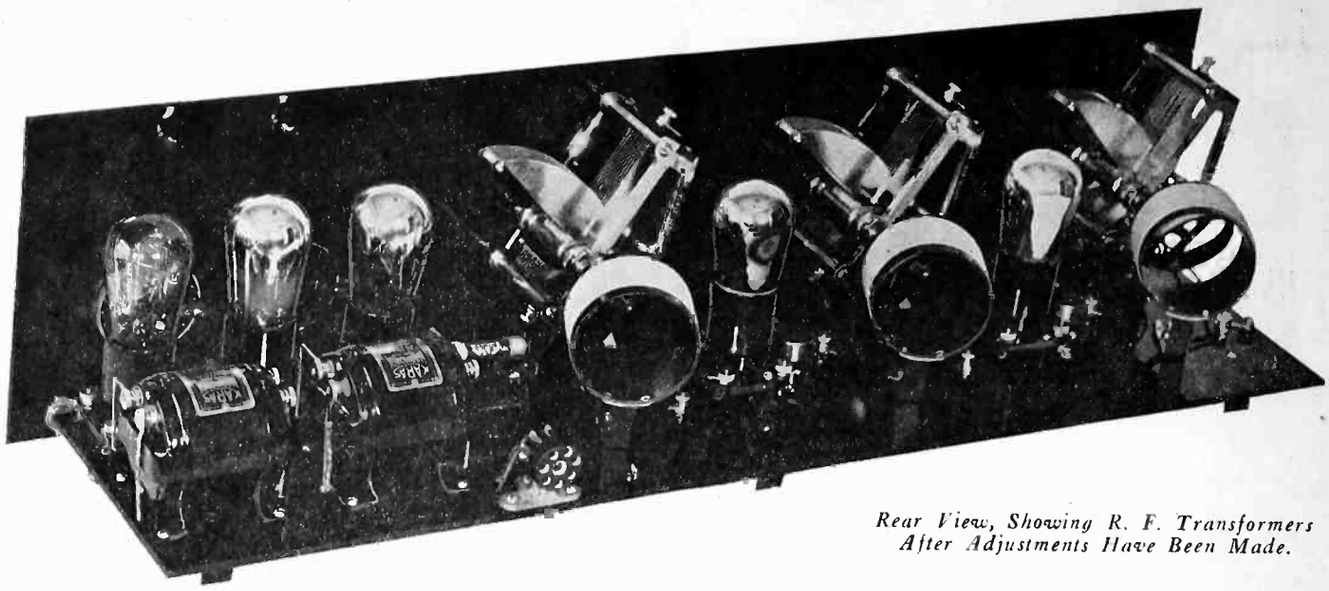
Fig. 1. Position of Primary and Secondary For Equamatic Control.

A complete five tube receiver is shown in the pictures, the set being of the conventional type with three tuning controls, two stages of r.f. amplification, detector and two stages of transformer coupled audio amplification. The schematic wiring diagram is shown in Fig. 2 and gives all connections to the various pieces of apparatus. The transformers, sockets and associated equipment are mounted on a bakelite or formica subpanel, which is fastened to the front panel by means of a set of brackets. In building the set, the list of parts given in the text will be of assistance. This list includes the parts used in the set shown in the pictures. Substitutions may be made to suit the individual taste of the set constructor.

Mount all the apparatus on the subpanel in the manner shown in the pictures, and complete all wiring of this portion of the set before working on the front panel. After mounting the panel apparatus, attach the sub-panel by means of the brackets, and the few remaining wires can then be easily run. The panel drilling template of Fig. 3 gives the necessary dimensions for laying out the apparatus. There may be some who would prefer to wind their own coils and



Panel View of Equamatic Receiver.



Rear View, Showing R. F. Transformers After Adjustments Have Been Made.

data on this construction is given in the following paragraphs.

The secondary coils consist of 60 turns of No. 26 d. c. c. wire wound on a bakelite tube 2½ in. in diameter and 1¾ in. long. The primary coils consist of 14 turns of the same wire wound on a bakelite tube 2 in. in diameter and 7/16 in. long. The secondaries are mounted on the sub-panel by a metal foot 1¼ in. high, 1 in wide and 1/16 in. thick. This strip of metal is then bent over parallel with the sub-panel for a space of 2 in., the bottom portion being slotted down the center for a distance of 1¾ in. so that a screw and washer may be used to hold it in place on the sub-panel.

The primary coils are mounted on the end of the condenser shaft by means of a piece of heavy walled brass tubing and a set screw. The inside diameter of the tubing should of course be such that it will fit snugly over the condenser shaft. The tubing should be 2 in. long and should be flattened out for the last half inch of length. A cross piece of 1/32 in. brass, just as long as the inside diameter of the bakelite tubing used for the primary, should then be loosely riveted to the flattened end of the brass tubing, or else fastened with a machine screw and nut. It must not be tight, however, else it will be impossible to vary the position of the primary coil angularly with respect to the condenser shaft. The primary coil is then fastened to the ends of this cross piece in any convenient manner.

Brackets on which to mount the sub-panel may be made of 3/32 in. hard drawn brass, 7 in. long and ½ in. wide. These strips should be bent at right angles, 1 in. from one end, a hole tapped for an 8/32 machine screw being drilled in the short end. Two similar holes, 4 in. apart, should be drilled in the long end, in such a position that the back of the sub-panel will be flush with the back end of the bracket, and so that the two holes will be equidistant from the front and back edges of the sub-panel. Three of these brackets will be required.

After completing the wiring of the set, connect the batteries by means of the Jones Plug and battery cable, connecting the *A* battery first in order to test the filament circuit. If the tubes light when the rheostats are turned on, the filament circuit is O. K. Disconnect the positive *A* battery wire from the battery, and connect all the other wires in the battery cable in turn to the positive *A* battery. If any of the tubes light, there is a wrong connection in the circuit, which must be located before connecting the *B* batteries. If everything is correct, the batteries may all be connected, and the phones plugged in the first jack.

After adjusting the filament voltage of the detector and audio tubes to the correct value, turn on the rheostat marked "Volume," which controls the filaments of the r. f. tubes. Set the variable condensers at about 25 on the dials, vary them until a station is heard, and adjust until maximum volume is obtained. Assume that the fundamental wavelength of the antenna, by a rough estimate, is 250 meters, which is equivalent to a dial setting of 25 for the variable condensers, and adjust the coupling of the primary coil so as to give minimum coupling at this point. This does not mean zero coupling, but it should be extremely loose. The best way to determine the correct angle for the coil is to first set the primary parallel to the secondary when the plates of the condenser are completely meshed, and then turn the condenser to minimum, noting the angle of the primary and secondary coils. Loosen the set screw and turn the condenser dial until the secondary is tuned to the antenna fundamental, tightening the set screw again.

If there is a station transmitting on about this wavelength, it will be a good one to use in making the final adjustments. After the station is tuned in, loosen the screw holding the secondary coil to the sub-panel and push the coil forward over the primary, being careful to maintain the 58 degree angle. Suddenly the tube will commence to oscillate, so that the secondary should be backed away until the oscillations stop. At this point securely fasten the secondary to the sub-panel, and repeat the op-

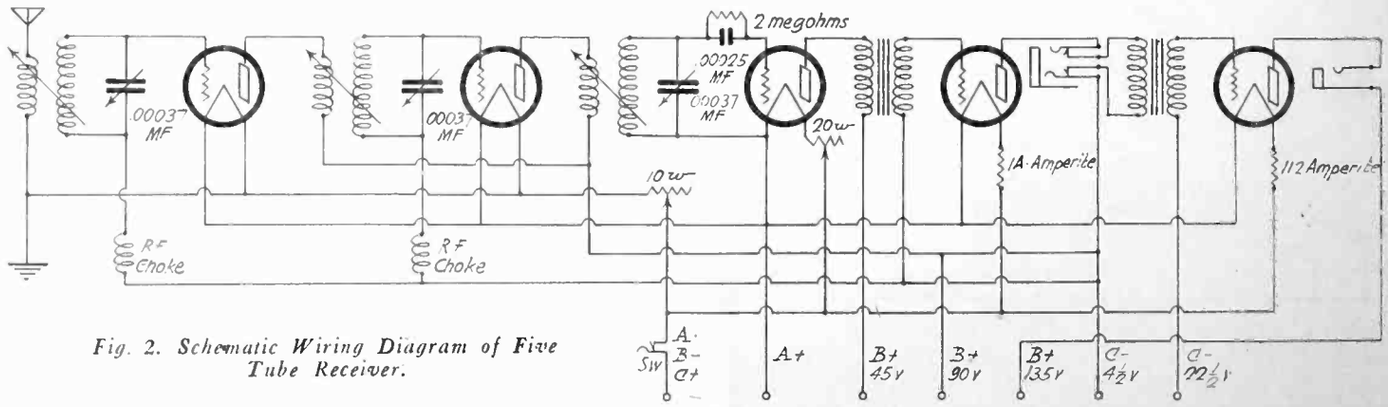
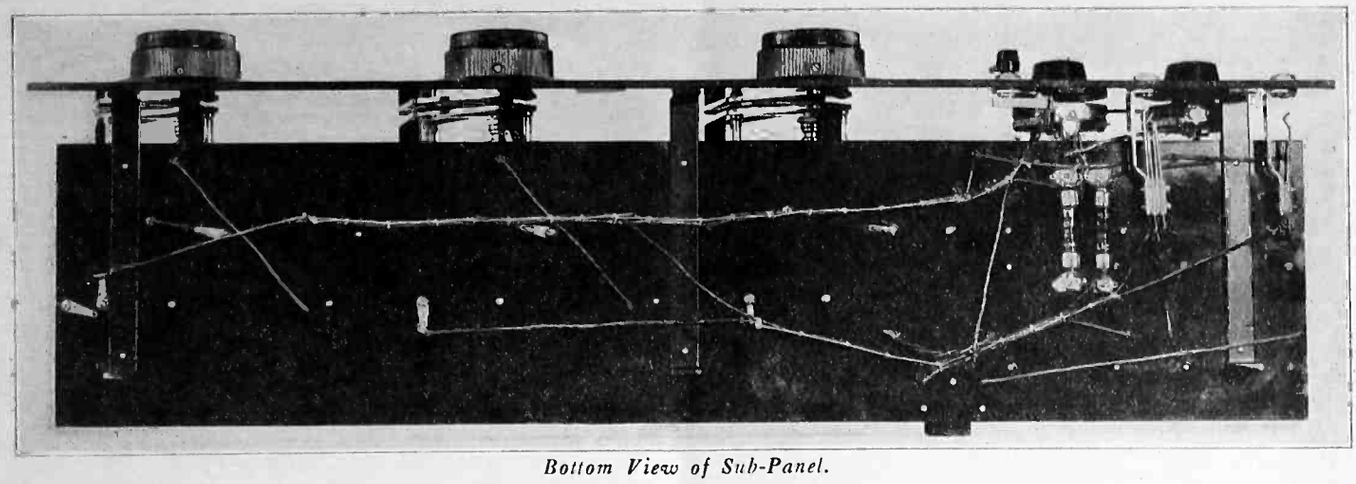


Fig. 2. Schematic Wiring Diagram of Five Tube Receiver.



Bottom View of Sub-Panel.

eration with the next secondary, until all coils are adjusted. You should now be able to vary all the the dials over the entire range, without the set oscillating at any point.

As the selectivity of the Equamatic transformer is so great that it may become too critical, a retard coil is placed in each grid return lead as is shown in Fig. 2. This coil has a very small amount of inductance, and is in no sense a "Losser." It may be purchased ready made, or it can be constructed by winding 55 turns of No. 36 single silk wire on a ¼ in. laminated core.

It will be noted that a *C* battery is used on all the tubes except the detector. This conserves the life of the tubes in the case of the r. f. stages, and is necessary in the audio stages not only from the standpoint of tube economy, but in order to permit proper volume with good tone quality. A type 171 power tube is recommended for the last audio stage, with 135 volts plate and 22½ volts negative grid, but other power tubes may be used, with appropriate changes in the *B* and *C* voltages. The 171-tube, with the voltages specified, does not have more than 12 milliamperes plate current, and hence no output transformer is required. If the *B* and *C* voltages are increased, however, it will be necessary to install an output transformer in order to prevent burning out the windings of the loud speaker. The *C* battery may be placed alongside the *A* and *B* batteries, there being a conductor in the battery cable available for the extra *C* connection.

LIST OF PARTS USED

- 3 Equamatic Transformers—Karas.
- 3 .00037 mfd. condensers with extended shaft—Karas.
- 1 Yaxley 10 ohm rheostat with dial.
- 1 Yaxley 20 ohm rheostat with dial.
- 2 Audio transformers—Karas Harmonik.
- 2 Karas Equamatic retard coils.
- 1 Closed circuit jack—Yaxley.
- 1 Open Circuit jack—Yaxley.
- 3 Vernier Dials—Karas Micrometric.
- 1 Filament switch—Yaxley.
- 1 .00025 mfd. fixed condenser with clips—Sangamo.
- 3 Sub-panel brackets—Karas.
- 1 2 megohm grid leak—Amsco.
- 1 1-A Amperite.
- 1 112 Amperite.
- 5 UX base cushioned sockets—Benjamin.
- 1 Formica panel, 7x28x3/16 in., drilled and engraved.
- 1 Formica sub-panel, 6x27x3/16 in., completely drilled.
- 1 Everendy No. 766 "C" battery.
- 1 Jones Multiplug with mounting and 8 ft. cable.
- Binding posts, screws, bus wire, soldering lugs, etc.

EUROPEAN BROADCASTING STATIONS

(500 Watts or More)

AUSTRIA:
- Vienna (ORV) 530 m., 1500 w., Oesterreichischer Radioverkehrs.
- Vienna (ORV) 488 m., 10,000 w., to replace above.
- Graz, 404 m., 500 w., Oesterreichischer Radioverkehrs, A. G.

BELGIUM:
- Brussels (BAV) 486 m., 1500 w., Radio Belgique Co.

CZECHOSLOVAKIA:
- Prague (OKP) 375 m., 5000 w., Radio Journal.
- Brunn (OKB) 521 m., 500 w., Radio Journal.

DENMARK:
- Copenhagen, 348 m., 500 w., Government.
- Soro, 1150 and 2400 mm., 1000 w., Ministry of War.
- Hjorring, 1250 m., 500 w., Government Relay.

FINLAND:
- Bjorenborg, 255.3 m., Nuoren Voiman Liiton Radioyhdistys.
- Helsingfors, 522 m., 500 w., Finnish National Guard.
- Helsingfors, 318 m., 750 w., Military.
- St. Michel, 561 m., 500 w., Nuoren Voiman Liiton Radioydistys.

FRANCE:
- Angers, 250 m., 500 w., Ministry of Posts, Telegraphs and Telephones.
- Bordeaux, 330 m., 500 w., Ministry of Posts, Telegraphs and Telephones.
- Issy-les-Moulineaux (QGA) 1800 m., 500 w., Ministry of War.
- Lyon (YN), 280 m., 2000 w., Dubanchet and Trolliet.
- Lyon (La Doua), 482.3 m., 500 w., Government.
- Paris (FL), 2650 m., 5000 w., Government. Eiffel Tower.
- Paris (5NG), 333 m., 500 w., Journal Petit Parisien.
- Paris (FL) 345 m., 500 w., Petit Parisien.
- Paris (8AJ), 1750 m., 4000 w., Cie. Francaise de Radiophonie.
- Paris (FPTT), 459.4 m., 500 w., Government.
- Toulouse, 435.1 m., 2000 w., La Radio Barcelona.
- Toulouse, 280 m., 2000 w., Government Aerodrome Station.

GERMANY:
- Berlin (AFT), 1300 m., 1600 w., Postal (relay).
- Berlin (AFT), 507 m., 2250 w., Postal Authorities.
- Bremen, 279 m., 700 w., Nordischer Rundfunk, A. G. (relay).

(*Continued on Page* 67)

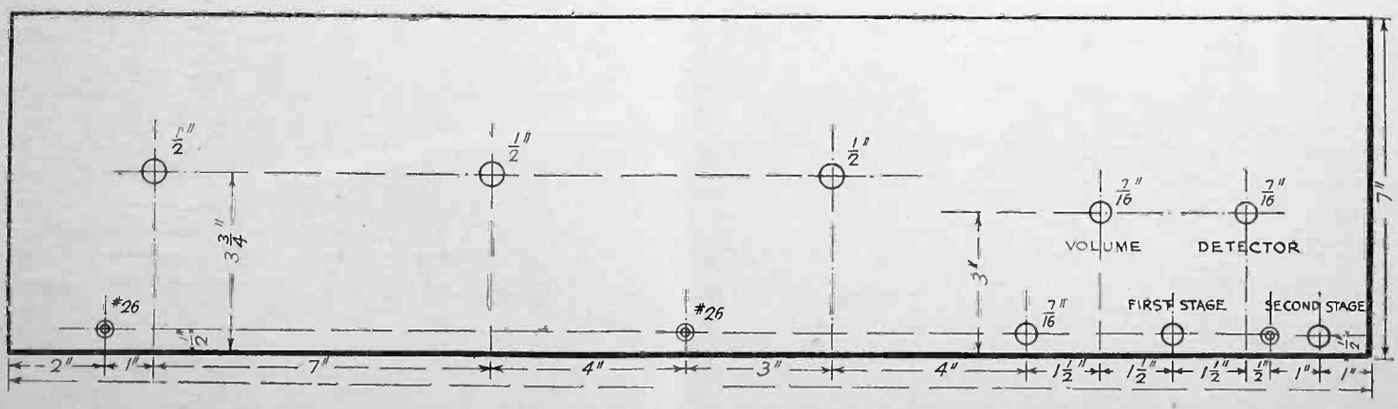


Fig. 3. Panel Drilling Template.

The Siamese Twins of Radio: Detection and Distortion

By Raymond B. Thorpe

IT MAY come as quite a shock to many a radio fan and set builder who has spent much time and money trying to eliminate distortion to learn that without some distortion properly controlled, that fine receiver of his would never reproduce a single fragment of the speech or music broadcast from his favorite station. So radical a statement will require some explanation and much support. Both are readily available.

The persistent reader of current radio literature has learned much about the meaning of distortion and has found ways and means described for its elimination. But all of these means apply only to amplifiers—audio, radio and intermediate frequency amplifiers. No one rightly informed, has seriously proposed to make the detector distortionless and any who have tried it have been rewarded with——silence. For there lies the secret: The detector must "distort" or it will not "detect."

This seeming paradox—that the most distortionless of sets must certainly distort or fail entirely to fulfill its purpose is not so alarming as it at first appears. We shall find on further inspection that the essential distortion may be made to perform its duty in such a way that the resulting speech or music is almost unharmed.

We should first renew our picture of the meaning of detection. It has been known by other names, most significant of which are *demodulation* and *remodulation* since it cannot be fully understood without consideration of its counterpart —modulation. Together they present a most complete picture of the essential processes of radio transmission.

It is a familiar fact that the microphone located in the studio of the broadcast station generates undulatory or alternating currents corresponding in form to the sound waves set up by the speech or music of the artist. It is also a familiar fact that these alternating currents do not leave the studio in just this form, but rather as a very high frequency alternating current. How this comes about can be readily understood from a consideration of vacuum tube characteristics.

The familiar curve of Fig. 1, which shows the relation between the grid voltage and the plate current of a typical vacuum tube, holds the key to this explanation. It will be noted that this characteristic curve is by no means straight throughout its length, and in fact, is rather sharply curved towards the lower end. This lower part, between the points B and A of the figure, is very nearly parabolic in shape. This is equivalent to saying that the plate current in this region is proportional to the square of the grid voltage, if we choose the point B, for example, for a starting point. It is this part of the characteristic which we ordinarily try to avoid in amplification, but which becomes the most important and interesting part of the characteristic in modulators and detectors. It can be shown that the plate current in this region may be expressed in the form of

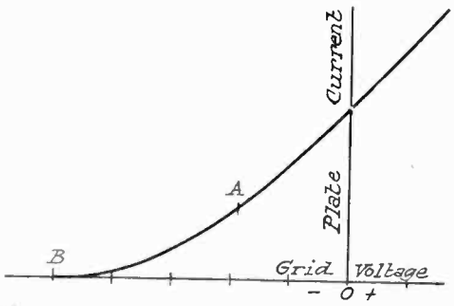


Fig. 1. Relation Between Grid Voltage and Plate Current.

$$i_b = K(E_b + \mu E_c + \mu e)^2 \quad \ldots\ldots (1).$$

Where K is a constant, E_b is the plate voltage, E_c the "C" battery voltage, μ the amplification constant of the tube and e is any alternating voltage impressed on the grid by a transformer or other means. This equation illustrates the fact that the plate current depends on the square of the grid voltage.

In case an output transformer is provided as in Fig. 2, any direct current components of the plate current will be suppressed by the transformer and it may be shown by simple algebra that the alternating part of the output current will have the form

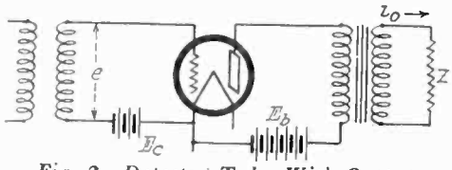


Fig. 2. Detector Tube With Output Transformer.

$$i_0 = a_1 e + a_2 e^2 \quad \ldots\ldots (2)$$

in which a_1 and a_2 are simple expressions involving E_b, E_c, μ and K.

It may therefore be stated that *for a simple vacuum tube circuit such as in Fig. 2 the output current is represented by two components; one of which is directly proportional to the input potential and the other proportional to the square of the input potential.* The magnitudes of these two components are functions of the construction of the tube, since they involve μ, and of the conditions under which it is operated. In fact it may be easily shown that the magnitude of a_1 is, among other things, increased by the use of a larger positive value of E_c, or conversely, that as E_c becomes more negative a_1 diminishes. This is an important fact when we are concerned with the amplification of the voltage e without distortion; that is, without introducing very much of the e^2 component.

Suppose now that we apply to the grid of such a vacuum tube voice and radio frequencies simultaneously. The latter is commonly known as the carrier frequency. Any alternating voltage may be expressed in the form $a \sin pt$ where p is 2π times the frequency, a the peak value of the voltage and t the time. A second frequency could of course be expressed by $b \sin qt$. Of course in speech or music many frequencies will simultaneously be present, but it will simplify our discussion and lead to the same result if we first assume a single frequency to constitute the music; for example, a 1000 cycle tone represented by $a \sin pt$. We will represent the carrier frequency, say 500 kilocycles, by $b \sin qt$. Then our input voltage is $e = a \sin pt + b \sin qt$. When we substitute this value in equation (2), equation (3) results. This is rather formidable at first glance, but on closer inspection it will tell us a number of interesting things regarding the output of a broadcast station. This equation is

$$i_0 = a_1 a \sin pt + a_1 b \sin qt + a_2 a^2 \sin^2 pt + 2a_2 ab \sin pt \sin qt + a_2 b^2 \sin^2 qt \quad \ldots\ldots (3).$$

Remembering our expressions for the voice and carrier frequencies it will be seen that the first and second terms are merely amplified currents of the voice and carrier frequencies, while the third and last terms are double frequencies* of the voice and carrier components. The fourth term of equation (3) appears to be an alternating current, $b \sin qt$, which is changed in amplitude at the rate $a \sin pt$. This is nothing but a mathematical way of making the familiar statement that modulation consists of varying the amplitude of the carrier current by means of the audio frequency. While this is a perfectly true statement of what happens it does not tell us all of the interesting and important facts since, in addition to the

*Note: Since $\sin^2 pt = \frac{1}{2} - \frac{1}{2} \cos 2pt$ from trigonometry, and $2p$ represents a frequency twice as great as that represented by p.

apparent changes of amplitude, there are certain frequency changes taking place in this fourth term which are not clear in its present form. With the use of certain trigonometrical relations this may be rewritten in the form

$a_2\ ab \cos (q—p)\ t—a_2\ ab \cos (q+p)\ t$ ..... (4).

It is now obvious that we have present a frequency corresponding to the difference between the carrier and the voice components $(q—p)$ and another corresponding to the sum of these $(q+p)$—the so called upper and lower modulation components. This equation combined with the second term of equation (3) is the proof of the familiar statement that the output of a broadcasting station consists of the carrier frequency and two side bands corresponding to the carrier plus the voice frequency and the carrier minus the voice frequency.

Equation (3) also shows us that the voice frequency, its second harmonic and the second harmonic of the carrier are likewise present. These are ordinarily ignored since the first two are never radiated and the last will not be received in a sharply tuned receiver which is set for the fundamental.

We are now concerned with what happens in the receiving set. Suppose that a vacuum tube exactly similar to the one used at the broadcast station as a modulator is available at the receiving point. When the carrier and modulation components of the radio wave are impressed on the grid of this tube the result is exactly similar to that occurring at the modulating point. It will be easier to get an expression for this result if we omit one of the two side bands. Not only is the result essentially unchanged, but this suppression of one band is physically possible, and has been employed in recent experiments. Under these conditions we are re-applying the two alternating voltages $a_1\ b \sin qt$ (carrier) and $a_2\ ab \cos (q—p)\ t$ (one side band) to the grid of our vacuum tube. When these expressions have been substituted in equation (2) and the undesirable terms disposed of we find one term in the form $ka\ b^2 \sin [q—(q—p)]\ t$ or $ka\ b^2 \sin pt$. This is the original modulating frequency resulting in this case as the difference between the carrier and side band frequencies. The terms of the complete equation, which have been omitted, are all of radio frequencies and their elimination from the radio circuit is accomplished by the use of an audio frequency transformer in the plate circuit of the detector tube since this will not amplify these radio frequencies.

In the case of resistance coupled amplifiers, which amplify radio frequencies as readily as audio frequencies, they must be suppressed by the use of choke coils and by-pass condensers as described by the author in a recent issue of this magazine.

If now the original signal were not a single frequency tone of 1000 cycles, but rather a musical selection involving, simultaneously, frequencies over the range of 50 to 5000 cycles, every one of these frequencies would have its corresponding pair of modulation frequencies lying above and below the carrier frequency. After demodulation in the detector, each of these frequencies would re-appear in its original form.

A new problem is now involved, however, since each voice frequency will produce a modulation component with every other voice frequency present. This is unimportant at the transmitting station, since these components will all be low frequencies which will not be radiated, but when the reverse process takes place in the detector many of the additional demodulation components will be found to be voice frequencies. These are undesired since they are not in the original music.

If, at a given moment, the music consists of two single frequencies, say 800 and 1000 cycles, the output of the modulator tube would contain, among others the frequencies 200, 800, 1000, 1800, 500,000, 500,800 and 501,000, these last three assuming a 500 kilocycle carrier frequency. The first four of these components would not be radiated, but the last three would reach the receiving set and be applied to the detector tube. Here they would result in sum and difference frequencies for each pair incoming. Consequently there would be in the voice frequency range, not only frequencies of 800 and 1000, but also a 200 cycle frequency resulting from the combination of the two modulation components in the incoming radio wave. This 200 cycle frequency was not in the original music and is undesired. Hence we are concerned about some means of suppressing it.

We have already shown that for a single frequency case the result of demodulation is in the form $kab^2 \sin pt$ where k is a constant and where a and b are respectively the original amplitudes of the voice and carrier frequencies at the broadcast station. This expression holds the key to a solution of our problem. Assume again that our music consists of frequencies 800 and 1000 cycles and that their relative amplitudes are a_1 and a_2. The resulting radio wave will consist of a carrier whose amplitude is proportional to b and two modulation components corresponding to the 800 and 1000 cycles whose amplitudes are a_1b and a_2b. Then the result of demodulation in the detector will give us an 800 cycle tone whose amplitude is proportional to a_1b^2, a 1000 cycle tone whose amplitude factor is a_2b^2, and a 200 cycle tone whose amplitude factor is $a_1b_2^2$. From this we see at once that if a_1 and a_2 are made small as compared to b, the 200 cycle tone will have a very much smaller amplitude than the desired 800 and 1000 cycle tones. In fact if b is about ten times as great as a_1 and a_2 the 200 cycle tone will carry about 1 per cent of the energy present in each of the wanted frequencies.

We conclude from this fact that the carrier current generated at the broadcasting station should be much stronger than the strongest voice frequency which will be applied with it to the modulator tube. This fact, though well recognized by the designers and operators of the more modern broadcast equipment, was apparently unknown in the earlier days of broadcasting. Many will remember the terrible "blasting" sounds which resulted from the broadcasting efforts from some of the earlier stations. It is true that not all of this was the fault of the broadcasting station, being in some measure due to the amplifier in the receiving set, but the fact that some of the "blast" was present even in a simple set consisting only of a detector is proof that the broadcasting stations were being over modulated. In fact so called "complete" modulation, which was often the goal of the station operator, consisted in applying to the modulator tube a voice frequency voltage as high as that of the carrier itself, resulting in very violent distortion in the receiving set.

The fact that a large amount of carrier must be present in order that detection may be accomplished without distortion of the music indicates that a broadcasting station is ordinarily a rather inefficient device. If, for example, the carrier voltage is ten times that of the modulating voltage only about 1 per cent of the radiated power will be found in the side bands, the remainder appearing in the carrier frequency itself. A 1000 watt station which radiates only 10 watts of modulated carrier is hardly ideal.

Considerable saving could be effected or much greater signal strength produced from the same size transmitting sets if it were not necessary to transmit the carrier frequency. Such is fortunately the case if some means can be provided for generating the carrier frequency locally at the receiving point. This result has actually been accomplished and the so-called suppressed carrier system has already been used in trans-atlantic radio telephony. The principal difficulty involved is in producing a current at the receiving station exactly equal in frequency to the carrier of the sending station without any means of controlling one by means of the other. It is this difficulty which has prevented the adoption of the suppressed carrier system for ordinary broadcasting where thousands of receivers are involved. On the other hand trans-atlantic telephony involves only a single receiver at the distant point and the tremendous saving in power more than justifies rather elaborate means of obtaining approximate synchronism between the original and the locally generated carrier frequency.

Thus far we have dealt only with a detector whose action depends upon the large negative C potential. Such a detector is frequently used as the first de-

tector in a superheterodyne. The more common types of detectors are either vacuum tubes employing a grid leak and condenser or crystal detectors. Our study of the negative *C* type detector has shown us that the essential requirement is merely that the output current should be proportional, at least in part, to the square of the input voltage. This will be true of any device whose characteristic input-output curve is non-linear.

This condition is obviously satisfied by the crystal detector, since it is a simple rectifier allowing current to pass in one direction and not in the other. The actual equation for the behavior of the crystal detector involves many terms in addition to the square term including the 3rd and 4th and other powers. These may be shown to be unimportant because of the relatively small amplitude of the effects which they introduce so long as we keep the transmitted carrier much stronger than the side bands. Similarly the equation of a detector arranged with grid leak and condenser will be found to contain the desired second power term which results in demodulation. The current voltage relations are not so obvious in this case and do not lend themselves readily to mathematical solution, but the demodulator effect is again due to the second power term.

If the effectiveness of the detector is due to the curvature of its input-output characteristic, we should expect that one having very sharp curvature would be more effective as a detector than one of less marked degree. An interesting application of this fact is found in the gas-filled or "soft" detector tube, whose characteristic curve is shown in Fig. 3.

Fig. 3. Characteristic Curve of "Soft" Tube.

The humps in the curve are due to ionization of the small amount of gas contained in the tube which results in greatly increased current at certain values of plate voltage. When the plate voltage and other constants of the circuit are so arranged that the normal operating point of the tube is *b*, for example, the curvature of the characteristic is very great—especially for weak signals. For this reason the gas filled tube often produces remarkable results. Unfortunately they are unstable in operation and require quite critical adjustments of the plate voltage and other constants. Moreover, it is difficult to manufacture them with uniform detecting properties and they are useless as amplifiers or in other parts of the circuits. For this reason they have largely given way to standard tubes provided with grid leak and condenser or a large negative "*C*" potential. Recently, however, a new tube of this general type filled with caesium gas at low pressure has been developed which is claimed to have most of the advantages of the older gas-filled types without being so critical or so difficult to manufacture with uniformity.

Two interesting applications of the fact that the demodulating properties depend upon the squaring action of the detector are found, first, in the effectiveness of radio frequency amplification and, second, in the use of push-pull modulators.

We have shown that the amplitude of the useful part of the detector output is proportional to the amplitude of the voice frequency produced at the studio, and to the square of the amplitude of the carrier current. If, therefore the carrier were doubled in amplitude by some means we would get four times as much volume from the receiver. It is for this reason that radio frequency amplification, even though inefficient in itself, becomes very effective. If, for example, the radio frequency amplification increases the voltage of the incoming signal ten times, this would be equivalent to increasing it one hundred times after passing the detector.

Equation (2) shows that the output current from a simple vacuum tube circuit has two components; one proportional to the input frequency and the other proportional to the square of that input frequency. It is possible to arrange a circuit such as that shown in Fig. 4 so that the output components

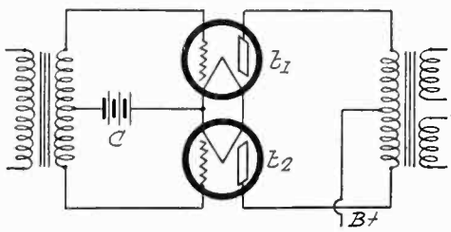


Fig. 4. Push-Pull Amplifier.

proportional to the input frequencies exactly cancel each other, due to the connections of the output transformer, while those proportional to the square of the frequency do not. If, for example, the input transformer applied one-half of the voltage to each tube the current for tube t_1 alone would be

$$i_0 = a_1 e/2 + a_2 e/4^2 \quad \text{(5-A)}$$

and for tube t_2 would be

$$i_0 = -a_1 e/2 + a_2 e/4^2 \quad \text{(5-B)}$$

If then the output transformers are so connected that the currents add directly the resulting current is

$$i_1 = a_2/2\, e^2 \quad \text{(5-C)}$$

or in other words pure squaring of the modulating current results. This same arrangement may be employed to completely eliminate the squared component and provide almost pure amplification by so connecting the output transformers that the currents are directly opposed. In this case equation (5-B) is subtracted from (5-A) obtaining

$$i_1 = a_1 e \quad \text{(5-D)}$$

or pure amplification. This is the arrangement commonly known as push-pull amplification which has been quite commonly used in recent years for audio amplifiers. Its most important application, however, is in the amplifiers of carrier telephone systems where several "radio" channels are simultaneously amplified. Under such conditions the modulation effects of the vacuum tube must be reduced to an absolute minimum or the several channels will inter-modulate and produce a confused jumble of sounds at the receiving end.

Two French radio engineers have conducted tests with aerials made of bare and enamel wire to see how they compared in results. They erected two aerials, one of bare wire and the other of enamel wire, as nearly alike in physical dimensions as possible, and made careful audibility tests on a standard signal over a period of two weeks. At the end of the two weeks, the strength of the signals brought in on the bare copper wire aerial had decreased nearly one third; while the signal strength on the enamel wire aerial was practically the same as the first day. The decrease in signal strength on the bare wire aerial was due to the formation of cupric oxide on the surface of the wire. This has a comparatively high resistance, and since, at the high frequencies employed in radio transmission, the current flows mainly on the surface of the wire, the voltage that found its way to the receiving set was considerably reduced. Wire with any other kind of insulation could have been used in place of the enamel wire, and would have been just as good, if it were not for the objectionable weight and cost of the extra insulation. The enamel, or other insulation, does not allow the air to reach the wire, and thus prevents the formation of the high-resistance oxide. The same thing applies to losses in the ground wire as well. The insulation offers no impedance to the radio waves, however.

An aerial having more than a single wire should not be insulated by connecting the insulators in the ends of each of the wires, as is the usual practice. Instead of that, all the insulators should be connected in series (that is, in a string) in the ropes that support the spreaders. Several insulators, which should be of glass, porcelain, or pyrex, connected in this way in each rope between the pole and the spreader are many times more effective than the same number of insulators connected singly in the ends of each of the wires.

Converting A Five-Tube Set to An Infradyne

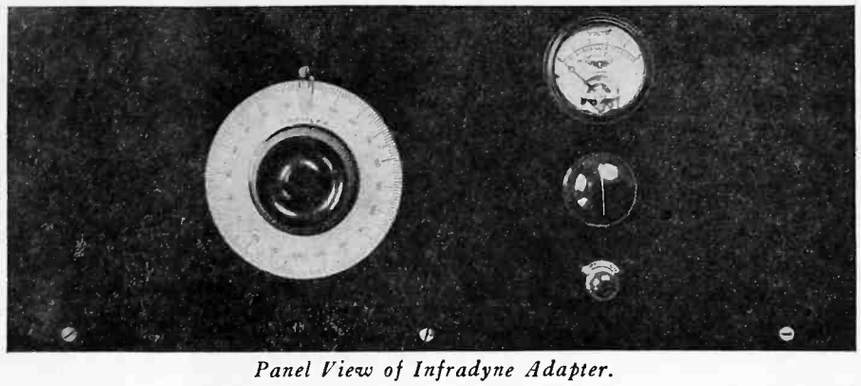
A Description of An Infradyne Adapter Applicable to Any Tuned R. F. Set. Also Some Suggestions for Selectivity.

By E. M. Sargent.

THOSE who have followed the series of articles on the infradyne circuit which have been appearing in these columns since August, 1926, have recognized the fact that a complete infradyne set consists of a five-tube tuned radio frequency set *plus* an oscillator-mixer and a three tube infradyne amplifier unit. In operation, the received signal is first amplified at radio frequency in the first two stages, then changed to a low wavelength of about 90 meters by the oscillator-mixer, then amplified to a still greater degree by the three stages in the infradyne amplifier, then detected or de-modulated by the detector tube, and finally amplified by two audio frequency transformers and tubes. In effect, an oscillator-mixer and infradyne amplifier have been merely added to a five-tube set.

That this addition can be easily made to almost any tuned r.f. set, including the neutrodyne, has been conclusively demonstrated during our laboratory tests. Consequently we have designed an infradyne adapter which will transform an existing five tube set into a complete ten tube infradyne set. This change can be readily made in a few minutes by simply adding the oscillator, infradyne unit and second detector whose constructional details were given in August RADIO.

As may be seen from the adapter circuit diagram in Fig. 1, the output from the plate of the original detector tube, now used as a mixer to give the *sum* frequency, is connected to the infradyne adapter. Then the output of the infradyne adapter is connected to the input of the first a.f. transformer. This, with the necessary battery connections, completes the job. The only changes made



Panel View of Infradyne Adapter.

in the original set is to disconnect the wire joining the plate terminal of the detector socket to the *P* terminal of the first audio frequency transformer, to remove the audio by-pass condenser in the tuned radio frequency set (if there

minal of the first a.f. transformer. Then make the battery connections as indicated in Fig. 1, first disconnecting the *A* battery from the set.

The complete unit to be added can be mounted on a panel and baseboard, as

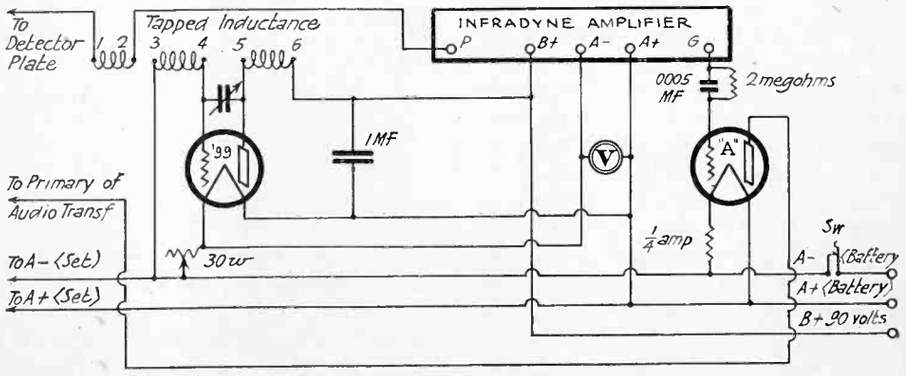
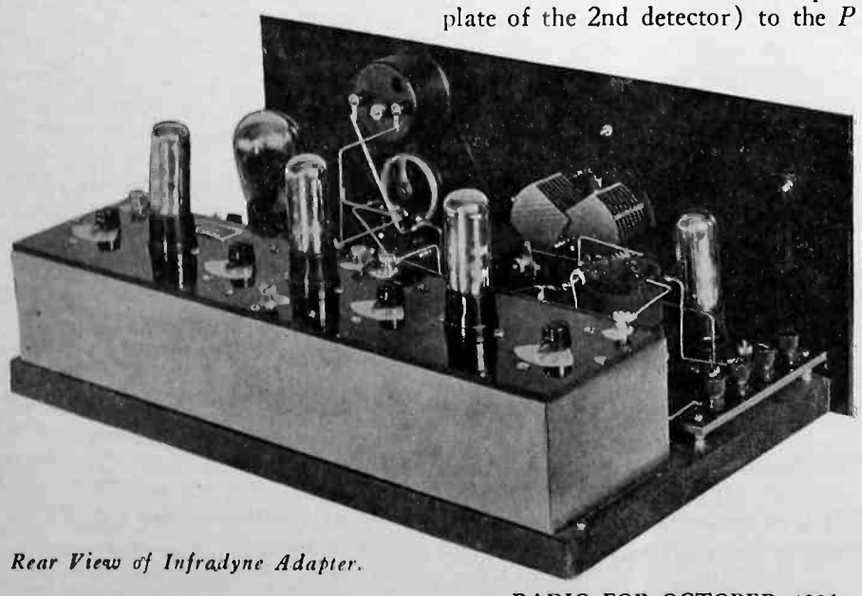


Fig. 1. Circuit Diagram for Infradyne Adapter.

is one), and to add a 30-ohm control rheostat for the first detector tube (if not already installed).

To add the infradyne adapter, connect its input terminal (point *1* of the tapped inductance) to the plate terminal of the detector socket and its output (the plate of the 2nd detector) to the *P* ter-



Rear View of Infradyne Adapter.

shown in the pictures, and installed in a separate cabinet which may be placed near the main set so that the additional dial control of the oscillator can be conveniently operated.

The panel is 7x18x3/16 in. and the baseboard 9x17x3/4 in. The parts used in the pictured unit are 1 Remler No. 700 infradyne amplifier, 1 Remler .0001 mfd. variable condenser, 1 Sangamo .0005 mfd. fixed condenser and 2 meg. leak, 1 bypass condenser (1mfd.), 2 CX type tube sockets, 1 d. c. voltmeter (0-5 volts), 1 rheostat (30 ohms, Frost), 1 ballast resistance (¼ amp.), 1 filament switch, 7 binding posts, and 1 tapped inductance.

The tapped inductance consists of three coils, one 10 turn and two 30 turns of No. 24 d.s.c. wire, all wound in the same direction on a 1⅝ in. diameter formica tube 3 in. long, as shown in Fig. 2. The space between turns is ⅛ in.

All connections should be soldered. If solid solder is used, a non-acid soldering paste is the best flux, using the paste

very sparingly, especially in the vicinity of the tapped inductance. If rosin core solder is used no other flux is necessary. But take care to "sweat" the joint with the hot iron until the solder runs into place, giving the wire a tug to be sure that the solder and not the rosin is holding the wires together. As rosin is a non-conductor and does not ruin insulation rosin-core solder is particularly good if properly used.

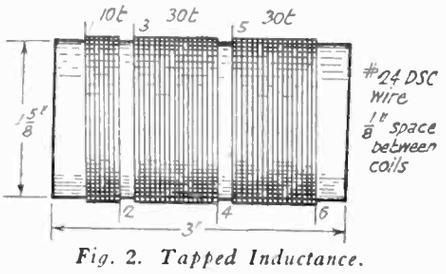


Fig. 2. Tapped Inductance.

Operation

USE "A" tubes in the first four sockets of the tuned radio frequency set and either an "A" tube or a power tube in the last audio stage. In the adapter, use three 99's in the infradyne amplifier, a 99 in the oscillator and an "A" tube in the detector. If the oscillator coil is built with care, and the Remler .0001 mfd. condenser used with the "high minimum" setting (see instructions regarding this in the condenser box), the Remler dial will set at about 48 degrees for 550 meters, and 142 degrees for 200 meters. This is a straight line frequency condenser and therefore the 96 channels used in broadcasting will be evenly distributed over the 94 degree swing of the condenser. This is practically one degree per wave band, which greatly simplifies tuning.

In the infradyne circuit, the oscillator condenser turns in the opposite direction from the tuning condensers. That is, the highest capacity setting is used to get 200 meters and the lowest to get 550 meters. This makes the tuning somewhat confusing if the regular Remler dial is used, and the writer recommends that this dial be replaced with a CCW dial. Also there is no reason why the dial should permanently read from 48 degrees to 142 degrees, and it is better after the limits of the broadcast band have been ascertained to reset the CCW dial so that it is on 0 for 200 meters.

To put the set in operation, the writer recommends making the adjustment on a moderately distant station,—some station that is out of daylight range but that comes in loud at night. The dial settings on the tuned radio frequency set will be in exactly the same places as when that set is used alone, and they can therefore be made in advance if a log sheet is at hand. Put the four indicators on the infradyne amplifier at 0, tune in the station with the dials on the tuned radio frequency set, and then slowly rotate the oscillator dial until the station is heard.

Sometimes the station can be picked up at more than one place on the oscillator if the other dials are not also moved. If this happens, locate all possible oscillator settings and select the loudest one. This will be the infradyne setting. These other oscillator settings are freaks which occur in any set using an oscillating tube, and the only time they appear is during a test of this kind. During normal operation of the set, no station ever appears more than once, unless the broadcast station itself emits a harmonic, in which case of course it will be heard on any set on one-half its fundamental wave length.

After the oscillator setting is determined, adjust the four indicators on the infradyne amplifier for maximum sensitivity, and also adjust the "increase" screw as per the instructions that come with the amplifier. If the set will stand it, a small by-pass condenser, usually not over .0001 mfd., may be used across the first audio transformer. This should not be put in, however, until the receiver and adapter have been tried without it first, as the insertion of this bypass sometimes causes troublesome oscillations.

This infradyne adapter makes a big improvement in a 5-tube set and true infradyne results can be expected. It is particularly good with sets of the single dial variety, as the resulting receiver is then only a two dial set and is easy to operate.

Increasing the Selectivity

AS WE have reports of a few cases of insufficient selectivity with sets that were built in accordance with the directions given in August RADIO, a few suggestions may be helpful in getting the fine results of which this set is capable. In every case the trouble is due to failure to properly line up the circuits tuned by the triple variable condenser.

This difficulty can be remedied very easily by mounting two vernier condensers on the panel, one on each side of the main antenna tuning dial at the level of the vernier tuning knob. We have found the extremely low minimum capacity of the General Radio No. 368A admirably adapts it for this purpose.

After these have been mounted, remove the tubes from the infradyne amplifier, the oscillator, and the second detector sockets. Then disconnect the wire from the plate terminal of the first detector socket and from it run a jumper to the plate terminal of the second detector socket. The set will now operate as a five tube tuned radio frequency, single dial control receiver, and this can be adjusted without having to bother with the infradyne amplifier at the same time.

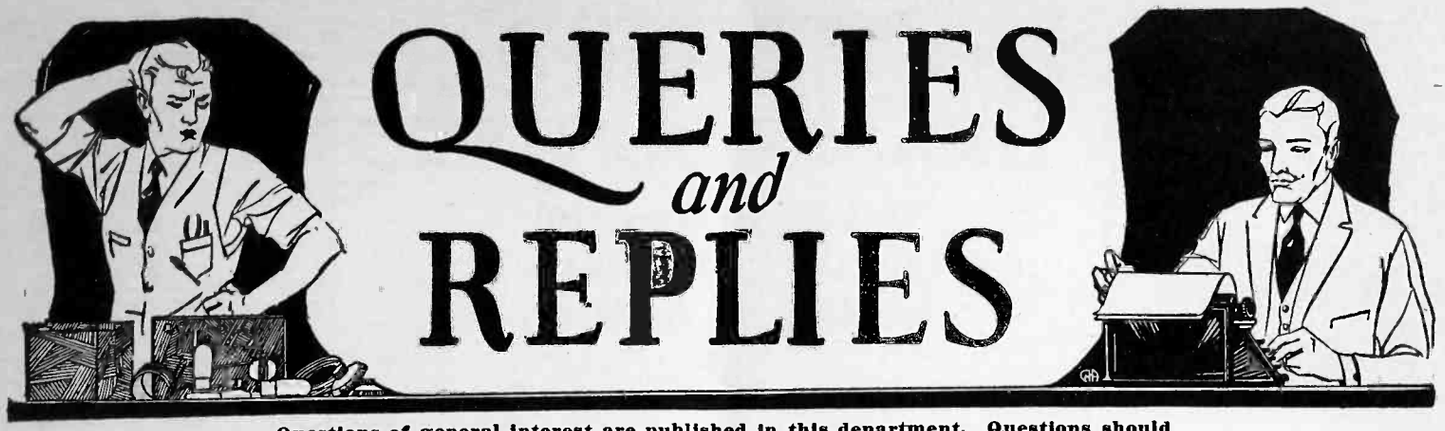
With the set connected in this way and the shield plates of the condenser set half way between sections, tune in a local station between 400 and 500 meters if such a local station exists. If not, take the nearest powerful station in this band. The Continental condenser is so constructed that the rotor sections are held in place with set screws, and loosening these will permit each rotor separately to be swung to any desired angle with respect to the others. With the set turned on and the station tuned in, loosen the set screw on the rear rotor section, and with the main rotor shaft held stationary slowly rotate this rear section until the point is found where the signal comes in the loudest. Fasten it there. Do the same with the center section, and fasten that in its new position. The antenna section need not be changed, as that section determines the received wavelength anyway, and is therefore already in its right place. As the three sections are thus brought into alignment, the amplifier will be thrown into oscillation, and the rheostat will have to be backed down to control it.

Notice now the relative positions of the three rotor sections. Those two that are farthest enmeshed with the stators are the ones that need the two trimmers (variable verniers). If the three are practically in line with one another, then the rear and center sections are the ones that need the verniers. Now connect them across the two sections where they belong and set each trimmer at one-half its maximum capacity. Then tune the station in again, and when it is tuned on dead center, once more adjust the rotors by the set screw method. This is the final adjustment, and if the set is thus lined up between 400 and 500 meters the trimmers will handle it all over the dial. Log a few local stations on different parts of the dial as these settings will come in handy when getting the rest of the set lined up, and then cut back to the infradyne hookup.

The infradyne equipped with trimmers as above is a far more selective set than the one originally described, and a larger antenna can be used with it. In fact, 50 ft. or more with a .0001 mfd. series condenser will give the best all around results. The ability of the set to handle this enlarged pickup will result in more DX and in more powerful signals from the stations within 1000 miles radius. In fact, this arrangement comes mighty close to the ideal in a radio receiver because it can be used with a large antenna which will pound through the energy from even a very weak station, and the selectivity is still great enough to cut through the local stations.

Drilling dimensions for the General Radio No. 368 A verniers are as follows. Distance down from the top of the panel, 5-5/16 in., distance of first hole from left hand edge of panel 6-3/16 in., distance between the two trimmers 5-9/16 in., size of hole for mounting trimmer condenser, 3/8 in.

(Continued on Page 76)



Questions of general interest are published in this department. Questions should be brief, typewritten, or in ink, written on one side of the paper, and should state whether the answer is to be published or personally acknowledged. Where personal answer is desired, a fee of 25c per question, including diagrams, should be sent. If questions require special work, or diagrams, particularly those of factory-built receivers, an extra charge will be made, and correspondents will be notified of the amount of this charge before answer is made.

Have several small motors which operate on direct current. Could the Raytheon tube be used for rectifying purposes, to furnish ½ ampere at 110 volts. Can you give me a circuit embodying a rectifying device which would be efficient and not require too much attention?—A. W. O., Edmonds, Wash.

The current output of the Raytheon, Type B, is 60 milliamperes at 180 volts. The new type BH will give 85 milliamperes at about 200 volts, but this would be entirely too small an amount to operate even a toy motor. Two 5-ampere tungar bulbs in a full-wave rectifier circuit, with transformer voltages of 120 per bulb, and the proper current limiting resistances would probably operate your motor satisfactorily, although a filter would be advisable. This sort of a device would be expensive, and would cost more than a new a.c. motor.

Please publish a circuit using a voltmeter and plate milliammeter, for checking the filament activity of 199 and 201-A tubes.—R. A. F., Passaic, N. J.

Complete details for a simple tube tester were given in an article by E. E. Griffin in March 1926 RADIO. If a copy of this issue is not available, the circuit will be sent on request.

In a past issue of RADIO, I note a statement that the amplification obtainable with a Browning-Drake transformer is 9 to 1. In order that I may compare this figure with the amplification of the intermediate amplifier in a superheterodyne, please publish a representative figure for the latter.—A. A. P., San Francisco, Calif.

The voltage amplification obtainable with an intermediate transformer depends on its construction, its peak frequency and whether or not it has an iron core. The average iron core intermediate gives a voltage amplification of approximately 5 to 1, and the air core intermediate from 3 to 1 up to 4½ to 1. This is the actual voltage step-up of the transformer, and not the transformer step-up times the amplification constant of the tube.

I have several .25 megohm grid leaks of the impregnated paper type which I desire to use in a B eliminator circuit to cut down the voltage. How much current will they carry without heating?—G. D. S., Washington C. H., Ohio.

It would be unsafe to pass more than 2 milliamperes at 100 volts through this type of leak. In other words, it will dissipate .2 watts of power without danger of burning out, but if more power is to be dissipated, grid leaks of the heavy duty type should be used. Metallized filament or other metallic resistor grid leaks will dissipate 1 watt without injury, and heavy duty metallic leaks which will dissipate 2½ or more watts are now available. Multiply the current passing through the resistance by the voltage drop across the resistance, and you have the value of power in watts which is being dissipated in the form of heat, by the resistance.

Have built a Best superheterodyne after directions in January 1925 RADIO. Use 8 dry cell tubes with 6 volt storage battery and control filament voltage with a 17 ohm rheostat. When I turn up the rheostat so that the filament voltage is 3 volts and then adjust the volume rheostat, the set stops at a certain point and no signal can be heard. The midget feedback condenser does not work. Please let me know how I can cure the trouble.—A. J. K., New York, N. Y.

Apparently the intermediate amplifier breaks into oscillation when filament voltage is normal. Have the intermediate and filter transformer tested to make sure that they are peaked at the proper frequency. Make sure that there is 2 mfd. by-pass condenser across the 45 volt B battery connection to the intermediate amplifier. If the feed-back condenser in the loop circuit does not work, the first detector tube may be low in plate current and consequently will not be a good regenerator. The condenser may also be too small in maximum capacity. Have the condenser tested to make sure that it is not leaky. If the insulation is not good direct current will flow through the condenser and prevent regeneration.

I would like to build the regenerative reflex receiver described in October 1924 RADIO. Can I use enameled or cotton covered wire instead of the silk covered wire specified?—H. M., Stanford University, California.

You can use the cotton covered or enameled wire without changes in the coil construction. If enameled wire is used, it would be a good idea to employ space winding, in which the wire is wound on the coil form in such a manner that there is a 100th of an inch air space between the turns. This makes a very efficient coil having low resistance. It is a good idea to place the coil form in a lathe and cut a spiral groove of about 20 to the inch so that the wire can be wound on the form easily.

I have a number of old Myers choke coils which I believe would be useful in an impedance coupled amplifier. Please publish the values of both the audio and radio frequency choke coils of this type. Can the radio choke coils be used where radio frequency chokes are specified in present day circuits. How many stages of impedance coupled amplification are proper for best results in the average broadcast receiver.—C. M. B., Lincoln, Neb.

The Myers audio choke coils which we have on hand measure about 10 henries inductance. The radio frequency choke coil averages 10 millihenries or more and can be used as a radio frequency choke in any of the receiver circuits. The customary number of impedance coupled stages is three, this number being equivalent to two stages of transformer coupled amplification.

I have an old-style three-tube regenerative set, with variometer in the plate circuit. Could this set be re-wired to incorporate improvements, including a stage of r. f. amplification, without changing the panel apparatus?—T. L., Eureka, Calif.

The simplest method of re-arranging your present set would be to use the diagram shown in Fig. 1, making the variometer serve as a plate reactance in the plate circuit of the r. f. amplifier tube, and impedance coupling this tube to the detector circuit through a blocking condenser and 2 megohm grid leak. While the condensers in your old set are larger than need be to cover the broadcast band, they will undoubtedly serve the purpose. If .0005 mfd. condensers are available, it would be better to use them, as the minimum wavelength will probably be considerably lower than with the .001 mfd. condensers.

(*Continued on Page* 48)

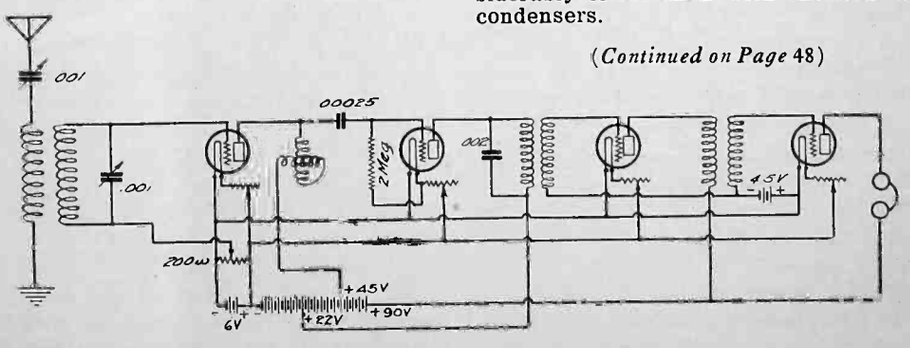
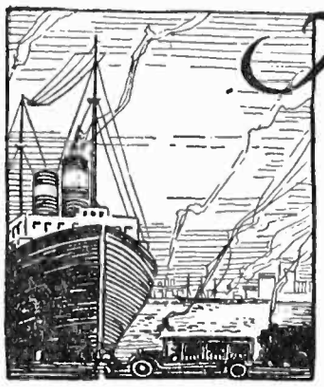
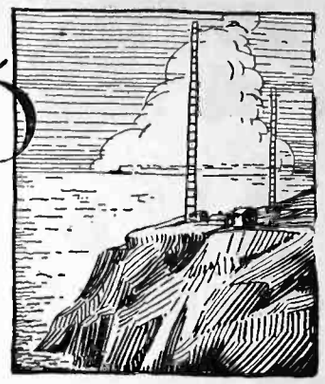


Fig. 1. Circuit for Tuned Plate Receiver.



The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



Edited by P. S. LUCAS

R. O. KOCH, *Great Lakes Correspondent* C. W. RADOS, *Boston Correspondent*

THE R. O. P. A.

Perhaps one of the uppermost questions on the minds of the commercial men today is: "Is this new organization I am hearing about really going to amount to something, or is it just another attempt to put over the impossible" Well, frankly, time, alone, will tell. Now don't mistake us; Time will *tell,* not decide. The success of this thing; the success of anything, in fact, depends upon the full-fledged cooperation of every man, woman or beast involved. And it is our opinion that every man, woman or beast who holds a commercial operator's license *is* involved in this effort that is being made to better the conditions of the radio operating profession.

Now, we have had a rather difficult task in deciding just what stand the Commercial Brasspounder should take in this matter. There will be some operators who are constitutionally opposed to unions of any sort; lots of them, and with reason, no doubt, while some will like the idea but will have reservations. Another thing to consider is that the R.O.P.A. is to have its own organ, namely, *The Lightning Jerker,* through which the members of the organization will be represented. Therefore it seemed wise for the Commercial Brasspounder to take an absolutely unbiased stand in the matter, and open its columns to all comers. In that way we may be of some value to the gang as a whole, for we may be able to iron out some wrinkles which are likely to stand in the way of the success of this organization. It has been, and it will continue to be our desire to bring the operators together so that, through united effort, they may better their profession.

We started out to give you the "low down" on the Radio Operators' Protective Association, so here goes, in brief. It was organized in May, 1926, incorporated under the laws of the state of New York, and privileged to operate in any state of the United States or its territories. The organizer and first president is Mr. Farra Merryman, well known in the East and around the Great Lakes as a brasspounder of over nine years' experience. Judging by the letters we have received from Mr. Merryman and those who know him, and by the constitution and by-laws that he and his committee have prepared, we feel that he is a man most thoroughly fitted for the task he has set out to accomplish. He is not a radical "Labor vs. Capital" man, or "Soapbox Jawsmith" or anything of that sort, but one who, realizing that the radio operating profession is not what it should be, has started a movement to bring it into its proper sphere. And he has gone about this task with thought and consideration, trying to see the situation from all angles. Now let us quote the preamble of the constitution:

"We, the commercial licensed radio operators of the United States of America, realizing that we are workers in a profession so new to industry as to not have, as yet, been properly classified, believe that, by forming an association, we can further the interests of both ourselves and our employers.

"Although the primary motive for forming this 'Association' was to protect the individual (and his rights as a worker and a citizen of this, our country), we wish to have both our members and our employers interpret the word 'Protective' in its broader sense and recognize that the 'Association' will adopt a progressive and constructive plan of operation and that it will exert every influence to avoid the calling of strikes.

"To facilitate this we will establish our own system of examining our members and so segregate and classify them that each member will be rated according to his ability. By thus classifying and segregating our personnel we hope to attract an ambitious and progressive type of operator. Our members will stay in the profession because of the long lists of promotions that will be open to all who will fit themselves for them.

"With these principles in mind we have formed the "Radio Operators' Protective Association of America," and written the following laws for its guidance."

It can be seen from this bit of literature that the Association has certain ideals to uphold, and that the benefits to the profession are not to appear only in the form of demands. The fact of the matter seems to be that the main difficulty today lies in the operating personnel itself. If every man who pounds brass were as competent from all angles as some we know, we feel sure that the desired recognition would soon be forthcoming. Such is not the case, however, and the trouble probably lies in the fact that, in the eyes of the government and the shipping companies, a license is a license, and a man flashing same before the eyes of a prospective employer should be able to competently handle any apparatus covered by it. True, he should, but oft-times isn't.

Now, the ideals of the R.O.P.A. might be summed up under four general heads:

First: A system of grading and classifying operators according to their specialty, their experience and their ability.

Second: To obtain a separate wage for each class of license so that a man's earning capacity will increase in direct ratio to his knowledge and his ability.

Third: To obtain government recognition of its ideas.

Fourth: To act as an employment agency and as a school for its members.

There are some mighty fine points brought out in these ideals which ought to be considered more at length, but due to the lack of space we cannot go into it as fully as we should like at this time. This isn't a thing to jump into without grave thought and contemplation. Every member has a say as to how it is to be run; therefore, as we have said before, its success or failure lies in the hands of the gang as a whole.

We see great possibilities in the R. O. P. A., although it is bound to run into some rough seas enroute; and we again invite you to discuss it, pro and con, criticize it, constructively, we hope, and offer any suggestion you may feel will help it, through these columns. It's up to us; so let's boost.

INTERCOASTAL AND EUROPEAN SKEDS

By KARL E. ZINT, KDNS

UR, Cartago, Costa Rica—Compania Radiografica Internacional de Costa Rica. Tube CW. Ship skeds on 600 meters: 8:30 A.M., 10:30 A.M., 2 P.M., 4:30 P.M., 6:15 P.M. 90th. Mer. Time. After 600 meter sked he QSYs 2200 and listens for ships on 2100 and 2400.

WNU, New Orleans, La.—T. R. T. Company. 3331 meters, CW. QST wx and tfk to ships at 11:30 A.M., and 11:30 P.M. EST. Right after these skeds he sends paid px to KUS on same wave.

WAX, Miami Beach, Florida—T. R. T. Company. 500 cycle tube on 2100 and 600 meters. Listens for 2100 meter ships last 15 minutes each hour, transmitting on 2175. 600 meters the rest of the time. Sends paid px to KUS at 6:30 A.M. EST, on 5551 meters CW.

WRQ. Sends px at 12:18 A.M. EST on 13,500 meters, CW, and usually continues for about 2 hours.

VQH, Santa Lucia, British West Indies—2400 meters first ten minutes each hour from 6 A.M. to 6 P.M. QSYs 600 meters for the remaining time between those hours. QSJ: Coast station, 10c; cable to California, 39c. Accounts settled by Colonial Treasury, Santa Lucia.

VAS, Louisburg, Nova Scotia. Sends px at 4 A.M. EST on 1300 meters, CW. Clears tfk on 600 and 2100 tube. QSJ: Coast station, 10c; LL to California, 11c. Marconi W. T. Co., of Canada, Ltd.

6FA, London Air Ministry—Sends Wx for the British Isles and Vicinity at 3 P.M., EST.

GBL—Px on automatic at 8 A.M., 8 P.M. and Midnight, GMT, on about 7500 meters CW. (Sometimes the auto is so fast it is impossible to copy it, but ordinarily it runs between 25 and 38 W.P.M.)

POZ, Nauen, Germany—Very condensed px dispatch in English. About 18,000 CW, at 6:15 A.M., EST.

For the benefit of those interested in the big league baseball scores, G. R. Anderson, of the *SS. T. J. Williams,* writes in that KDKA broadcasts the results at 6:15 P.M., 75th. meridian time, on 67 meters. The runs, hits, errors and pitchers are given. The runs are given again at 10 P.M., following time and weather reports.

SKEDS USED ON SAN FRANCISCO-PANAMA RUN

By R. D. RICHARDSON, M .S.
"City of Panama," RXZ.

The following is a list of Px, time, Wx and Tfc skeds which we use on the S. F.-Panama run and would also be useful on the S.F.-N.Y. run. All skeds given are for125th meridian or P.S.T.

KPH Px to QST and WWAA (carries about 1500 miles south) at 12:15 a.m. to 1:00 a.m. NPL or NBA Px to QST starts at 2:00 a.m.

The only time signal not already mentioned in these columns is from XDA, Mexico City, on 2800 CW which comes through at 11:00 a.m.

NBA can be heard as far as Mexico, coming north, with a time signal at 10:00 a.m., and NPG can be heard at noon and 10:00 p.m. a few days out from S.F. going south but does not carry as far as NBA.

KPH Wx at 12:15 and 8:15 p.m. can be copied after leaving Mazatlan when coming north but QRM is bad as some fellows don't seem to know about this sked and will even call KPH while he is QRW QST on 675.

WNU is QRK anywhere on the coast as per skeds in August "RADIO."

XDA sends Wx for Mexican Coast immediately following the time sig. By the way, if you have traffic for a Mexican station the only sure time of getting it through is right after XDA finishes Wx on 2800. There are four stations that can be picked up about one day apart in the following order going south:

XAF, La Paz, Lower Calif.; XAE, Mazatlan, Sinaloa, Mexico; XAK, Acapulco, Mexico; XAN, Salina Cruz, Mexico. They all repeat XDA Wx on 600 spark and then call "CQ QTC?" Don't wait too long after they sign to call. They don't exactly stand a continuous watch.

SDA is next in order and is located at San Salvador. He works on 600 spark and can be worked two or three hundred miles depending upon QRN. His first CQ is supposed to be at 4:00 a.m. and every hour thereafter up to 8:00 p.m., but is usually about every two or three hours and as a rule he is ten or fifteen minutes late. There is no use calling him until after he CQ's as he does not stand continuous watch.

LVA is located at Guatemala City but does not work ships at present.

Next come the Tropical Radio Tel. Co. stations in Central America. These are good stations and will handle your traffic like KPH himself.

UL, Managua, Nicaragua, 600 ICW calls CQ and listens 600; after 600 is clear calls CQ on 2200 CW, then listens 2400. Skeds: 6:00, 9:00, 11:30 a.m.; 3:00 p.m.

UG, Tegucigalpa, Spanish Honduras: 7:15 a.m. on 4330 CW "CQ," listens 600. 8:00 a.m. CQ on 975 CW and 600 ICW, listens 600; 9:15 a.m. 4330 CW and 600 ICW CQ and listens 600; 2:00, 6:00 and 8:00 p.m., CQ on 975 CW and 600 ICW, listens 600.

UC, Tela, Spanish Honduras: Calls CQ and listens 2400 CW at 7:15, 8:00, 9:00 and 10:30 a.m.; 12:15, 1:30, 2:50, 4:00, 6:30 and 7:30 p.m.

UA, Castilla, Spanish Honduras: Calls CQ and listens 600, works 775 CW at 5:15, 7:00, 8:15, 10:30 and 11:15 a.m.; 1:00, 2:15, 4:40 and 7:45 p.m.

UR, San Jose, Costa Rica: Calls CQ 600 ICW and works on 765; then CQ's on 2200 at 6:30 and 8:00 a.m.; noon; 2:40 and 3:15 p.m.

US, Swan Island, 600 Spark only: Continuous watch from 4:15 a.m. to 5:30 p.m. daily. Listens last fifteen minutes of each hour for CW ships on 600.

Approaching the Panama Canal, NNT, NBA and NAX all work ships on 600 CW which is much superior to the old spark but even so I have never heard anyone work NNT over 150 miles daylight on 600 on account of dead spots right there.

RADIO IN FOREST PRESERVATION

By W. G. D. ALLEN

The popularity attending broadcasts of speech and music has eclipsed, in the public eye, many of the less ostentatious, but none the less useful fields of radio communication. In the air, on ships at sea, at stations on desolate, rock-bound coasts, beneath the sweltering sun of the tropics, and isolated in the ice-bound regions of the far north are devoted men, sacrificing most of the luxuries of life, to the ever increasing need of modern civilization—communication.

Let us take a dip into the life of the aircraft operator. High over the snow-capped, rugged peaks of the Rockies the Forest Patrol airplane steadily drones its way northward. The altimeter shows an elevation of 17,000 feet, and at that altitude the air is thin, and the bitterly cold 100-mile-an-hour wind rushing past cuts like a knife. The radio man huddled in the rear cockpit wipes his cracked and bleeding lips as his keen eyes scan every mile of the wooded slopes and valleys for the faint haze that may mean the start of that all devouring monster, a forest fire.

Small hope if engine trouble were to develop here! The warm air currents rising from the valley cause the 'plane to buck and pitch like a small boat in a rough sea, whilst every few seconds, encountering an air pocket, it drops with a sickening bump that threatens to tear the wings from the body, and lifts the observer half out of the machine.

From time to time the operator closes a switch and sends back to the listening radio man at the aerodrome, some 150 miles away, their position and any information of interest. Suddenly, the airman's roving eye detects a smudge rising from a valley to the west. A word through the speaking tube to the pilot, and the 'plane, banking steeply over to the left, has turned with a speed that causes the aerial dangling beneath to writhe like a giant whip-lash.

Circling over the smoke they descend, to find it arising from a healthy young bush fire, as yet not extensive, but with every prospect of becoming so if ignored. The radio man notes the details of surrounding country, fixes the location on the map, throws his switch and imperatively calls the ground station.

The operator on duty at the receiving station instinctively stiffens, and twirls his dials skillfully in an endeavor to bring to maximum intensity the faint fluctuating whistle emanating from the 'plane hovering over the fire in that distant valley. Swiftly his pencil moves over the pad as he copies the location followed by full details of the fire. He checks the accuracy of his copy as the message is repeated then reaching to the telephone puts in a priority call to the Forestry office in Calgary, some 40 miles distant.

A glance at a map suspended on the wall tells the Forestry man on duty the nearest ranger sation to the fire, and within 14 minutes from discovery a fire-fighting party is preparing to make its way to the scene. Thus does ubiquitous radio play its part in the preservation of our timber lands.

SDT—THE S.S. BOREN

Doubtless many of you have been hearing SDT around the Pacific Coast during the past few years and have wondered what it was doing over in these waters so much of the time. Well, the fact of the matter is that the *Boren* very seldom puts in at her home port in Sweden, but regularly runs between California and Australia and the Philippines. We have a letter from Thornton Gedda, the operator of SDT, which we thought would be interesting, as it tells something of the problems which confront the Swedish operator.

Mr. Gedda tells us that the *Boren,* which belongs to the Swedish Transatlantic Company of Gothenburg, carries a 2 k.w. Telefunken Spark, supplied by a separate generator driven by a steam turbine. An auxiliary outfit consisting of a ½ k.w. spark is also carried. This is supplied by batteries.

The receiving set is a Kennedy Universal with a two-step amplifier, and the station is equipped with a bug and a break-in relay. (Tie that, you American ships).

One interesting phase of the operating game in Sweden is the so-called mate-operator. Mr. Gedda tells us that there are a lot of these officers in his own company, and that it is the dream of every owner to eventually eliminate the full-time operator. Not so good; and the owners are certain to realize that fact one of these days, much to their sorrow.

WHO'S WHO AND WHERE

Leo Shapiro, *S.S. La Brea,* is back from a trip to Hamburg. A good time was had by all, says he.

Bill Ferguson, ex-*S.S. Coalinga,* is now holding down the *Warwick.* Johnson got homesick and is on his way east after nearly three years on the *Santa Maria* and *Warwick.*

L. E. Windser, second trick, and Ben Springer, third trick, KOK, have just returned from enjoyable vacations. J. B. Delaney, ex-KURC, did the relief honors.

A. R. Foran, *S.S. La Puprisima,* was relieved by Bruce Piersol, ex KMTR. Watch the modulation on that arc, OM.

Francis E. Beaulieu brought the *Point Sur* around from New Orleans and liked Los Angeles so well he thought he would stay out of that port. He is now on the Santa Maria enroute to Buenos Aires, via Cape Horn.

George D. Fell off the *Olinda,* (N.B. Put a comma after Fell.) thence *Admiral Dewey,* has taken the *Coalinga* to South America vice Bill Young who says he wants some more schooling at Whittier.

Arthur S. Gunther relieved Fell on the *Admiral Dewey.*

H. D. Watson wants to practice his Spanish so he is going to Ensenada for his vacation.

F. A. Yarbrough, assistant manager of the F. T. Co., Los Angeles, drove 3,500 miles, invading the wilds of Vancouver—and returning intact.

Operators who are looking for a speedy run to the Hawaiian Islands and back had better keep a weather eye out for the *S.S. Malolo,* now being built for the Matson Navigation Company. Cutting the swells at the rate of 25 miles an hour, she is designed to make the round trip from S. F. to Honolulu in eight days, and that's making knots. The *Malolo* is now being built in the East and is expected to be completed in the spring of 1927, costing the trifling sum of $6,500,000. With her 22,000 ton displacement, her 582 ft. length and her 83 ft. beam, she will be one of the finest passenger vessels on the Pacific. We haven't been able to get the details of the radio shack as yet, but have learned that she will carry as part of her lifeboat equipment two 30 ft. steel motorboats fitted out with the most up-to-date radio transmitting and receiving sets. This apparatus will consist of a ½ k.w. transmitter for 600 meters and a receiver with a range of 200 to 4000 meters. A 1 k.w. generator will charge the batteries.

An Amateur's Mercury Arc Rectifier

By Don. C. Wallace

THE mercury arc rectifier at 9ZT-9XAX has proven to be the cheapest, simplest, and most satisfactory means for supplying plate current for one or more 50 watt tubes. Its slight drop of 14 volts is negligible in the 1000 to 3000 volts used on amateur sets. It causes no sparking or mechanical noise and it starts and stops more quickly than a motor. Its output is completely rectified and easily filtered to any desired degree. In this latter connection many station operators prefer a certain amount of a.c. in the note which is thus easier to copy and more distinctive.

The rectifier tube itself may often be bought second hand from some old series arc lamp system or a new tube may be ordered from any General Electric jobber at a cost of not more than $35. It operates efficiently at any voltage from 500 to 5000.

The tube is immersed in oil such as used in a Ford crankshaft, the oil being held in a 5-gallon can mounted in a wooden framework and cradle as shown in Fig. 1. If it is more convenient to have it several feet from the operating table the cradle can be rocked by a rod as shown.

The circuit, as shown in Fig. 2, is designed so that the keying may be done in the primary of the plate transformer, thus obviating any load on the transmitting tubes or filter circuits when the key is up. Ordinary keying in other parts of the circuit will cause excessive load somewhere with possible breakdown. Many sets are run below what would otherwise be a safe load just so as to prevent this possibility. The key can be held down indefinitely without any change in plate, grid, or antenna current.

It happens, however, that in keying any set of even moderate power, a line flicker generally occurs. This is an actual drop in line voltage, with resultant drop of voltage at the filament terminals of the transmitting tube. Actual tests will show that a 1-volt filament variation in some sets will change the emitted wave ½ or ¾ meter. If the variation is as much as 1/10 of a volt the wave change will be noticeable. The receiving operator cannot change the wavelength of his receiving set for each dot and dash. Consequently he will state that the note is chirpy, or the note is ragged, or he will simply say nothing, little realizing that the note he listens to could be made about three times as beautiful, cut through interference easily, and be copied at twice its present speed, by simply steadying the filament.

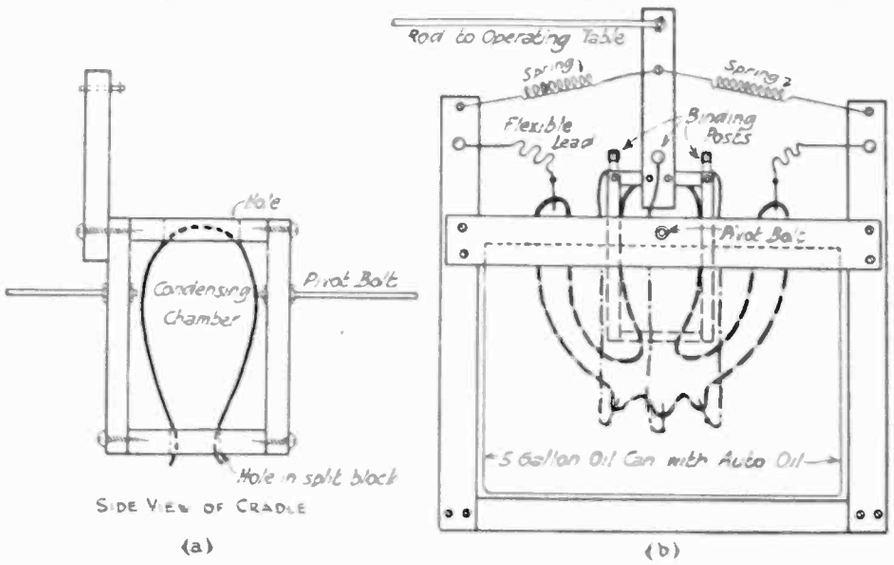


Fig. 1. A Simple Mercury Arc Shaker.

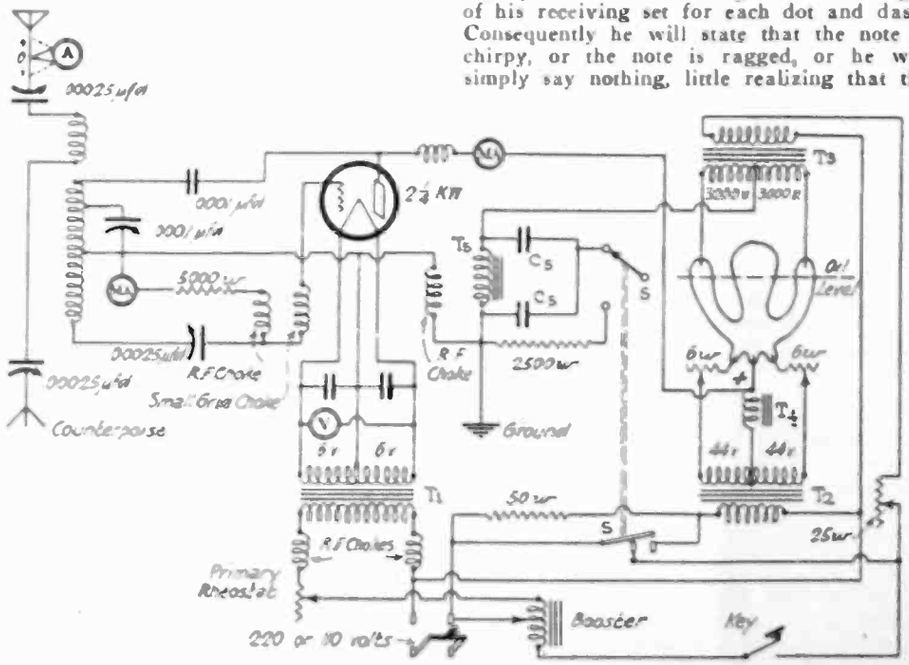


Fig. 2. Circuit Diagram for High Power Mercury Arc Transmitter.

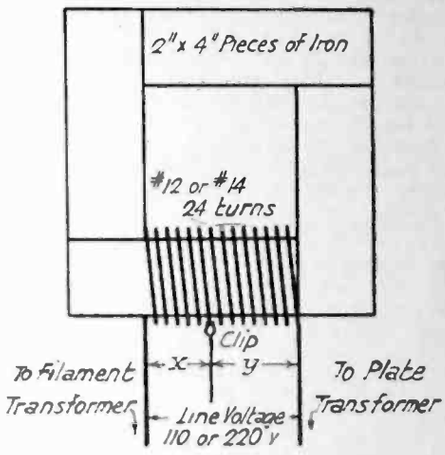


Fig. 3. Filament Line Booster for Steadiness.

The filament "steadier" shown in Fig. 3 can be made from any old iron such as stove pipe iron, or old transformer core iron. The exact size of the core is immaterial. The arrangement as shown is satisfactory and consists of about 24 turns of double cotton covered No. 12 or 14 wire wound over one leg of the core. Half of this winding is tapped at every turn, and the whole may be bunched up, or be wound in a single layer; 24 turns is so easy to wind that the wire may be slipped in and around the core if the core is already together.

The plate current in passing through the portion of the winding marked *y* induces lines of force in the iron core, which build up the current and voltage in the portion of the winding marked *x*. As the full filament current is already on, this added fraction of a volt makes up for the drop in line voltage occasioned by the drain due to increased plate transformer load. By simply moving the clip, and trying out the different taps, a point will be found where the filament voltage is exactly the same whether the key is up or down, regardless of how fast or how slowly it may be keyed. If there are not enough taps, the connections *F* and *P* may be reversed, bringing the taps on the other half of the winding.

This filament booster is simple, effective, keeps the filaments steady and is a contributing factor in the steadiness of the note. Any attachment on the key slows down sending and spoils the "fist" and we feel certain that this simple and effective booster will be welcomed by all who have the least drop in filament voltage while they send, regardless of whether they use a mercury arc rectifier tube.

The booster is shown in Fig. 2 completely wired. The "keep alive" circuit was suggested by 10A and draws less than 200 watts when the key is up. Compare this to a motor generator running idle, or the filaments of kenotrons, or the terrific consumption of chemical rectifiers and it will at once be seen that this is one of the most economical plate supplies ever used in an amateur station. We have already shown that the mercury arc itself with the key depressed was practically 100% efficient, and with the low "keep alive" consumption the overall efficiency immediately jumps so that it is much greater than a motor generator, chemical rectifier, an high power kenetron, or filtered sync rectifier. The keep-alive circuit

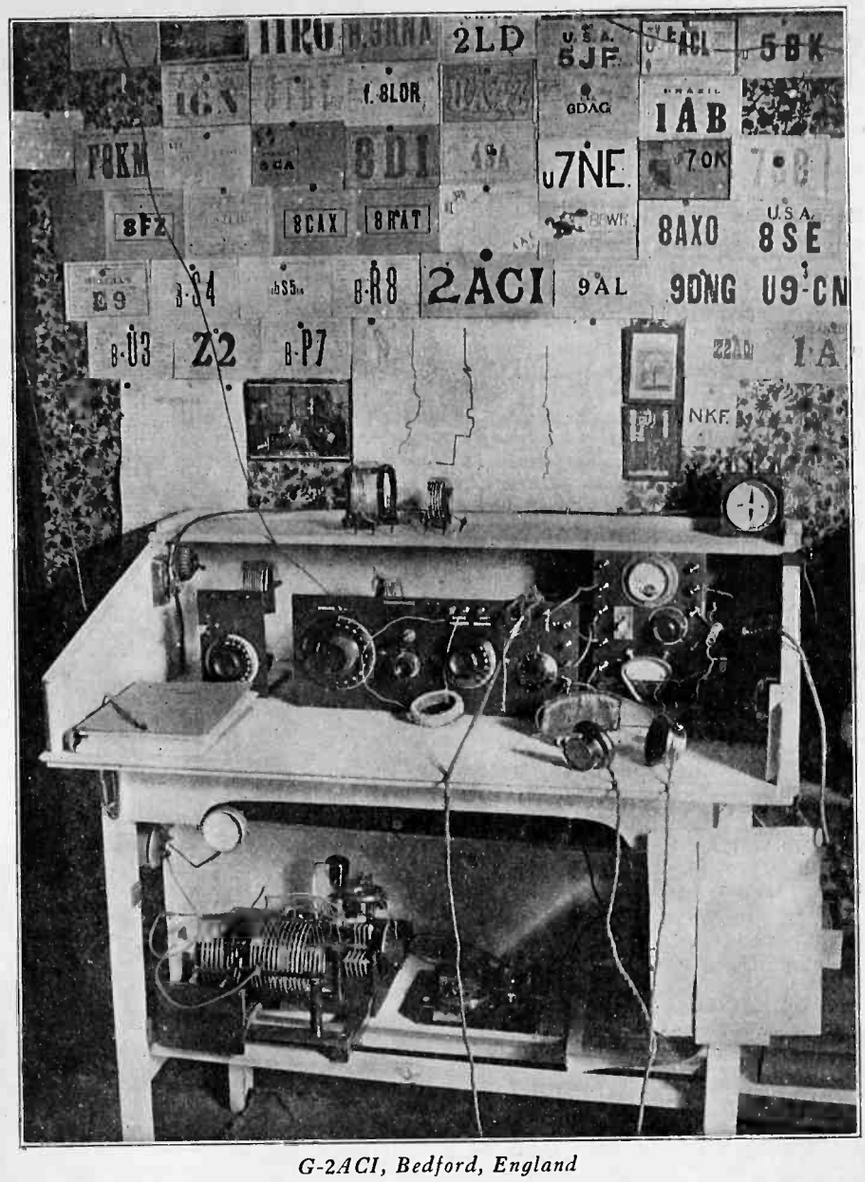
has one tapped transformer and one choke T_4, which consists of the primary winding on a filament transformer pulled out of the junk pile. The 6 or 10 ohm rheostats enable the settings on the keepalive circuit to be kept as low as possible, reducing heating around the starting electrodes. The starting electrodes, incidentally serve as a complete rectifier in this case. Transformer T_4 may consist of two large bell ringing transformers, or an old pole line transformer run backwards. The latter is used here because of the greater insulation between primary and secondary, necessary in the case of high voltage, as this keepalive circuit is all on the positive side of the high voltage plate supply once the key is depressed.

By using a plate transformer, mid-tapped, with a little more than the necessary voltage, control of power, required by the radio law, and convenient for most purposes, is secured by the use of an old Ward-Leonard motor rheostat. If such is not available, 2 ohms is necessary at the same place to take care of keying surges. The 2 ohms may be made by winding 100 feet of No. 16 iron wire on a broomstick, and then suspending the coil back and forth between some porcelain insulators. The key may be any old spark key, or telegraph key having "dime" contacts. In the diagram all line voltages are shown as 220v. 110v may be used just as well, depending on the design of the transformers.

The switch s s is all one, controlled by a rope on the operating table. The switch itself is a 600 volt DPDT switch, quick action type, with an extra contact placed at z as shown. This switch is shown in the running position. When the switch is lowered, the key is shorted out, the 50 ohm resistance in series with T_2 shorted out, the filter open circuited, and 2500 ohms placed across the output of the mercury arc tube. With this arrangement, the arc may be struck in the minimum amount of time. A spring on s s enables the switch to fly to "run" position the second it is released by the hand of the operator. The arrangement here is such that the left hand controls this switch, while the right hits the shaker rod. This starting switch arrangement is really the reason why the arc is so fast in starting, and so convenient. The starting load all around, including the transmitter, is thus about 4 KW. It just has to start in about 2 seconds with that load. The transmitter is on so the distant operator will know that the set is coming on the air. It doesn't start with the filter. and the keepalive circuit will actually run on a much smaller power than it will start on. A Bradley radiostat, or old heating elements, will do in that circuit. The 2500 ohms, or whatever is used there, may be a lamp bank, or Ward-Leonard resistances to pass ½ to 1 ampere. It is only on a second or two at a time, so most anything will do.

T_5 C_5 C_6 is a "brute force" filter. Any type of filter may be used. If one arm of the tube filters better than the other, or if it doesn't filter, 1OA suggests the use of tin foil on one arm, and a coil of wire on the other. A couple inches of tinfoil and about an inch or two of loosely wound wire on the other arm has always proved satisfactory.

The transmitting circuit may be any of the favorites generally used. The "climb" as well as the "chirp," with resultant difficulties, may be minimized and practically eliminated by the use of very small plate and grid blocking condensers. If these condensers are made small with respect to the balance of the circuit, the heating of the filament, and elements within the tube will have little if any effect on the wave. Generally with condensers as large as .002 mfd. used as stopping condensers, a climb or warble is noted which is quite annoying to the distant receiving operator.



G-2ACI, Bedford, England

G-2ACI, BEDFORD, ENGLAND

Mr. S. Williamson, G-2ACI, 22 Hurst Grove, Bedford, England, has a very well known international station and has made remarkable records with very low power. The complete installation is shown in the picture, the receiver being mounted on the top compartment of the table, with the trans mitter on the bottom shelf. Mr. Williamson says of his set, "The little panel on the left is an absorption type wavemeter, next is the 'DX-Getter' itself, consisting of detector and 1 loud pedal, while to the right is the 'juice' control panel. This consists of a voltmeter and milliammeter and by means of a Dewar switch, the latter can break in on the plate circuit of any valve. Under the table is the transmitter, a coupled Hartley, with ordinary receiving tube, and 18 watts input." The best records made by G-2ACI to date have been 1300 miles per watt, with Australian, South American, and all U. S. Districts in the list. We are wondering how Mr. Williamson manages to operate the transmitter, as the key is apparently located on the bottom shelf alongside the transmitter. Perhaps he has an educated foot.

Glass towel bars make the best cheap antenna insulators it is possible to obtain. An 18 in. bar, with a rim on each end for fastening costs fifteen cents. The aerial wire can be attached by tying it securely, or by making a wood clamp to fasten around the bar below the rim.

QUEEN CITY RADIO CLUB TROPHY CONTEST

The Queen City Radio Club wishes to announce that they are offering a cup for traffic handling in the State of Maine. This cup is to be given to the station, located in the State of Maine, handling the largest number of messages in the three months beginning July 26, and ending October 26, 1926. The object of this contest is to create a greater interest in traffic handling in the State of Maine and to keep up the interest already shown during the summer months.

In regards to the regulations governing this contest. The messages must be genuine traffic which is handled in accordance with the Rules and Regulations of the A.R.R.L. Communications Department which was sent to every Official Relay Station last month. If you didn't receive one of these copies then, write for it!

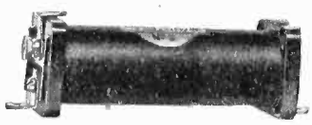
A complete file of all messages should be kept for inspection at the close of the contest. The Judges of this contest shall be the Officers of the Queen City Radio Club.

This cup is a handsome thing and well worth working for. It will make a beautiful addition for some Ham Shack. On a black base it stands over a foot tall. Take it from us OMs, "Dis ain't no germ's bathtub!

Who will be the lucky man to carry off this nice big cup Somebody has got to do some work so let's get going now OMs; brush up on proper message form, etc., and renew those old schedules. Nuf sed, you know the time, the object, the rules, and the prize, so let's all fight for her. Let's go.

FROM THE RADIO MANUFACTURERS

Samson R. F. Chokes, as made in various sizes, are helically wound to minimize self-capacitance. They are used to prevent distortion by keeping radio frequency currents out of the B battery cir-

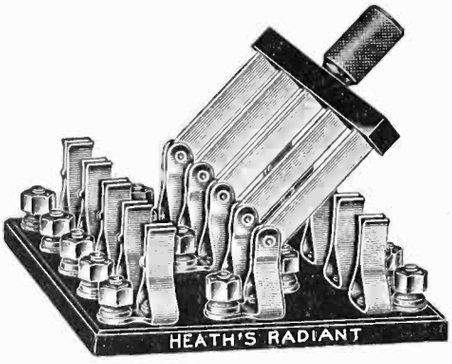


cuit and audio amplifiers. The No. 85 choke has an inductance of 85 millihenries and a distributed capacity of less than 4 micro-microfarads. The No. 125 choke has an inductance of 250 millihenries and a distributed capacity of less than 3 micro-microfarads over the broadcast band. These chokes have no pronounced self-resonant points.

The new Utah "Book" speaker employs an electromagnetic unit whose impulses are applied tangentially to the edge of a curved membrane, thus differing from other speakers whose diaphragms are

moved by a piston-like action at right angles to the surface. The completed speaker looks like a beautiful open book 13x17 in. with hand tinted pages done in sepia, finished in gold and brown morocco. It has excellent tone and good volume.

Heath double throw switches are made in ten sizes, ranging from a single pole, single throw, to five pole, double throw. While these switches are small and beautiful in appearance, they are sturdy,



strong and rigid. The base is of bakelite and all metal parts are nickel plated. Their unique construction gives a positive and lasting contact, easy and smooth in operation.

The Swan-Haverstick lightning arrester is an improved device made almost entirely of bakelite, with a special protecting disk of bakelite to protect the arrester from moisture. It is of the air gap type, with terminals moulded in bakelite, insuring perfect insulation. The ar-

rester has been approved by the Board of Fire Underwriters, and is provided with a handy bracket by which it may be fastened to the side of the house near the antenna lead-in terminal.

The Donle - Bristol B-6 is a super-sensitive vacuum tube designed exclusively for use as a detector. It is not critical as to filament or plate voltage, drawing .25 amp. at 5 volts filament and using from 22½ to 90 volts plate. It is reported that signals otherwise inaudible have been brought in with loudspeaker volume by substituting this tube in the detector socket. There is claimed to be no impairment in quality.

The Apco "A" battery converter is an unusually convenient trickle charger which automatically maintains an A bat-

tery at maximum efficiency. The converter delivers 6 volt direct current when connected to 110 volt alternating current supply.

The Amsco floating socket is a cushioned socket for X base tubes, designed to eliminate microphonic noises

caused by the vibration of tube elements. The inner base, supporting the tube, is connected to the outer shell by means of a set of springs, which absorb mechanical vibration, and prevent mechanical coupling between the tubes and the loud speaker.

The Valley two-bulb charger may be used with either one or two bulbs in charging six-volt batteries. With one bulb it gives a 2½ ampere charging rate,

with two, 5 amperes. It is supplied with cord, plug, ammeter, battery leads and clips, Rectigon bulbs being purchased separately. This charger has no moving parts and requires no attention.

The Fada loud speaker is a new design, with free-floating cone 22 in. in diameter, and arranged either for the radio

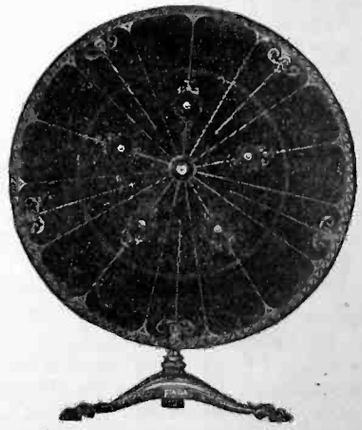
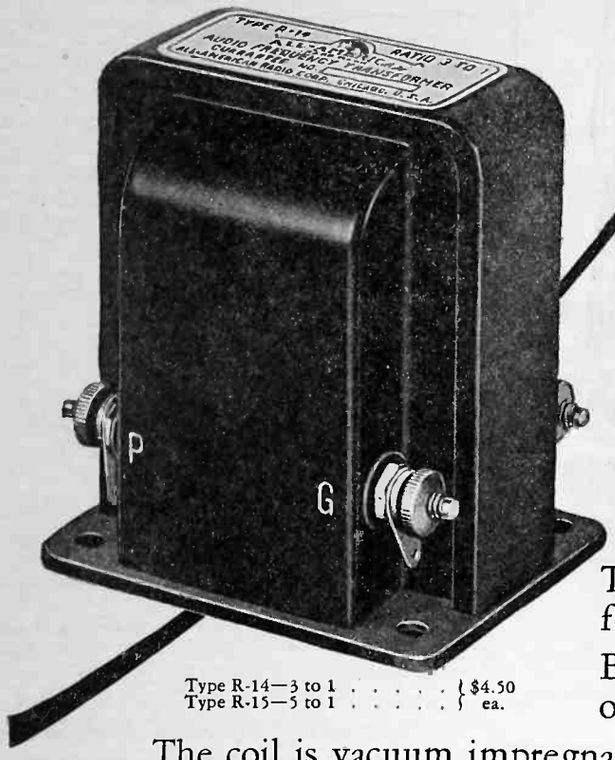


table or with pedestal for floor mounting. It is particularly efficient in reproducing the low notes for which the well designed actuating mechanism and carefully balanced paper cone are in a large part responsible.



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This latest development meets the new demands for compact wiring and longer life—

Binding Posts are conveniently located for straight or sub-panel wiring—

The coil is vacuum impregnated—

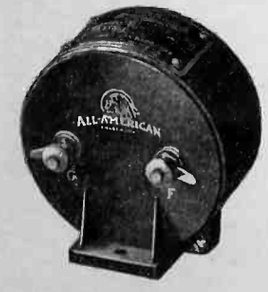
After assembly the shell is filled with special compound and the complete unit hermetically sealed. *A transformer that sets a new standard.*

Tone Quality Is the Keynote

No standards of quality can be higher than those we set for our own products; no inspection is more rigid; no tests more severe.

Each of these All-American Transformers plays its part in determining the quality of radio reception. Each is designed and made with the same care that goes into the finest receiving sets.

These products have helped to create All-American leadership.



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Everybody who enjoys radio should read it—an interesting 48-page analysis of radio in terms anybody can understand; with complete constructional details of the leading types of circuits. Send 10c in coin or stamps for your copy.

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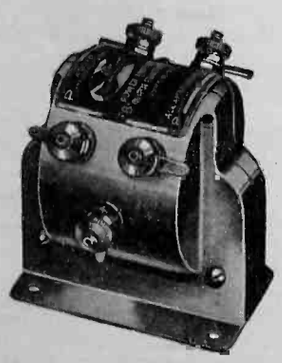

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An audio Transformer, famous for its perfect tone reproduction—an outstanding product. Made with painstaking thoroughness without regard to cost

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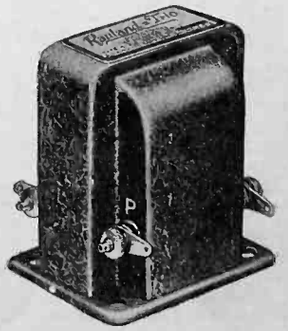
An inductance, a resistance and a capacity perfectly balanced in one shell—a compact factory-built unit for impedance coupled amplification



DOLLARS FROM RADIO INVENTIONS

(*Continued from Page* 18)

insignificant and paltry reward. Yet I have met some of these men who are far above such commiseration; their characters are too lofty to grieve over a deluge of dollars that are not theirs; they live for and in their work, considering all reward mean as compared to the joy of carrying on in that magnificent army whose banner is a sun-like torch. How many have read with amazement and a feeling of shamed sympathy and respect for a truly noble spirit that the late Chas. P. Steinmetz labored for virtually no worldly reward other than the provision of the plain necessities of life and of apparatus for his work, and was prevented from crossing the Atlantic to render up his abilities upon similar terms to the Russian Republic only by his death.

The salaries paid radio research engineers in corporation laboratories vary a good deal. About the lowest amount paid to a man recognized as an engineer is $3600 a year; the highest around $15,000 or $18,000. The requirements for such a position are: first, inborn ability of the right kind; second, a college education, or its equivalent, with special technical training; third enough aggressiveness or downright belligerence to go and get a job in or near a laboratory, even though it be only to make practical use of a broom and dustpan. Then, if you're destined to be a radio engineer or inventor, you'll get into your groove, probably.

The greatest engineers, like other great men, are often rather strange characters. I know one fantastic genius, a radio-laboratory engineer who was attached to a struggling concern that was finally wiped out in a foul and savage manner by a powerful corporation. The corporation offered this engineer a salary-contract of $11,000 a year to enter its laboratories, and a cash sum of $25,000 for a certain electro-chemical process he had invented. This graying and penniless radio magician proudly tore up both offers and sent them back with a quite unprintable note to the radio pharaohs, and went away to live in a rude cabin by a lake up among the snow-mantled Rockies; where he will die with his genius and his secrets.

It is true that college training is not always essential to a career in the field of radio. A youth of high ability may assuredly gain an education by other means. A young man trained as a commercial radio operator and sailing on a merchant vessel has ample opportunity for a certain amount of self-improvement. A high-strung young assistant radio-editor that I used to sell stories to years ago, and who now sits among the powers that direct the business policies of the Radio Corporation of America, is an ex-radio-operator; and some others

(*Continued on Page* 46)

DOLLARS FROM RADIO INVENTIONS

(*Continued from Page* 44)

holding quite important positions in this company are former brasspounders—though none of these are research engineers.

I should always say to the aspiring radio experimenter: Go to college—even though he must work his way through and it cost him a bitter struggle; for, in the long run, the lack of a university education cannot but be a severe handicap to the radio inventor and engineer, while its acquirement proves to be of incalculable cultural value to any one gifted with talents and ability.

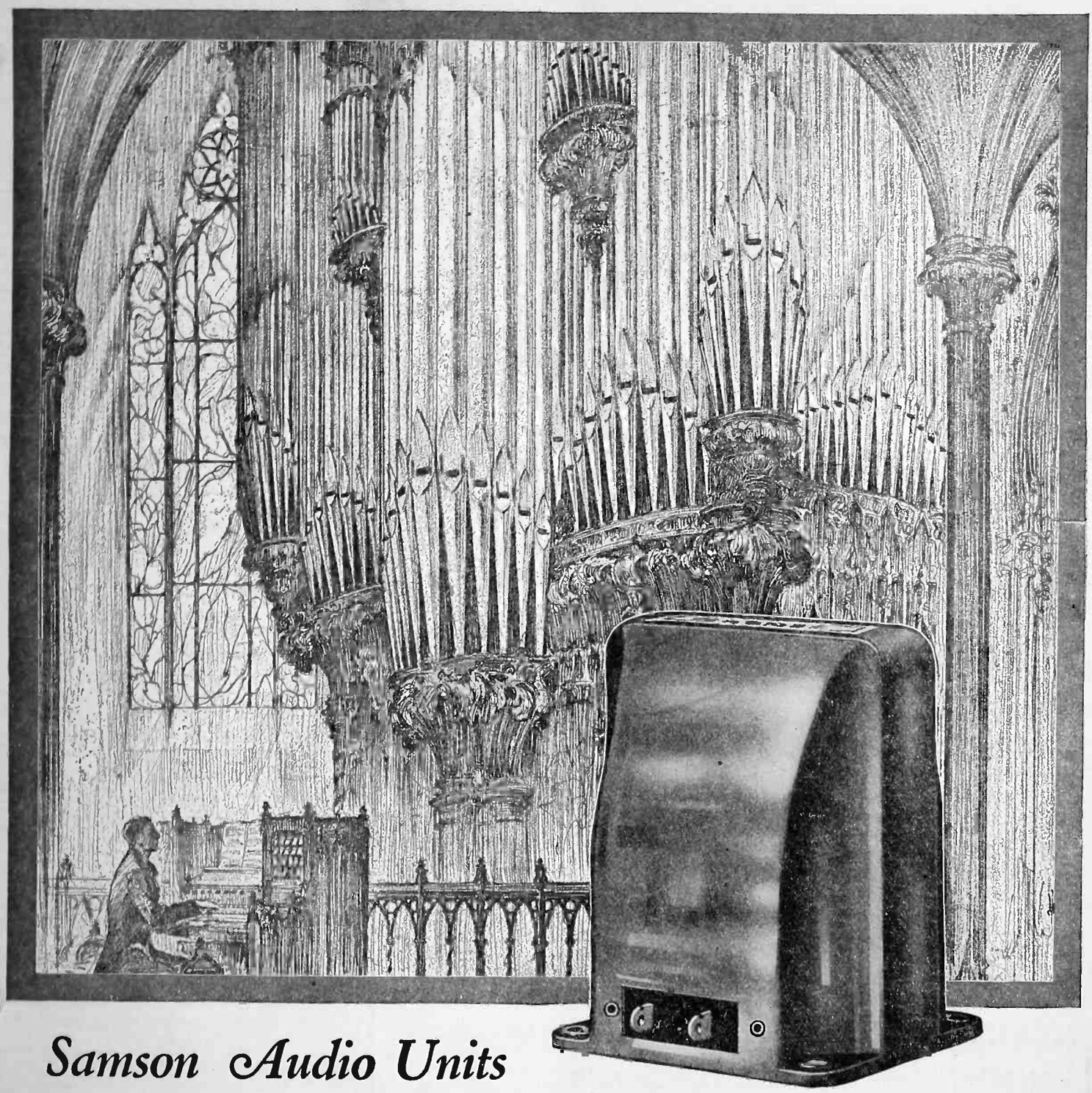
It is illogical and beside the question to condemn the universities because of evils that exist in them, or to point to college graduates who are white-collared vagabonds or polished triflers. No university can often, if ever, make a great man out of a plethoric clod, or of a giddy-headed charlestoning knee-shaker; no more than the best baker can make a good loaf with bran-husk flour. If one's mind is a sandy waste, it may not easily be made to blossom; if a fertile garden, the weeds must be hoed out and the beautiful plants encouraged to grow.

In the days of crude mechanical inventions, little education was necessary to an intelligent inventor, for little had yet been done. The English lad who tied strings and sticks to the valves of a mine-pumping engine, so he wouldn't have to sit and manipulate the valves by hand, was the inventor of the first automatic steam valve-gear; but he would find no great scope for such simple untrained intelligence on the floor of a 100,000 horsepower plant of today.

Of course, there are many other lesser employments in radio besides inventing and research work that yield good livelihoods to those who do not aim at the stars. Commercial wireless operating can be learned in about a year, and, at present, commands salaries of from $90 to $150 a month, with accomodations and food, on shipboard; and from $125 to $250 a month in commercial coastal stations, in transoceanic systems, and in music-broadcasting stations, of course without accommodations or food.

Radio manufacturing industries employ few or no real radio men on the production-floors of the factories; for the making of radio parts is usually a matter of machine operations and assembly with unskilled female labor. The manufacture of the more costly and elaborate radio sets and pieces of apparatus requires skilled mechanics, testers, and inspectors; but these are not necessarily radio experts. However, such factories do have radio men in their laboratories, in their executive departments, and, usually, on their sales forces. There are all kinds of selling jobs in radio, from that of the $19-a-week clerk behind the counter of the small radio store, to the

(*Continued on Page* 48)



Samson Audio Units

are capable of uniform and faithful amplification well in excess of the most exacting broadcast requirements.

Their range extends from the lower fundamentals through the higher harmonics enabling them to reproduce, with equal clarity, the dull rumble of the tom-tom or the thin shrill of the flute.

This ability to reproduce the harmonics or higher multiple frequencies is what gives tone-color or background to sound—is what permits the listener to distinguish notes of the same pitch but from different instruments—results not possible with audio units which cut off at comparatively low frequencies.

In a word—with a loud speaker of corresponding range—

Samson Audio Units

insure the sort of radio you've hoped to hear—the quality of radio that will make you think you've been translated from a broadcast listener to one of an audience which is listening, firsthand, to a speech or to music.

For 1926-27 the Samson Electric Company offers eleven different audio units:

Symphonic Transformers		**$9.00**
Push-Pull Input Transformer	**Type X**	**5.50**
Standard Transformers	**Type HW-A3 Ratio 2-1, 3-1, 6-1**	**5.00**
Dual Impedance	**Type D (Donle Design)**	**5.00**
Output Impedance	**Type O**	**5.00**
Push-Pull Output Impedance	**Type Z**	**5.00**
Plate Impedance	**Type P**	**4.50**
Grid Impedance	**Type G**	**4.50**
Audio Frequency Choke	**Type No. 3**	**3.00**

Our book—"Audio Amplification"—already accepted as a manual of audio design by many radio engineers—contains much original information of greatest practical value to those interested in bettering the quality of their reproduction. Sent upon receipt of 25c.

SAMSON ELECTRIC COMPANY

Main Office, Canton, Mass. **Factories at Canton and Watertown, Mass.**

MEMBER RMA

Manufacturers Since 1882

DOLLARS FROM RADIO INVENTIONS

(*Continued from Page* 46)

$5,000-a-year manager of a big mail-order concern. The newspapers of the large cities in the northern half of the United States employ a good many radio men as editors and assistant-editors of their radio pages, at salaries ranging from $25 to $85 a week.

SO, now in conclusion, you will see why I believe that the odds are perhaps a thousand to one that all of the big radio inventions of the future will be made by highly-educated men; for the two main aspects of education are, first, to be supplied with a pretty thorough knowledge of what has already been done; and, second, to be taught to think with clearness, power, and vision, and to make one's own the metaphysical tools that must be used in future advances. Also, cooperation among radio engineers, chemical engineers, electrical engineers, astronomers, and other specializing scientists is essential; for these men must often take their problems to one another for mutual help, advice, and encouragement.

As a last word, don't waste time with unreasoned combinations of inductances and condensers; don't bury baskets of permanent-magnets under your ground-wire or hang a lot of cannon-balls on your aerial. Familiarize yourself first with at least all the known laws of electricity, magnetism, and electronic activity; learn what has already been discovered before you arrived on the scene; and you won't waste your life or an hour in trying to apply blind poker-luck to your moves with the scintillating chessmen on the table of science.

QUERIES AND REPLYS

(*Continued from Page* 37)

I notice several recent circuits for audio amplifiers, in which the grid leaks are replaced by choke coils. What is the purpose of this change and would it be of any benefit in my impedance coupled amplifier?—G. F. M., Elgin, Ill.

In an ordinary impedance coupled amplifier the grid circuits are connected to their filaments through ½ megohm resistances. If the tubes are overloaded the grid circuits become paralyzed and this is evident by a scratching or grating noise in the loud speaker. If the grid leaks are replaced with choke coils having a very high inductance, but low direct current resistance, the accumulated charge on the grid of each tube is allowed to leak away very readily and while the overloading of the tube may still be present it is not as apparent as when a grid leak is used. Consequently, overloading of the power tubes can be tolerated to a somewhat greater extent than when the grid leaks are used, thus permitting more volume without annoyingly evident distortion. The overload point of the power tube depends entirely upon the plate and grid voltages used and the tube overloads at exactly the same point, no matter whether a grid leak or grid choke is employed; but with the latter, the overloading point is not so easily heard, particularly if the overloading is not bad.

You be the judge of its value""

Dealers who sell the Majestic "B" Current Supply are confident that it improves reception. So confident, they make you this unusual offer: Buy a Majestic today. Attach it to *your* set and use it for one week right in your own home. If, at the end of this time, you are not fully convinced that it gives you better radio performance *—more dependable power at less cost*—your money will be refunded!

Economical to Operate

You couldn't want a better proposition than this. The Majestic "B" Current supply, because of its unvarying constant voltage, gives you improved tone, greater volume—all at the low cost of about one-tenth cent an hour. So you can appreciate that here is a *practical* radio investment.

Your original purchase price will be returned through operating economy alone.

Majestic "B" Current Supply

delivers pure direct current-From your light socket

Give that set of yours the power it needs—power for any variation in tone. Then you'll have a new appreciation of radio. You will have one delightful program after another—summer evenings—winter evenings *—ALL the time!*

That's when your set is equipped with Majestic "B" Current Supply. Your set seems *Alive* with marvelous energy. You sense a new joy in radio.

You at last forget its mechanics, for a simple switch releases all the power you need for any program. Power—*clean—constant—abundant!* Power that instantly responds to high soprano, and as easily brings you the full resonance of an orchestration! Easily attached to your light socket saving you constant bother and attention.

No Filament to Burn Out

All the Majestic "B" Current Supply units are manufactured complete in our factory and are equipped with the famous Raytheon Tube. (Endorsed by numerous radio engineers and editors) which is a non-filament tube with full wave rectification, no acids or back surge. Tests of the Majestic "B" on the oscillograph demonstrate that all A-C hum is eliminated.

Majestic Standard-B

Especially adapted for sets having not more than seven 201-A tubes, or six 201-A plus one 135-150 volt power tube. Popularly priced for the average set. Improves tone—betters reception.
Price $35.00

Majestic Super-B

Capacity 1 to 12 tubes, including the use of 135-150 volt power tubes. Complete with switch to control current from light socket.
Price $37.50

Majestic Master-B

Rating 60 mils at 150 volts. Particularly adapted for Radiola 25, 28 and 30 and Super heterodynes. Will operate all power tubes, also the new super-power tube UX-171 (180 volts). Unequalled for sets having a very heavy current draw.
Price $45.00

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Grigsby-Grunow-Hinds Co.

4580 Armitage Avenue · Chicago, Illinois

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Emeryville, (Oakland), California

AN IMPROVED SUPER.

(*Continued from Page 21*)

of the oscillator. The circuit used here is known as the tuned grid circuit, in that the tuning condenser is connected across the grid coil only, instead of both grid and plate coils. By this means, the settings of the various stations on the condenser dial are spread out to a considerable extent, and no change in tuning due to body capacity will result when using condensers with non-insulated shafts. The grid should be connected to the stator plates of the condenser, and the rotor should go to the ground end of the coil. The pick-up coil is placed in the grid return lead, giving better control of the amount of oscillator current fed into the frequency changer, and improving the selectivity.

The tuned r. f. amplifier requires a little adjustment after the set is completed. The antenna circuit is aperiodic, the rotor coil being used as the antenna inductance. It should be varied until the right amount of coupling is obtained. Under ordinary circumstances, this coupling should be quite loose, or nearly at right angles to the plane of the secondary winding. The nearer the two planes are to being parallel, the more the outside noise, and the less the selectivity.

The secondary circuit is of the split-winding type, the center tap going directly to the negative filament, and the plate circuit being connected to the secondary through a small feedback condenser. A radio frequency choke is placed in the plate circuit in the position shown, to permit greater regeneration, as the impedance of the r.f. transformer primary is rather low. This choke should have as few turns as possible to secure the necessary feedback, and ordinarily will require about 200 turns of No. 36 silk covered wire wound on a spool of the following dimensions: turn the spool out of bakelite, hard rubber or hardwood, 1⅜ in. wide and 1 in. thick. Cut a slot in the spool 3/16 in. deep and 3/16 in. wide, winding 200 turns of No. 36 single silk or enameled magnet wire in the slot. Any extra turns will merely tend to decrease the signal strength.

The remaining r. f. chokes in the set can all be made from the same specifications, or chokes such as the Samson or Silver-Marshall can be purchased ready-made. If you wish to wind your own chokes, turn out four more spools exactly like the one of the plate of the r. f. amplifier, and wind 300 turns of No. 36 silk or enamel wire on each spool. A small support is placed on each choke, as is shown in the picture, to keep it away from the shield and prevent coupling due to capacity between the winding and the shield.

In order to avoid complicated battery connections, the set is designed for operation from a 6-volt storage battery. The voltage is cut to 3 volts for the

(*Continued on Page 52*)

The Crosley Musicone, announced little more than a year ago, introduced a revolutionary speaker principle and took the radio loud speaker market by storm.

Its overwhelming populatity, which has involved the replacement of hundreds of thousands of old type loud speakers, establishes beyond challenge the Musicone's superiority.

And now Powel Crosley, Jr., announces ... the Crosley *Super* Musicone!

This larger 16-inch cone utilizes the same Crosley patented actuating unit as the smaller Musicone ... and this, *not* the cone shape, is the secret of Musicone excellence.

It offers, by virtue of its larger proportions, still more superb volume. It produces, especially in the bass, still richer resonance!

The 12-inch Musicone has been reduced to $12.50. Also at $32 in the form of a beautiful Console, in which both receiver and batteries may be placed.

THE CROSLEY RADIO CORPORATION, CINCINNATI, OHIO ··· POWEL CROSLEY, Jr., President.

CROSLEY *Super* MUSICONE

BETTER · $14.75 · COSTS LESS

Write Dept. 19 for illustrated booklet *All prices slightly higher West of the Rockies*

AN IMPROVED SUPER.

(*Continued from Page* 50)

CX-299 tubes, by means of a 30-ohm rheostat, and a voltmeter having a 5-volt scale indicates when the proper voltage adjustment is obtained. The current in the power tube is limited to ½ ampere by means of a type 112 Amperite or its equivalent, the same type being used for either CX-112 or 371 power tubes. In view of the different values of *C* voltage for the two types of power tubes, the *C* terminal of the last audio transformer is brought out to a separate binding post, as is shown in Fig. 1, and the *C* battery for the power tube is connected externally. For the CX-112 tube, the *C* voltage should be 10½, with 157 volts plate, and for the CX-371 tube, the *C* voltage is 40 and the *B* voltage 180. The *C* battery for the dry cell tubes is contained within the set, and has no connection with the *C* battery for the power tube.

Volume control is obtained by means of a 30-ohm filament rheostat inserted in the positive filament lead of the first two intermediate frequency tubes, this being a simpler method than using one of the shunt type potentiometers generally employed.

In order to use the receiver with a loop antenna, it is only necessary to remove the first plug-in coil and connect with a short piece of wire the terminals marked *3* and *6* to the terminals marked *1* and *2*. Then connect the three tap loop to the three binding posts. When it is desired to use the antenna, remove the connecting wires, insert the coil and connect the antenna and ground to the two outside binding posts.

LIST OF PARTS

- 3 .0005 mfd. variable condensers.
- 3 Plug-in Coil mountings.
- 2 Plug-in Inductance coils.
- 1 Plug-in Oscillator coil.
- 9 UX base sockets—1 cushioned.
- 3 Intermediate frequency transformers.
- 1 Filter transformer.
- 2 Audio transformers.
- 1 Output transformer.
- 2 30-ohm filament rheostats—1 for volume control.
- 7 1-mfd. by-pass condensers.
- 1 .002 mfd. fixed mica condenser.
- 1 .00025 mfd. grid condenser.
- 1 3-megohm grid leak.
- 1 Voltmeter—0-5 volts.
- 3 3-spring jacks.
- 2 .00005 mfd. midget variable condensers.
- 5 r. f. chokes.
- 1 112 Amperite.
- 9 Binding posts.
- 1 7½ volt C battery.
- 1 Panel 10x21x3/16 in.—Bakelite or Formica.
- 1 Piece sheet brass 10x21x1/16 in.
- 1 Piece sheet brass 7x19½x1/16 in. for shelf.
- 4 Pieces sheet brass 4¾x7x1/16 in. for partitions.

The completed receiver should be mounted in a shielded cabinet, sheet brass or copper being recommended. One precaution should be observed, however, that the shielding of the lid should not touch the top of the shielding on the sides of the cabinet, and the shield of the back panel should be connected to the cabinet shielding at only one point.

You can build a better set than you can buy

THE outstanding sets in any community are those built by radio fans. Although the receivers they build may not look as well as some of the manufactured sets, actual results make them the talk of the town. Such a condition is not the fault of the manufacturer. His greatest desire is to build just such a receiver. But radio improves too quickly for him. He can not swing his great productive forces into making sets with this year's many new devices and improvements until next summer's lull.

The designers of the Henry-Lyford Receiver, understanding fully the manufacturer's problem, have developed a receiver that when built, has the same polish and finish as a manufactured set, and at the same time includes the very latest improvements in radio design. It is as near the broadcast listener's "perfect receiver" as any receiver to date can be, because it was designed to follow the consensus of opinion of hundreds of broadcast listeners.

The broadcast listener designated just what a "perfect radio receiver" should have. His demand, first of all, was for tone quality, then in turn, simplicity of operation, sensitivity and selectivity, beauty and permanent utility, from 37 meters to 550 meters.

To incorporate all these points was a gigantic task, and to incorporate them in the highest state of perfection known to broadcast listeners was an even greater problem. It took a long series of experiments and investigations to produce what we believe to be more nearly "the perfect receiver" than any other set heretofore offered to the experimenter and home constructor.

Easy to Build

The Henry-Lyford Receiver is not difficult to build. Almost any novice can wire it within a few hours.

The panel is designed and engraved especially for the Henry-Lyford Receiver. Of standard size, it fits into numerous designs of cabinets. In the console model it is most attractive.

Order a Complete Set of Parts Today

Complete sets of parts for the Henry-Lyford Receiver are now ready for shipment. If your dealer cannot supply you, send check or money order direct to the University Radio Mfg. Corp., 50 Park Place, New York City, or if you desire, a complete set of parts will be sent to you C.O.D.

The Henry-Lyford Receiver will be on display at the Radio World's Fair, Booth No. 4, Section GG, Madison Square Garden, New York City, September 13-18th. Plan to see it.

COMPLETE LIST OF PARTS

1 Bakelite panel, 7x24, drilled and engraved.
1 Bakelite sub-panel, drilled, with 5 Benjamin sockets mounted.
2 Precise 350 mmfd. variable condensers, type 845.
1 Precise 55 mmfd. variable condenser, type 940.
1 Centralab modulator, type 500 M.
1 Carter "Imp" filament switch.
1 Carter No. 102a jack.
1 Carter No. 103 jack.
1 University antenna coupling transformer, type B-1.
1 University radio frequency transformer, type B-2.
1 University tuned radio frequency transformer, type B-3.
2 Thordarson Audio Transformers, type R-200.
5 Tobe Deutchmann 1 mfd. fixed condenser.
1 Micamold .002 mfd. permanent condenser.
1 Micamold .001 mfd. permanent condenser.
3 Amperites, type 112.
10 Coil mounting jacks.
1 pair of Benjamin brackets, type 8629.
1 sub-panel supporting post.
2 Eby binding posts marked Ant., Gnd.
2 4-in. Kurz Kasch dials, 100 to 0.
1 8-wire battery cable.
1 coil of Belden hook-up wire.
1 complete set of hardware.
Complete set of parts..... **$69.50**

Dealers and Jobbers: Write us for further information.

UNIVERSITY RADIO MFG. CORP., 50 Park Pl., New York

THE NEW HENRY-LYFORD RECEIVER

FIVE-TUBE RECEIVER

(*Continued from Page 26*)

Now turn the sub-panel right side up again, with the tube sockets toward you. By-pass condenser No. 2 is now mounted in the holes provided behind and slightly to the right of socket No. 2. The connecting lugs are toward the back edge of the sub-panel. By-pass condenser No. 1 mounts in a similar position, behind and to the left of socket No. 1. Now all of the parts are mounted on the sub-panel with the exception of the untuned radio frequency transformer which we will mount later.

All of the instruments which go on the front panel should now be mounted. Three counter-sunk holes will be found in the proper place for mounting each of the large variable condensers. These condensers are held off of the panel by bushings which are provided. The small balancing condenser mounts in the single hole between the two larger condensers, with the stationary plates down as shown in the illustrations. The modulator is mounted in the hole just below the word *volume*. The filament switch is mounted directly below the modulator, with its binding posts in a line parallel with the bottom edge of the panel. Now mount the minimum jack, the one with the three contacts, in the proper position. Then mount the maximum jack in the single remaining hole. Be sure and mount both jacks with the frames nearest the bottom of the panel.

The panel may now be mounted on the brackets by means of the holes provided for that purpose. We are now ready to wire the receiver. Place the mounted panel and sub-panel upside down with the panel away from you. Notice that the picture wiring diagram shows the set in this position and that the sockets, condensers, Amperite mountings and jacks are numbered for ease of reference.

Start the wiring by soldering a wire to the upper right contact of socket No. 1 which is the positive filament connection. Continue on with this wire to the same terminal of sockets 2, 3 and 4, ending it at the terminal No. 3 of the maximum jack. This terminal is next to the top terminal of the jack, No. 4 being the top, or furthest away from the metal frame of this jack. Now connect the three left hand terminals of the Amperite mountings as shown in the picture wiring diagram. The next step is to take two pieces of wire and solder a lug on one end of each. Now take the four nuts off of the radio frequency transformer and place one of these lugs, with a wire soldered to it, over the grid post and the other one over the plate post. Then put the four posts of the transformer through the holes in the sub-panel provided for that purpose, as shown in the diagram, with the *P* and *G* posts nearest the sockets. Now put the nuts on the posts of

(*Continued on Page 56*)

KELFORD

Air-Cooled Rheostat

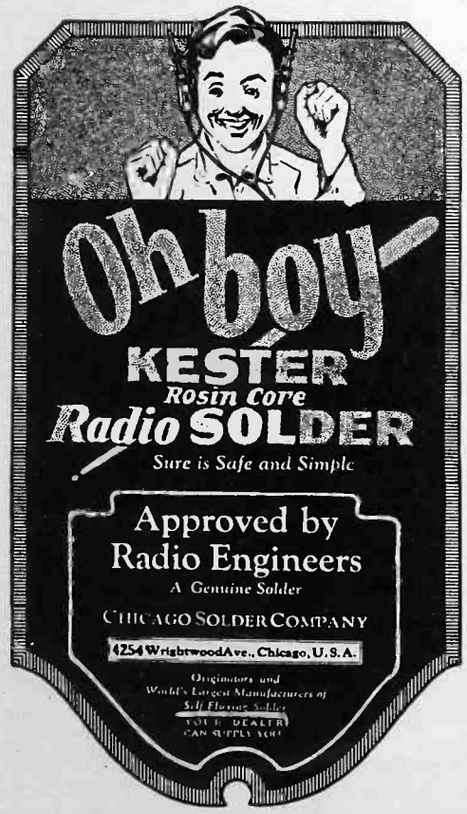
Adjustable sliding contact arm; aluminum base; resistance exposed on all sides; operates without appreciable temperature rise and at constant co-efficient of conductivity. List Price, 50c.

"Cushion" Type Socket

Takes new standard UX type tubes, also tubes with old-style bases except UV-199. By substituting Kelford "Cushion" Type Sockets, tube jars and resulting noises are eliminated. List Price, 50c.

Ask Your Dealer for Kelford Products

THE AMERICAN SPECIALTY CO.
BRIDGEPORT, CONN.



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Valley Electric

Uses only *the* RAYTHEON TUBE

"For reliable reception"

Delivers 50 milliamperes at 180 volts

Operates without hum or noise
Better than dry batteries

The Valley B Power Unit takes the place of B batteries by providing plate voltage from the house lighting circuit for any radio receiving set of 12 tubes or less.

It will supply the plate voltage necessary for a power unit or power tube. Its maximum output is 50 milliamperes at 180 volts.

We use the Raytheon Tube in the Valley B Power Unit because only the Raytheon Tube gives full wave rectification and has no filament to burn out. Also, it is the only rectifying tube for this service which will deliver full current and voltage continuously over a long period of time.

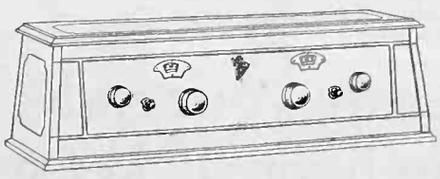
Operates without hum or noise—as silent as dry batteries. Mounted in handsome black grained metal case. Comes complete with Raytheon Tube, cord and plug.

Other Valley Radio Units

To the left are shown other Valley units as follows:

Top—The Valley Type TBC Charger, the twin-bulb charger. Charges at 2½ amperes with one bulb, and at 5 amperes with two bulbs. Use of both bulbs is optional. Absolutely noiseless.

Center—The Valley Type ABC Battery Charger. The original vibrator type charger. More than 200,000 in successful use. For six and 12 volt batteries.



Bottom—The Valleytone Model 52 Radio Receiver. Five-tube, tuned radio frequency. Two dial control. Wired so that use of power tube is optional.

VALLEY ELECTRIC CO. · RADIO DIVISION · ST. LOUIS, MO.

District Offices: **Boston, Chicago, Cleveland, Indianapolis, Kansas City, Minneapolis, New York, Philadelphia, San Francisco**

FIVE-TUBE RECEIVER

(*Continued from Page* 54)

the transformer from the top side of the sub-panel to hold it in place. The wire from the *G* post of the transformer is soldered to the lower left hand or *G* terminal of socket No. 2. The wire from the *P* post of the transformer is connected to the lower right hand or *P* terminal of socket No. 1 and continues on to the rotary plates of the balancing condenser *B*.

Run a wire through the hole in the sub-panel directly over the left hand terminal of the by-pass condenser No. 1 and solder to this terminal. Connect the other end of this wire to the right hand terminal of Amperite No. 1 as shown. Then run another wire through the hole in the sub-panel over the right hand terminal of by-pass condenser No. 2 and solder it to this terminal. Now solder this wire to the wire that runs from the by-pass condenser No. 1 to Amperite No. 1 which you have just previously connected. Continue it on to the upper left hand terminal of socket No. 2 and then end it at the corresponding terminal of socket No. 1, which are the filament negative terminals of these two sockets.

Now solder one end of the .001 fixed condenser to coil jack No. 5 by bending the lug of the jack up and over the terminal of the condenser. The other terminal of this condenser should be connected to the stationary plates of the balancing condenser *B*. This can be done neatly by looping this wire under the wire connected to the upper right hand terminal of socket No. 2 and then straight out to the balancing condenser. Now connect a wire from the lower left hand terminal of socket No. 1 to coil jack No. 6 and then to the stationary plates of the antenna condenser *A*. Next connect a wire to the rotary plates of the antenna condenser *A* as shown in the diagram. Run it to coil jacks 3 and 4. Now continue this wire, under the radio frequency transformer, to coil jack No. 7 and end it by connecting it to the rotary plates of detector condenser *D*.

Now run a wire through the hole in the sub-panel over the left hand terminal of the by-pass condenser No. 2. Solder it to this terminal and also to a soldering lug under the nut on the *F* post of the radio frequency transformer. Connect the other end of this wire to coil jack No. 7. Then run a wire from the lower right or *P* terminal of socket No. 2 to the coil jack No. 9. Now solder the end of the wire to the upper left-hand terminal of socket 4 which is the negative filament connection and run it to the corresponding terminal of socket No. 3. Continue this wire to the right hand terminal of Amperite No. 2 and then over to the left hand terminal of by-pass condenser No. 3, where it should be soldered. Connect the right hand terminal of by-pass condenser No. 4 to the left hand terminal of by-pass condenser No. 5. Continue the wire on to the up-

per left terminal of socket No. 5 which is the negative filament connection. Now run this wire over to the right hand terminal of Amperite No. 3. Run a wire from coil jack No. 8 to the lower left terminal of socket No. 3, or *G* post, and continue on to the stationary plates of the detector condenser *D* as shown in the picture wiring diagram. Next run a wire through the hole in the sub-panel directly over the *P* post of the audio frequency transformer No. 1 and connect to it. Connect the other end of this wire to the lower right hand terminal of socket No. 3 which is the *P* post. Now run a wire through the hole in the sub-panel directly over the *G* post of audio frequency transformer No. 1 and connect to it. Run the other end of this wire to the lower left terminal of socket No. 4 which is the *G* post. Continue this wire to the No. 1 terminal of the modulator, or volume control, as shown.

Now run a wire through the hole in the sub-panel directly over the *F* post of audio frequency transformer No. 1 and connect to it. Run the other end of this wire to terminal No. 2 of the modulator. Now connect another wire to this wire and run it to the right hand terminal of by-pass condenser No. 3 as shown in the wiring diagram. Now run a wire through the hole in the sub-panel directly over the *G* post of audio frequency transformer No. 2 and connect to it. Connect the other end of this wire to the lower left hand terminal of socket No. 5, which is the *G* terminal of this socket. Run a wire through the hole in the sub-panel directly over the *F* terminal of audio frequency transformer No. 2 and connect to it. Connect the other end of this wire to the right hand terminal of by-pass condenser No. 5. Next place the .002 by-pass condenser between sockets 3 and 4 as shown in the diagram. Connect one end of it to the lower right terminal of socket No. 3 and the other end to the upper left hand terminal of socket No. 4. These connections are sufficient to hold this condenser in place.

Now connect a wire from the coil jack No. 10 to the No. 1 contact on the minimum jack, which is the contact nearest the jack frame. Connect the No. 3, or top contact of this jack to the lower right hand terminal of socket No. 4 which is the *P* terminal of this socket. Run a wire through the hole in the sub-panel directly over the *P* post of the audio frequency transformer No. 2 and connect it to this post. Connect the other end of this wire to the No. 2 or middle terminal of the minimum jack. Terminal No. 1 on the maximum jack, which is the terminal nearest the frame of the jack should now be connected to the left hand terminal of by-pass condenser No. 4. Terminal No. 2 of this jack should be connected to the lower right hand terminal of socket No. 5 which is the *P* connection of this tube. Terminal No. 4

of this maximum jack, which is the terminal furthest from the jack frame should now be connected to the upper right hand contact of socket No. 5, which is the positive filament connection of this socket.

Now run a wire through the hole in the sub-panel over the right hand terminal of by-pass condenser No. 1. Solder it to this terminal and also to a soldering lug under the nut on the *B* post of the radio frequency transformer. Run the other end of this wire through the hole in the sub-panel directly over the B post of the audio frequency transformer No. 2 and connect it to this post. Also run a wire from this wire to coil jack No. 10 as shown in the picture wiring diagram.

Now one terminal of the filament switch is connected to the upper right hand terminal of socket No. 4 which is the positive filament terminal. Next solder the lug under the Antenna binding post to the coil jack No. 1 and connect the lug under the ground binding post to the coil jack No. 2. This completes the wiring of the receiver and we are now ready to connect on the battery cable, which is being made especially for this receiver.

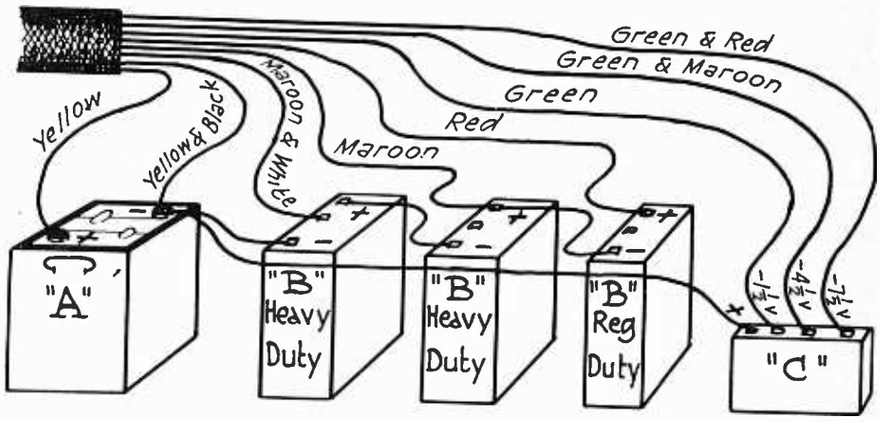


Fig. 3. Arrangement of Battery Cable Connections.

The solid yellow wire is first connected to the terminal of the filament switch which has not been previously connected to. The yellow and black wire should now be connected to the left hand terminal of Amperite No. 1. The maroon and white wire should be pushed through the hole in the sub-panel over the *B* post of audio frequency transformer No. 1 and connected to it. The solid maroon wire is soldered to the coil jack No. 10. The solid red wire should now be connected to the left hand terminal of by-pass condenser No. 4. Connect the solid green wire to coil jack No. 7. Solder the green and maroon wire to the right terminal of by-pass condenser No. 3. The last wire to be connected is the green and red wire and this should be soldered to the right hand terminal of by-pass condenser No. 5.

The dials and knobs may now be put on. The condenser dials should be adjusted to read 100 degrees when the plates of the condenser are fully interleaved. The knob on the balancing condenser should be set so that the arrow points directly to the right when the plates are fully interleaved. The knob on the volume control is adjusted so that the arrow is pointing directly to the left when the shaft of this control has been turned as far as possible to the left. This is the minimum position.

We will now test out the receiver. First connect the solid yellow *A*+ wire and the yellow and black *A*— wire to a 6 volt storage battery. Insert a tube in each socket separately, taking care to have the pin on the side of the tube pointing in the same direction as the arrow on the socket. With the filament switch turned on the tube should light in all sockets except the last, and should light in this socket when a plug is inserted in the maximum jack. If the filament circuit is shown to be correctly wired by these tests, the *B* and *C* circuits may be connected and tested. The remaining wires in the cable are now connected as shown in the diagram, taking care to connect the *B*— and the *C*+ to the *A*—.

Again insert a tube separately in each socket, and it should light up as before. This indicates that the *B* and *C* circuits are correctly wired. If these tests show that the battery circuits are apparently correct all of the tubes should be inserted in their proper places, the power tube going in the fifth socket. Now hook up the antenna and ground to the binding posts and plug in the coils. When first trying this receiver, turn the volume control half way on and set the *balance* so that the arrow points at the letter *E*. Now rotate the tuning dials slowly, keeping them together in reading.

When a signal is heard, adjust the *balance* for clarity, which will probably necessitate only a very slight movement of the knob. Adjust the *volume* control until the signal has the desired strength. For greatest volume and distance the antenna rotor coil should be set parallel to the fixed coil, but if greater selectivity is desired this coil may be rotated until it is nearly at right angles, if necessary.

THE FATAL L-RAY

(*Continued from Page 28*)

employ to erase figures from a ledger, when he made an error. At first the bookkeeper had used an eraser for this purpose. But he was not a good bookkeeper and he frequently had to stay until midnight erasing all his mistakes and he looked about for a simpler method.

"A radio set," said he, "picks up small sounds from a distance and magnifies them. Now if a radio set could be made to work backward it would reduce sounds and obliterate them altogether. If then this effect could be projected into space by a ray, it would obliterate anything it touched—sound, light, solid objects. And that would be the cat's distinguished whiskers."

It was really quite simple when you came to think about it. The bookkeeper tried X, Y and Z rays. Then he worked back through the alphabet until he came to the L-Ray which was just what he wanted—a moderate priced ray, with stream lines and that mark of quality which catches the attention.

"At last," said the bookkeeper, and sat him down to dream.

And while he dreamed, Edisi, who had been watching him all the time, reached through the window and carried off the L-Ray and got a patent on it in his own name and skinned the poor bookkeeper out of his pot-right with a twist of the wrist.

Now in proper hands, the L-Ray might have been a useful invention. But Edisi, as we have said, was a born conspirator and he immediately set about using the L-Ray for deviltry. He had eight plans devoted to deviltry with the L-Ray alone. He had twelve plans devoted to deviltry with the L-Ray and a machine-gun, and nine plans which included the L-Ray and measles. Then he had another plan in which the L-Ray and the secretary of war figured.

There were other plans, too, too diabolical to even think about unless he was locked in a room all by himself. And there was one particular plan that was so terrible he did not even dare to think of it. At the moment of which we speak, he was sitting in his workshop wishing with all his soul that he dared think about this most terrible plan of all.

Into the silence came a knock on the workshop door. Edisi peered through a small fraternal hole in the panel. It was a royal messenger.

"His nobs, the King, says 'be at the Palace tomorrow at 10 o'clock and bring your L-Ray,'" said the messenger. "Sign here!" He thrust a receipt through the hole.

Edisi signed. As the sound of the departing messenger's feet faded away the inventor sank into a chair.

"Tomorrow at 10—history will be made!" he gritted through set teeth.

Under ordinary circumstances he might have been right, for 10 o'clock is really as good a time as any other to make history. But he had reckoned without Princess Katerina Eloise Eclypta Tasselhaupt, called "Tassie" for short, who, at the moment, was combing the rough for a ball she had sliced dismally at the ninth hole. The Princess Tassie's keen eye had noted the royal messenger as he came from the inventor's cobblestone mansion.

"Ha!" said Tassie cannily. "There's monkey business in Denmark."

She tiptoed across the moat, climbed the portcullis, and swung lightly to a bastion. There, by standing on a stone griffin she could peer through a window into the private chamber of Edisi the inventor. It was not a ladylike thing to do because she was not a private detective. However, she did it and like all persons who look through a hole into a room, she was repaid amply for her trouble.

There, under the blaze of a couple of cheap candles, she saw the inventor in close conversation with Prime Minister Blannerhassett who had apparently just come in the back way.

"Then all is set?" asked the prime minister.

"Aye," said Edisi. "We'll demonstrate to the King and army at the same time. When you give the signal, I'll swing the deadly L-Ray on the whole bunch and wipe 'em out—lock, stock and barrel. After that—we cut the kingdom. Eh?"

The prime minister's eyes gleamed with an avaricious light.

"All I ask," he said, "is that you save the proud and haughty Princess Tassie for me."

"Take her and welcome," said Edisi generously. "All I want is the breweries."

Outside the window a silent witness of all this, the Princess Tassie clung like a leech to the ledge. Her hat was over one eye. Her face was smeared with cobwebs. But in her heart burned a high resolve that rendered her almost incandescent. Slowly she let herself down to the roots of the bastion.

"Ha!" she said. There was not much to the exclamation but she could have been arrested for what she was thinking.

Midnight! Rorick of Orrick is seated in Orrick hall smoking before the great Orrick fireplace. A log that has been in his family for generations, smoulders on the hearth. An unopened copy of the Encyclopedia Brittanica marked at "Premature Baldness" lies in his lap. At his feet are a dozen great Danes. Now and then Rorick takes a huge cow-drumstick from a platter at his elbow and hurls it to the hounds who crunch it gratefully. All is peace and majestic domesticity.

Suddenly through one of the windows steps the Princess Tassie of Uvala. She

is incognito in raincoat, ear-muffs and rubber boots, although the moon is shining. The disguise is complete. Not even a hotel clerk would have recognized her. She fools Rorick. But hounds and horse-flies are not fooled so easily, and there is sudden uproar in the room as a dozen tails beat frantic welcome on the solid oak floor.

"Call off the drum-corps, old egg," said the Princess. "I would have speech with thee."

Rorick's eyes opened. He threw a rug over the dogs, effectively silencing them.

"You Tassie—here . . . at this hour . . . ?" His tone was nervous, as one who expects to be trapped by the district attorney.

"None other," said Tassie easily. She sank down beside him on the bach-fugue and drew off her knitted mittens. "Listen! What I have to tell you is a wow!"

As she talked, Rorick's eyes gleamed.

"And you say you'll guarantee Marie to me if I do this for thee?" he asked softly.

Tassie nodded brightly.

"F.O.B. palace," she promised. "In the original carton."

Rorick suddenly jumped to his feet, jerked the rug from the dogs and began kicking them joyously.

"Hear that, old fellows . . . f.o.b. palace . . . Marie, old fellows, Marie . . . ."

He swung about, his hands outstretched. But where the Princess Tassie had sat, there was only empty space. Like a flitting shadow she had faded from the picture. Had he turned quicker he would have seen her—a slim, graceful figure, perched for an instant on the window sill, looking back at the fire-lit room with its golden candelebra and gnawed bones. As it was all he heard was the "whoosh" of her rubber boots as she cleared the twenty-five foot moat in a leap and was gone into the night. Brave Tassie! Dumb but faithful!

Blannerhassett, the prime minister, summoned the Scurvey Council to be present when the King and his Cabinet met with Edisi the inventor in the great hall of Uvala, where in times past discredited minorities had been scuttled and sunk.

"What was the idea of turning this into a mass meeting?" demanded the King in some irritation.

"Just this, sire," explained the prime minister. "It will give the public a chance to see how we safeguard the national weal. The real business will be transacted, of course, star chamber. I have seen to that."

"Perhaps you are right," said the King. He strode to the window and looked out. "How come—the troops?"

"Aye," said the minister. "This is an event. Edisi may demonstrate his L-Ray for the cabinet and the Scurvey Coun-

cil. It is best to have the stage set. It would convince the people that the administration is ever alert to popular welfare."

The King turned suddenly and laid a kindly hand on his prime minister's shoulder.

"Blanny," he said, "this ought to have been a republic so you could get into the Senate. Your talents are wasted here."

A light gleamed in the minister's eye. Wasted! If the King but knew!

Promptly at 10 a.m., the chimes of the King's wrist watch rang out the hour of 09:00:00 G.M.T. With a fanfare of trumpets he took his seat at the head of the great council chamber, nodding to his cabinet and the Scurvey Council which stood at respectful attention until he had sunk to rest. Blannerhassett stood at his left and at his right was the famous Sword of Uvala, used only in case of a deadlock in the cabinet.

"Show in Edisi!" commanded the King.

The curtain must be drawn at this point, for, as the chamberlain explained to the accredited representative of the Irrational Press Association who flashed a press badge on him at the door, while the proceedings of the council were at all times public property, the dignity of traditional custom dictated that what they actually did must be masked in secrecy. Sufficeth it therefore, that Edisi and the King got together on a basis that protected the best interests of the people, the Scurvey Council and the Cabinet getting the usual twenty per cent.

Outside on the balcony, the Princess Tassie and Rorick of Orrick met in the most casual manner.

"Did't smear the works?" inquired Tassie in a low tone.

"Like a burglar's dream," said Rorick cryptically. "I got into the workshop about 3 a. m., Edisi was upstairs dead to the world. I reversed the gadget . . . . . "

Tassie laid a quick hand on his arm.

"Say no more," she whispered. "The less I know when this goes before the grand jury, the better for all concerned."

Rorick lighted a cigarette.

"And all for you," he said, "And the reward?"

"You will find Marie of Eluria in the kitchen," said Tassie. "She is in the ice-box. Go—and find your happiness."

Rorick leaned forward suddenly and kissed her on the elbow.

"My Princess!"

There were tears in Tassie's eyes.

"Roll your hoop," she said. "And come back for the finish."

Rorick dashed away. The Princess sighed, and pulled out her vanity case. Directly behind her lavalliere was a sob.

"If I ever find a guy that can love like that and still draw checks," she said, "I'll nail his feet to the floor."

It was an hour later that the King suddenly came out on the front porch of

Uvala palace, accompanied by Edisi the inventor and Blannerhassett his prime minister. Behind walked the Council and Cabinet. Eighteen brigadier generals saluted at once. Five hundred lieutenant colonels stood at attention. The army aviator touched his cap. The King smiled with pride. The troops made a fine appearance in the bright Octobril sun, with their guns held at kitty-corner, their toes turned out, and their eyes on the mess tent. Such as it was, it was indeed an army to be proud of.

A squad of footmen pushed the deadly L-Ray machine onto the balcony beside the great inventor. The machine looked much like a radio set save that it had a projector attached which resembled a fire nozzle. It was Greek to the King. It was Cheko-Slovakian to the prime minister. But to the people it was Sanskrit and not one of that vast throng gathered there beyond the troops but showed it in his or her face. Only Edisi knew the secret of this terrible weapon that was due to make history in Uvala.

"If your Majesty and these other gentlemen of the Cabinet and Council would but take a position in front of the Army," said Edisi, the inventor, with oily suavity, and a glo-co manner, "you will be able to see the better. I will demonstrate from the balcony so that all may witness this triumph of the age."

Down the marble steps went the King, Blannerhassett, and the vested guardians of the people. The King was garbed for the occasion in the most flambuoyant uniform of the kingdom—that of a sergeant of marines. Flanked by his generals, his councillors and his army aviator, he made an imposing figure as he stood beneath the crossed lions of Uvala at the head of his troops. Edisi remained on the balcony alone. Slightly behind him, unobserved by the inventor was Princess Tassie in the uniform of an admiral's sister, her jaw tightly clamped on a wad of gum. In her eyes was a gleam that could not by any possibility have been traced to mascara.

"What shooteth he at?" demanded the King of Blannerhassett.

"Yon oak," said the prime minister, indicating a giant tree that stood on an eminence at some distance from the palace—an oak on which in times past, no less than six monarchs had been hanged by popular decree.

On the balcony Edisi the inventor laid a fond hand on his great weapon. His hair was flying. His deep-set eyes burned with a fanatic's fire. His tie was screwgee-ed. For a moment he looked down upon them—King, courtiers and army, spread out like ants on a fruit cake.

"This is my great moment," he shouted suddenly.

The King stirred.

"Cut out the election talk," he called. "Do your stuff."

"Aye," cried Edisi. "I'll do my stuff —you old shoat!"

The King turned to the prime minister.

"What did he call me—a shoat?"

"Yes, sire."

"Do you think he knows what a shoat is?"

"Undoubtedly, sire. Else why pick you, sire?"

The King whirled back to the balcony in wrath—to stand transfixed by what he saw. Edisi had swung the nizzle of the L-Ray machine directly on him.

"Hey!" cried the King feebly. "Hey—look out!"

Edisi's face was that of a madman. The prime minister took one look at him and ran quickly to the end of the line of soldiers. There he paused and raised his handkerchief three times—like a dowager flagging a taxi-cab.

"Edisi—Uberalles!" shrieked the madman on the balcony and before the horrified eyes of King and court, he pressed the little brass lever on his terrible machine marked "volume control."

Instantly the King, his Cabinet, the Scurvey Council, the eighteen brigadier generals, the five hundred lieutenant colonels, the army aviator, and the whole army, ducked as one man. From the balcony there came a sudden whirr, a hiss, a cough, a grunt, and a moan. A puff of dust whirled in air and then, before their eyes Edisi, his machine, the table on which it sat—all faded away and disappeared.

One moment he was there and the next—he had gone like a summer mist before a wind . . . . he and his great invention—vanished!

A vast silence fell on the place. Blannerhassett stood like one stricken, his hand still in the air holding the Judas handkerchief with a neatly embroidered "B" in one corner. From her alcove the Princess Tassie suddenly jumped down, walked over to the spot where the inventor had stood and passed her hand through the spot. Then she leaned over the balcony.

"Come on up, papa," she called. "He's blown the works! The party's all over."

The King was not especially quick in the head and it was some time before he managed to grasp the details of the plot. When he did he turned to Rorick.

"Then it is you we have to thank?" he said.

Rorick smiled modestly.

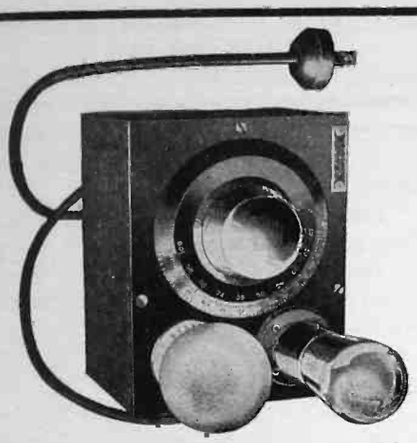
"Well, sire—I dids't reverse the gizzard of his device so that it would work backwards instead of forwards with the results you have seen. It has been my pleasure, sire. Edisi is dead—long live the King."

The courtiers, the Scurvey Council, the Cabinet caught up the words and echoed them. Outside, the army bursting with loyalty took up the cry and began firing their weapons into the air.

"Edisi is dissipated—long live the King!"

Tassie, who had been waiting for this

(*Continued on Page 66*)



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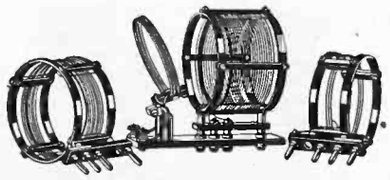

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THE FATAL L-RAY

(*Continued from Page 64*)

moment, dragged Marie of Eluria from beneath the sofa where she had been hiding and thrust her forward, wig-wagging a signal to His Majesty. The King tumbled. He turned to Rorick.

"Take her, my son," he said kindly. "My blessings on you both. We'll get that route to the sea by some other means. Perhaps the State Highway Commission may unbend its budget . . . ."

He paused and ran an eye over the great hall of Uvala.

"Where's that skunk Blannerhassett?" he roared.

There was a moment of silence, and then from behind a curtain the prime minister stepped into view, crossed the intervening space on all fours and bowed before his ruler.

"Your forgiveness, sire," he petitioned. "I was but a weak vessel . . ."

"A cracked vessel," the King amended bitterly. "A worthless tear-jug without a handle. I trusted you and you betrayed me. Nay you would have shredded me like a breakfast cereal. It is my will that you be put where treasons, strategems and spoils shall pass you by." He turned suddenly to his Cabinet and Scurvey Council.

The court crowded forward. This was going to be good.

"Gentlemen," said the King. "This man must be punished in proportion to his crime. He double-crossed his country and his King. He hornswoggled the people and the state. As the highest judicial officer in the state, I have the authority to soak him the limit and there is no appeal. Am I right?"

There was a murmur of assent. The King stepped forward and removed his crown. With a sudden smacking movement he clamped it down on Blannerhassett's head—down to his projecting, fan-like ears.

"Blannerhasset," he said, "I sentence you to be King of Uvala—Uberalles of the Realm—the figurehead of this great and glorious empire."

There was a gasp of astonishment. The Secretary of State leaned forward.

"But sire—what about you?"

The ex-King chuckled and there was real mirth in the chuckle.

"Who, me? Oh, I'm going to be prime minister, and get some of the soft pickings myself. Incidentally I'm going to keep this royal corkscrew busy watching my movements. Come Tassie!"

And taking the Princess Katerina Eloise Eclypta Tasselhaupt by the arm, the new prime minister of Uvala, formerly its King and Uberalles, stepped through the palace window, to avoid assassination, and went whistling merrily down the veranda.

Behind them, as they went, the new minister and the Princess Tassie heard King Blannerhassett of Uvala sobbing into his embroidered mouchoir.

EUROPEAN BROADCAST STATIONS

(*Continued from Page* 31)

Breslau, 414.8 m., 4000 w., Schlessische Funkstunde.
Hamburg, 392.1 m., 2000 w., Nordischer Rundfunk, A. G.
Hanover, 296 m., 1500 w., Ditto (relay).
Konigsberg, 463 m., 10,000 w., Ostmarken Rundfunk, A. G.
Munich, 485 m., 10,000 w., Deutsche Stunde in Bayern.
Nuremberg, 340 m., 750 w. Ditto (relay).
Stuttgart, 446.1 m., 1500 w., Suddeutsche Rundfunk, A. G.

GREAT BRITAIN:
Aberdeen (2BD), 497.1 m., 1500 w., B. B. C. (government).
Belfast (2BE), 438.7 m., 1500 w. Ditto.
Birmingham (5IT), 476.6 m., 1500 w. Ditto.
Bournemouth (6BM), 385 m., 1500 w. Ditto.
Cardiff (5WA), 351.6 m., 1500 w. Ditto.
Daventry (5XX), 1600 m., 16,000 w. Ditto.
Dublin (2RN), 1500 m., Irish Free State Government.
Glasgow (5SC), 421.6, 1500 w., B. B. C. (government).
London (2LO), 362 m., 3000 w. Ditto.
Manchester (2ZY), 376.8 m., 1500 w. Ditto.
Newcastle (5NO), 403.9 m., 1500 w. Ditto.
Nottingham (5NG), 326 m., 1500 w. Ditto.

HUNGARY:
Budapest, 1050 m., 2000 w., Magyar Tavirati Iroda.
Reykjavik, 430 m., 500 w.

ITALY:
Rome (IRO), 434 m., 2600 w., Unions Radiofonica Italiana.
Milan, 308 m., 1200 w. Ditto.

NETHERLANDS:
Hilversum (HDO), 1050 m., 1000 w., N. S. F. and H. D. O.

NORWAY:
Oslo, 381.2 m., 1500 w., Broadcasting Co., A. S.
Bergen, 358 m., 500 w., Bergen Broadcasters.

POLAND:
Warsaw, 480 m., 8000 w., Polski Ericsson.

SPAIN:
Barcelona (EAJ1), 325 m., 500 w., Assoc. National Radiofusion.
Barcelona (EAJ13), 462 m., 750 w., D. Rufino de Orbe Radio Catalana.
Madrid (EAJ2), 335 m., 500 w., Radio Espana.
Madrid (EAJ4), 340 m., 1000 w., Don Antonio Castilla.
Madrid (EAJ6), 392 m., 750 w., Radio Iberica.
Madrid (EAJ7), 373 m., 1000 w., Union Radio.
San Sebastian (EAJ8), 425 m., 500 w., Don Sabino Ucelayeta.

SWEDEN:
Boden (SASE), 1200 m., 1000 w., Radiotjanst.
Goteborg (SASB), 290 m., 500 w., Radiotjanst.
Karlsborg (SASF), 1365 m., 1000 w., Radiotjanst.
Malmo (SASC), 270 m., 500 w., Radiotjanst.
Stockholm (SASA), 427 m., 100 w., Radiotjanst.
Sundscall (SASD), 545 m., 500 w., Radiotjanst.

SWITZERLAND:
Berne, 302 m., 1500 w., Post and Telegraph Office.
Berne, 435 m., 1500 w., Radio Club.
Geneva, 760 m., 500 w., Radio Broadcasting Society.
Lausanne (HB2), 850 m., 600 w., Champ de l'Air Station.
Zurich (RGZ), 515 and 650 m., 500 w., Zurich University.
Zurich, 514.1 m., 1000 w., Radio Genossenschaft.

YUGOSLAVIA:
(HFF), 1650 m., 2000 w.

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Anl one hearing mi sigs pse qsl. All qsls answd. Xmitter hr: 10 watt Hartley.

By 6BBV, J. Barsby, 1010 Bates Ave., Hollywood, Calif.

1aao (1cmx) 1cpf, 2ahm, 2ahk, (2atc) 2au, 2xg, 3bva, 3tr, 4fa, 5agn, 5alj, 5akt, 5ank, (5aq), (5ato), 5aty, 5auq, 5avf, 5bn, 5lt, 5mb, 5pk, 5qy, 5va, hu6axw, hu6buc, hu6dbl, hu7dcf, 7aae, 7abz, 7adf, 7alk, 7amf,, 7bm, 7df, 7do, 7ef, 7ew, 7gb, 7ge, 7gm, 7ho, 7jc, 7kk, 7mg, 7oc, 7or, 7pu, 7dl, 7ru, 7tk, 7uz, 7wc, 7wq, 7yk, 8abl, 8bg, (8csr), 8cug, 8dan, 8fj, 8zu, 9acr, (9adn), 9alk, 9aoi, 9aon, 9atq, 9atv, 9bib, 9bmd, (9bqo), 9bv, (9caa), 9caj, 9caw, 9ckm, 9cjs, 9cj, 9cp, 9cul, 9cuz, 9cwz, 9cxc, (9dez), 9dkm, 9dmw, 9dpu, 9eak, (9edc), (9eeh), 9eel, 9egy, 9eji, 9fb, 9fj, 9im, 9jh, (9kd), 9qy, 9uq, 9vl, (9wl), 9xl, 9xm, 9zt. z1ao, z1aw, z1fq, (z2ac), z2ae, z2aj, z2ak, z2am, z2bx, (z2ga), z2so, z2xa, z3af, (z3ai), z4ac, z4am. a2cg, (a2gq), a2hl, (a2ss). a2yi, a2yx, a3ef, a3im, a3xo, a5kn (a7cs). (c4bf), (mjh), jlaa. picd8. (plwvz), wxf, npl, npm, whq, wiz, kel, vgm.

By 6BZR-6CXU, 1720 S. Catalina St., Los Angeles, Calif.

U. S.: u1cmx, u1qb, u2byg, u2ctf, u2cu, u3zo, u3ot, u4cu, u5aky, u5apo, u5uk, (u6abn), (u6ae), (u6bdw), (u6chm), (u6cxn), (u6dal), (u6deg), (u6des), (u6hf), (u6or), (u6yd), (uex9cme). u7gy, u7hf, u7jc, u7ki, u7jf, u7mn, u7mz, u7nz, u7ps, u7uq, u8aof, u8bay, u8bpl, u8bjf, u8cbr, u8chp, u8cks, u8ded, u8dmm, u9aoa, u9dbq, u9dpw, u9wi, u9wd. New Zealand: z1ax, z2xa, z3xb, z4aa, z4am, z4av, a3ls, hu6cst, hu6bc, hu6bdl, hu6bv, hu6buc, hu6ccr, hu6dcf, hu6eg, ch2ar, ch2ah, ch2id, ch4aq. Canadian: c3by, c4dy, c4dq, c4gt, m1x, m5c. m9a, bb3?, ab1?, nkf, wiz, ccf?, fr5?, anf?. qra of those marked with question marks? w'l qsl all cr'd's.

By I. M. Carlson, 2527 Ross, Dallas, Texas, 5AKG.

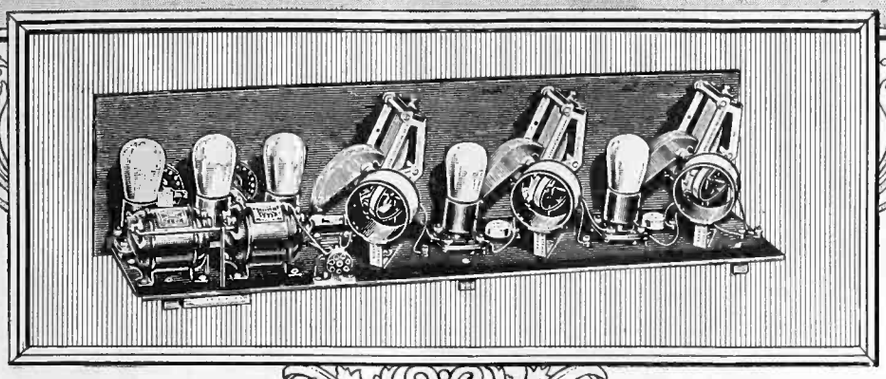
1aae, 1aep, 1blf, 1ccz, 1fl, 2af, 2anx, 2awq, 2crc, 2cxl, 2gv, 2kg, 2nf, 2pl, 2pu, 2qb, 2rr, 2uo, 2xaf, 3aad, 3af, 3al. 3bjt. 3ckl, 3lk, 3pw, 3zo, 4aah, 4am, 4aw, 4bu, 4bx, 4by, 4dd, 4fm, 4fw, 4go, 4hl, 4hl, 4iq, 4is, 4jn, 4jr, 4ko, 4ni, 4ot, 4pf, 4pl, 4pz, 4qb, 4ri, 4rr, 4ry, 4se, 4si, 6abb, 6adk, 6adv, 6aiv, 6ajm, 6akm, 6arx, 6asv, 6auf, 6bam, 6bbn, 6bgc, 6bgt, 6bjl, 6blw, 6bsz, 6bv, 6bxc, 6byc, 6cap, 6cbj, 6cgw, 6cjl, 6ckw, 6cmt, 6cub, 6cuni, 6cuw, 6cvv, 6cwg, 6dcq, 6ddo, 6dp, 6dx, 6ea, 6ge, 6hv, 6ky, 6np, 6rj, 6sz, 6xs, 6zr, 7ag, 7wc, 7wu, 8aaj, 8acx, 8ada, 8aim, 8amd, 8ara, 8atv, 8axf, 8ayp, 8bcx, 8bns, 8bpe, 8brc, 8brf, 8brl, 8bth, 8byf, 8cbr, 8ccm, 8ci, 8cks, 8dew, 8dia, 8diq, 8dqk, 8dsy, 8ef, 8eq, 8oq, 8ry, 8sx, 8sy, 8ul, 8zz. Miscellaneous: a6bg, a5bo, a3kb, c5am, lp1, m1k, m9a, z1sv, z3cu, z4am, nao, wiz, kel, wnb, npm, fw, wsa, cjo, sa, kely. All crds QSLed.

By 9APY, 3337 Oak Park Ave., Berwyn, Ill., U. S. A.

1aci, 1aff, 1air, (1ajm), 1apv, 1auk, 1avl, 1awe, 1awx, 1byx, 1ch, 1cjh, 1cmp, 1qk, 2abt, 2adu, 2anm, 2avb, 2brg, 2cpo, 2cuq, 2cxl, 2em, 2nj, 2or, (2to), 2uo, 2va, 3acu, 3aig, 3aiy, 3blc, 3bmc, 3bof, 3cdk, 3ceb, (3cjn), 3jw, 3nr, (3ue), 4bt, 4fa, 4ha, 4id, 4iz, 4mi, 4qb, 4si, 5agl, 5amn, 5api, 5auc, 5auz, 5ax, 5dl, (5ed), 5eh, 5lg, 5pi, (5qb), 6akm, 6aod, 6asa, 6bjl, 6cuw, 6dcq, 6pw, 8ade, 8aek, 8aof, 8bbm, (8bfe), 8bmy, 8brc, 8cdv, (8cek), 8ckp, 8cor, 8cxh, 8dks, 8mf, 8vx. Mexican: m-1N, m-9A, m-CYY. Canadian: (c-3cs). Italian: i-1co. Brazil: bz-spc. Commercial: agb, fw, glq, kel, wiz, wva, wvr. Anyone know of x-aou?

Something *NEW & AUTOMATIC* in Radio!

The Karas Equamatic Five Tube Sensation



Licensed Under King Patents Pending

You can bring in every station with equal volume with this amazing new automatic system of tuning

THINK what this means! To be able to turn your dials from one end of the scale to the other, bringing in all intermediate stations with exactly the same clear, pure tone and volume. No forcing of tubes at high wave lengths. No troublesome oscillations on lower wave lengths. No need to touch your rheostats when tuning from one station to another. You can get these results with the Karas Equamatic because this circuit makes it possible for the first time to operate your tubes at their highest point of efficiency ON ALL WAVE LENGTHS.

An Old Radio Problem Is Solved

Ever since broadcasting first began radio engineers have strived to find a way to keep tubes operating constantly at their highest point of efficiency. In the Karas Equamatic System this problem has been solved completely by an entirely new form of R. F. transformer design that keeps the tubes operating just below the oscillation point CONSTANTLY and AUTOMATICALLY at ALL wave lengths from 200 to 600 meters. This new transformer design provides an ABSOLUTELY EQUAL TRANSFER OF ENERGY from primary to secondary coils throughout the entire range of broadcast wave lengths and that is the secret of this receiver's high efficiency.

The Equamatic Working Principle

In designing the Equamatic System the inventor has separated the primary and secondary coils from each other. Then by a very simple mechanical method he has made it possible to vary the coupling between these two inductances at an ever-changing rate so that there is always just the right amount of energy transferred from the primary to the secondary coils. This variation of coupling takes place automatically in exact step with the movement of the condenser plates simply by turning the condenser dials in the ordinary process of tuning.

Karas Micrometric Dial

Primaries Attached to Condenser Shafts

In the Equamatic transformer the primary coil is mounted by a swivel connection to a sleeve-like fitting that slips over the extended shaft of the condenser. The secondary coil is carried on the sub-panel by means of a sliding bracket that makes it possible to push this coil toward the primary or away from it. The adjustable features of both coils give perfect control of the degree of coupling and also the rate of variation as the dials are turned.

Unbelievable Sharpness and Selectivity

In the Karas Equamatic five-tube sensation the energy transfer between primary and secondary coils is always at the practical maximum for EVERY WAVE LENGTH setting of the dials. Due to this PERFECT coupling and the positions and angles at which coils and condensers are placed, there is no overlapping of electrostatic and electromagnetic fields with their harmful broadening and distorting effects. The result is that every part works at its highest efficiency. Stations snap in and out with remarkable sharpness and precision. The Karas Equamatic is as sensitive as a regenerative set, as selective as a super-het and as clear and pure as a crystal receiver.

Power, Volume and Tone Beyond Your Expectations

The NEW Karas Equamatic receiver is powerful and rangy with a tone quality and volume that has never been approached by any other five-tube set. Reproduction is the most natural of any multi-tube receiver you have ever heard. Build one of these sets yourself and you will experience a brand new thrill from radio.

The Equamatic Is Easy to Build

Set builders all over the country are building this powerful, clear-toned, long-range receiver easily and quickly. Even though you never have built a set before you can build this one by following our simple and easily understood instructions. Packed with every set of Karas Equamatic Coils is a complete manual of simple diagrams and instructions showing where to place every part and telling you exactly how each connection is made. This manual also gives you in full detail a completely illustrated explanation of the system. To build this receiver you will need the Karas parts listed below, plus other standard parts that you can easily secure.

Order From Your Dealer or Direct From Us

Karas Equamatic parts are carried in stock by reliable dealers in most cities. If your dealer happens to be out of stock order direct from us by using the coupon below. Send no money. Just pay the postman the price of the parts plus a few cents postage.

Essential Parts of the Karas Equamatic Sensation

Karas Equamatic Inductance Coils  are packed three in a carton and come to you with complete manual of simple diagrams and instructions, all necessary nuts, screws and binding posts, ready for mounting in your receiver. Price, set of three coils.....$12.00

Karas Special 17-Plate Orthometric Condensers, three of which are used in the Equamatic Receiver, have special extended shafts upon which to mount the primary coils of the Inductances. Price, each .....$7.00 

Karas Harmonik Audio Frequency Amplifying Transformers are essential to the tone quality success of the Equamatic Receiver. Two of these are used for the two stages of Audio frequency amplification. Price, each .....$7.00 

Karas Equamatic Retard Coils, two of which are used, were designed especially for the Equamatic System. Price, each $1.00

Karas Equamatic Sub-Panel Brackets. To insure the necessary exact positions of primary and secondary coils these brackets are essential. Price, set of three.....70c

Karas Micrometric Dial. It has a 63 to 1 vernier and tunes to 1/1000 of an inch. Price $3.50

KARAS ELECTRIC CO.,
1047 Association Bldg., Chicago, Illinois

Please send me a set of 3 Equamatic Inductance Coils, $12.00; 3 special Orthometric Condensers with extended shafts, $7.00 each; 3 Micrometric Vernier Dials, $3.50 each; 2 Harmonik Audio Transformers, $7.00 each; 2 Equamatic Retard Coils, $1.00 each; and 3 sub-panel brackets, 70c, for which I will pay postman $60.20, plus postage, upon delivery. It is understood that I have the privilege of returning any of this apparatus for full refund any time within 30 days if it does not prove entirely satisfactory.

Name.....

Address.....

City.....State.....

(If cash accompanies order we will ship postpaid)

KARAS ELECTRIC COMPANY

1047 ASSOCIATION BLDG., CHICAGO

RADIO DIAGRAMS

(*Continued from Page 24*)

it from howling, squealing, grunting, sizzling and what not! Why? Because the first two stages of radio-frequency amplification are not neutralized. You have heard of neutralization, haven't you? All it means is that the internal

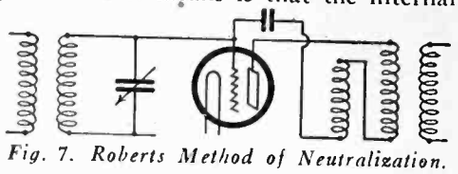


Fig. 7. Roberts Method of Neutralization.

capacity of the tube is balanced in such a way as to prevent it from squealing. The grid and plate of tubes are not connected to each other, being slightly

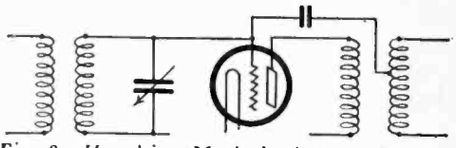


Fig. 8. Hazeltine Method of Neutralization.

spaced, and any two electrical conductors in proximity to one another will act as a condenser, resulting in a definite capacity. There are several methods used to neutralize the grid-plate capacity of tubes.

If we want to ascertain whether or not the R.F. stages are neutralized, we look at the radio-frequency tubes to see if a condenser symbol, either fixed or variable, is connected between the grid and plate leads of the tube. This is shown as a fixed condenser in Fig. 7, originated by Prof. Roberts. Fig. 8 gives the well-known neutrodyne method. The neutralizing condenser is connected between the grid of one R.F. tube to the center of the secondary of the next R.F. transformer, the net result being the same, as the secondary is inductively-coupled with the primary, the latter being directly connected with the plate of the neutralized tube.

It would be well for the beginner to remember that only tubes operating at radio frequency need be neutralized, never the detector or audio-frequency amplifier tubes, as they operate at audio-frequency. In fact, regeneration is used to encourage the detector tube to oscillate!

Oscillation can be controlled by a potentiometer in the filament circuit of an R.F. tube, or by reducing the number of turns on the primary winding of the R.F. transformer (which is connected to the plate of the R.F. tube). The sensitivity of the set is decreased by the latter method and is therefore inefficient. Bear in mind that the above two methods bring oscillation of an R.F. stage under control, thereby making tuning more stable, but this is not known as neutralization.

In the foregoing paragraphs we have taken up the methods of differentiating between regenerative and non-regenerative circuits, radio and audio-frequency

amplifiers, and neutralized and unneutralized tubes. The transformer type of audio amplification was explained, as it is by far the most commonly used.

Another popular and efficient circuit is the reflex, best known for tube economy. The diagram in Fig. 9 shows the Harkness reflex. It is very easy to tell at a glance, once we know a few simple fundamentals.

Let us see how the reflex does away with tubes. The first one on the left we know is a radio-frequency amplifier, (1 stage R.F.) because there is no condenser or grid leak in its grid lead. Now we start from the plate as formerly and we see the plate is tuned by a variable condenser connected or shunted across a coil inductively coupled to the plate coil. Then we come to the symbol for the mighty little crystal detector, which, of course, does the detecting, or rectifying of the output of the preceding R.F. tube. Next we trace the two wires leading from the coil and crystal and come to the familiar audio-frequency transformer symbol. The rectified current is boosted by it, and it has a clear path to the grid of the first tube again, this time the tube acting as an audio-frequency amplifier!

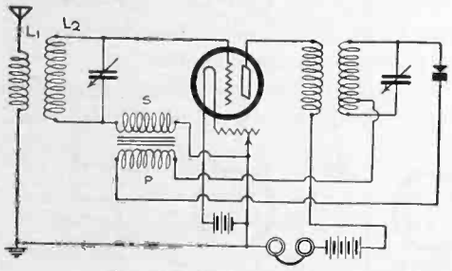


Fig. 9. Harkness Reflex.

Why? Because its grid is connected (through coil L_2) to the secondary of an audio-frequency transformer, isn't it?

You will recall that radio frequencies are all frequencies higher than audio frequencies, so they are vibrating at widely differing rates, and therefore do not bother each other while "passing through" the tube. The result is we have "one stage R.F., detector (crystal) and one stage A.F.," all on one tube.

In a few words, how can we tell if a circuit is reflexed? If the secondary of an audio-frequency transformer is connected to the grid circuit of a preceding tube it is reflexed, (or turned back). The grid circuit comprises all instruments that are connected between the grid of the tube and the filament lead wire. The lower connection running from secondary coil of an R.F. transformer to filament of tube is called the "grid return." This is generally where the secondary of an A.F. transformer is attached when it is a reflex, seldom any other part of the grid circuit.

We have taken up enough of the fundamentals of radio frequency amplifiers and detecting circuits to be able to read a diagram with these units incorporated. The only type of audio-frequency amplification discussed was the straight trans-

former-coupled. Needless to say, radio-frequency amplification always precedes the detector, and audio-frequency amplification comes after the detector tube (or crystal), so we will find out how to ascertain the various methods of A.F. amplification by the diagrams. First we will take the push-pull system. This employs two tubes and two transformers for one stage. Not economical, is it? But it has the advantage of a high rate of amplification with a minimum of distortion, and is utilized for power amplification, as it can stand high plate voltages.

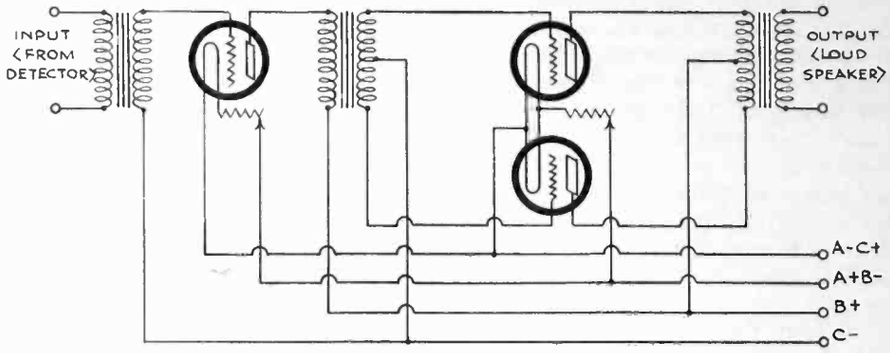


Fig. 10. Push-Pull A.F. Amplification.

In Fig. 10 is pictured one stage of ordinary transformer-coupled amplification followed by one stage of push-pull amplification, the detector tube being omitted. Note the transformer symbols. They are different than the ones in the other diagrams, as they have taps or wires leading from the center of their windings. The one on the left has a wire leading from the center of the secondary coil. (Primary windings or coils are always pictured on the *left* side of the transformer symbols, the secondary on the right). Remember, primary on left, secondary on right. That applies to R.F. transformers also. The transformer on the right has a middle tap on the primary.

Nine times out of ten push-pull stages have the tubes drawn under each other, so that is one way of knowing them. The best and surest method is to start at the grid of the tubes in doubt, as we did previously. If the grids of both tubes are connected to the secondary of the SAME transformer (one lead at each end) and the plates of the same tubes are similarly connected to the primary of the *next* transformer, that indicates one stage of push-pull amplification. The transformers always have a middle tap, one with a tapped secondary for the input and the other with a tapped primary for the output end.

Now we will see how we can tell what is usually called resistance-coupled amplification. It should be termed resistance-condenser-coupled to differentiate between resistance-battery-coupled.

A glance at Fig. 11 informs us no transformers are used in this amplifier, as no symbols for such appear.

Instead of having a transformer between the plate circuit of one tube and the grid of the next, as in the other two types explained, this system has a fixed condenser (see symbol in Fig. 1). Note the resistances which are connected to each side of the condenser, so it is appropriately termed resistance-condenser-coupled amplification, or just plain "resistance-coupled." The other form mentioned before employs a small *C* battery in place of the condenser between the plate of one tube and grid of the other, and only uses one resistance, it being in the plate circuit of each tube. This system is called resistance-battery-coupled or aperiodic resistance-coupled. As it is rarely utilized, we will not picture it.

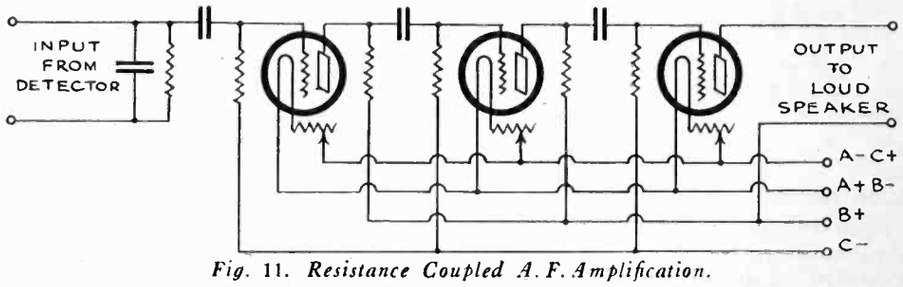


Fig. 11. Resistance Coupled A.F. Amplification.

(*Continued on Page 74*)

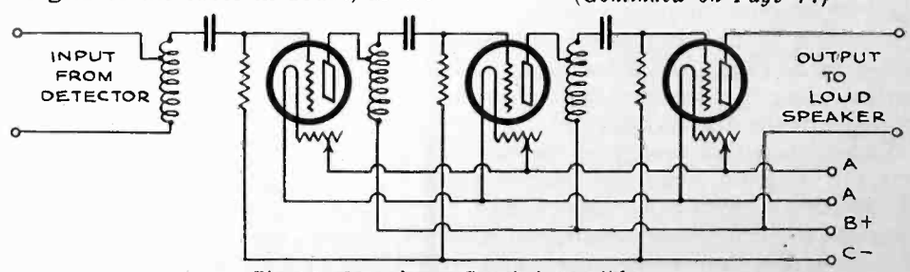


Fig. 12. Impedance Coupled Amplifier.

RADIO DIAGRAMS

(Continued from Page 72)

Probably you have heard of impedance-coupled amplification and have listened to a set incorporating it, but when you saw a diagram of such an amplifier circuit it meant nothing to you.

As in the previous paragraphs, it is not necessary to understand the operation and theory of the "whole works" to know it when it is drawn. An impedance-coupled amplifier circuit is shown in Fig. 12.

Looking it over you will notice that a single coil tapped in the middle is used as the coupling device between tubes, it acting as both primary and secondary. This coil symbol represents an autoformer, which has the appearance of an ordinary transformer outwardly, but with three instead of four connections. Observe the similiarity of this system with the resistance-coupled in Fig. 11; the autoformers being in the place of the plate resistances. The rest is practically the same.

If you have absorbed the foregoing simple non-technical methods, and believe you are capable of reading ordinary diagrams, study the circuit in Fig. 13 before you go further, and see if you can tell if it contains r. f. amplification, and if so, how many stages? Neutralized? Which tube is the detector? Regenerative or non-regenerative? How many stages of a. f. amplification? Will it get distance? Loud speaker operation? How many controls? And does it use an outside or loop aerial?

Try to answer the above questions before reading the following answers:

It is a four-tube Roberts' circuit. Briefly analzed, we see it has one stage of neutralized r. f. amplification, regenerative detector, 1 stage reflexed a. f. amplification and one stage push-pull amplification. This set is capable of getting distance because of r. f. amplification, and a sensitive detector due to regeneration. It is designed for an outside aerial, as no loop aerial symbol is pictured. The a. f. stages assure us it will operate a loud speaker.

In the matter of controls, it employs two variable condensers for tuning, tickler for regeneration (rotor of variocoupler), a variable primary coil and three rheostats regulating the filament current for their respective tubes, which means three major controls and four minor ones.

If you succeeded in answering the above questions you have actually dissected a fairly complicated hook-up.

The reader would probably desire to learn the merits and disadvantages of the circuits mentioned in this article, so we will give them with the understanding that they will apply to the various circuits only as a general guide, owing to the many factors involved.

The non-regenerative circuit in Fig. 2 will give exceptionally clear, but not strong, signals without any howls while tuning. The regenerative hookups of Figs. 3 and 4 will give much stronger signals, more distance, more selectivity than the non-regenerative, but will howl badly in the hands of an inexperienced operator, and the neighbors will pick up the howls radiated by these sets.

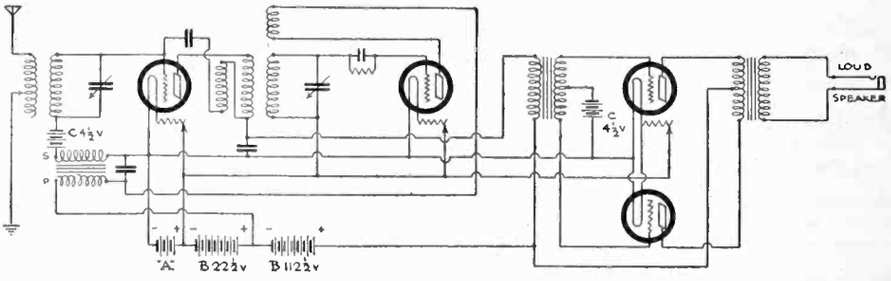


Fig. 13. Four Tube Roberts Circuit.

The three-tube regenerative in Fig. 5 will have the same characteristics, with additional volume to operate a loud speaker. The five-tube circuit of Fig. 6 was discussed before.

Reflex circuits, one of which is pictured in Fig. 9, will give good quality reproduction with excellent volume, and if well designed will not squeal. As a rule, reflexes are only fairly selective, therefore unsuitable for congested broadcast areas.

There are many arguments pro and con, among radio engineers, concerning the best method of amplification. With the appearance of the large core transformers on the market, the question now seems to resolve itself into how much a person will spend for results.

The upkeep of a two-stage ordinary transformer-coupled amplifier is comparatively low, and if cheap transformers are used the initial cost will be smaller than with other types, and distortion will naturally result. This distortion is minimized by using better transformers. Resistance-coupled amplifiers give good quality and little distortion if proper size coupling condensers are employed. Three tubes and more plate voltage (*B* batteries) are needed to equal the volume of the two-tube transformer type.

Impedance coupling requires three tubes also, but there is less drain on the *B*-batteries than with resistance coupling. Quality is excellent.

The push-pull type usually is one stage of transformer coupled and one of push-pull, total of three tubes, and with high plate voltage will give the most volume with a minimum of distortion.

Some circuits utilize two methods of audio amplification, for instance, one stage of transformer-coupled, and two stages of resistance-coupled following it. Another might have two stages of impedance-coupled amplification following a stage of straight transformer coupled, and so on. The same systems are used to trace them, as described previously.

Providing the reader has closely followed this article, he will be in a position to experiment with circuits more systematically, and ought to know what to expect from a circuit by studying a diagram of it.

Ordinary bell annunciator wire is excellent for wiring a receiving set. This wire, which is about No. 18, comes with various colored insulation. Thus, wire with insulation of one color can be used to wire the filament circuit, insulation of another color can be used in the plate circuits, and a third color can be used for the grid circuits. Using wire with different colored insulation for the different circuits has the advantage that it makes the set more simple and easy to wire; and makes the tracing down of trouble in the finished set less difficult. Connections between instruments should run as straight and direct as possible. Annunciator wire is cheaper than bus-bar and spaghetti tubing, and, when connections are run direct, makes much more efficient wiring; though it does not make such a fancy-looking job as does the bus-bar.

Dry cell batteries that are too far run down to work as filament batteries still have enough voltage to make good substitutes for standard *C* batteries. Very little current is needed in a *C* battery; the voltage being most important. A dry cell that has been used to light the filament of a C-299 tube until it has become too weak to operate the tube will usually register about one volt. Batteries that are bulged out or eaten through the zinc are no good. Four or five used dry cells is about the right number to use with an amplifier employing 90 volts on the plates of the tubes. If worn dry cells are used, a one-half to two microfarad condenser must be connected across the battery to keep the voltage steady.

A neat way for the amateur and broadcast listener to keep their QSL cards and reports of reception cards so they will be handy is to file them in a cardboard or wooden box. The amateur can divide the QSL cards he has received into districts by regular index cards; and the broadcast listener can divide the cards acknowledging his reception of broadcast concerts into states. A file with a good number of DX report cards makes an interesting exhibit of the range of a receiver or transmitter.

RADIO FOR SOUTH SEA EXPEDITION

Zane Grey, the novelist, is taking his big schooner, the *Fisherman,* for a year's cruise to Australia, New Zealand and the South Seas (recently made famous by Gilda Grey). Wilford Deming, Jr., of Los Angeles, is installing aboard her the finest of long and short wave radio equipment. There will be a Navy-Marconi ½ kw. spark on 600, 700 and 800 meters, and a 1 kw. 500 cycle tube transmitter on the amateur bands of 20, 40 and 80 meters, to be normally operated on 40 meters. The receivers will be as follows: Grebe equipment throughout, a CR7 for long waves CR6 for commercial traffic and broadcast reception, and a CR18 for the short wave traffic. As the purpose of this extended trip to the South Seas is more or less of a scientific nature, the value of reliable radio communication is evident. Mr. Deming will accompany Mr. Gray as radio operator, leaving early in November. Schedules are now being formulated and it is expected that this ship will become a center for all radio traffic to and from ships in the South Pacific ocean.

U. C. RADIO CLUB

Things at the University of California Radio Club at Berkeley, Calif., are again in full swing. Lester D. Culley, '27, 6ACO, has been elected president; C. White, 6MP, hooked the chief Op's job and J. M. Barnett was elected secretary. New members were initiated into the organization at an informal dinner. Everything was conducted in an orderly, yet underhanded manner, and all the neophytes stood the test to perfection. The initiation committee consisted of J. Barnett, 6CTI, A. Binnewig, Jr., 6BX-6XAA, and L. H. Sortais, 6ANT. At a short business meeting held at the conclusion of the exercises it was decided to buy equipment for a powerful short-wave transmitter. 6BB is to be overhauled and will soon be on the air again with new equipment. The entire membership intends going down to the Hamfest to be held at San Jose in October.

INFRADYNE

(*Continued from Page* 36)

In the original infradyne circuit, the input radio frequency amplifier tubes were controlled with the filament rheostat. This means of control is rather abrupt when the set is lined up and operating from a small antenna, and if desired, a smoother control may be had by the method shown in Fig. 3. In that circuit, the tube filaments are supplied with current through a half ampere ballast resistor, and the control is accomplished with a 500,000 Centralab or Carter variable resistance inserted in the *B* battery lead. A 1 mfd. bypass condenser must be connected between the plate side of this resistance and the filament to provide a low resistance path for the high frequency current.

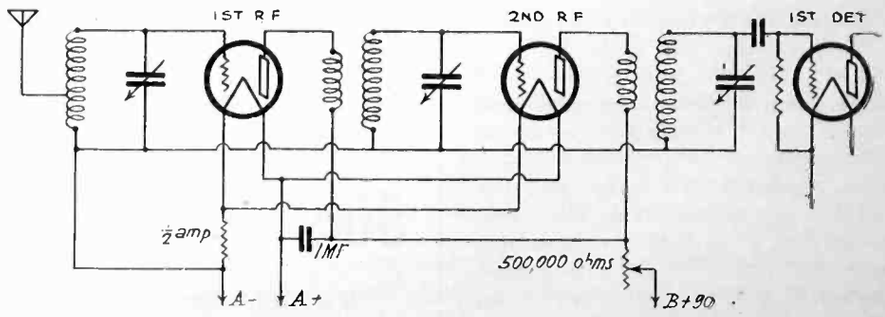


Fig. 3. New Plate and Filament Circuits for First Two Tubes.