JAN. 28 1928 Vol-17 No-19 15c
305

RADIO WORLD
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America's First and Only National Radio Weekly

THE DAVEN AC FIVE

Impedance of Condensers Explained for Novices

3-TUBE PRE-POWER UNIT

A Quality Analysis of Resistance Coupling

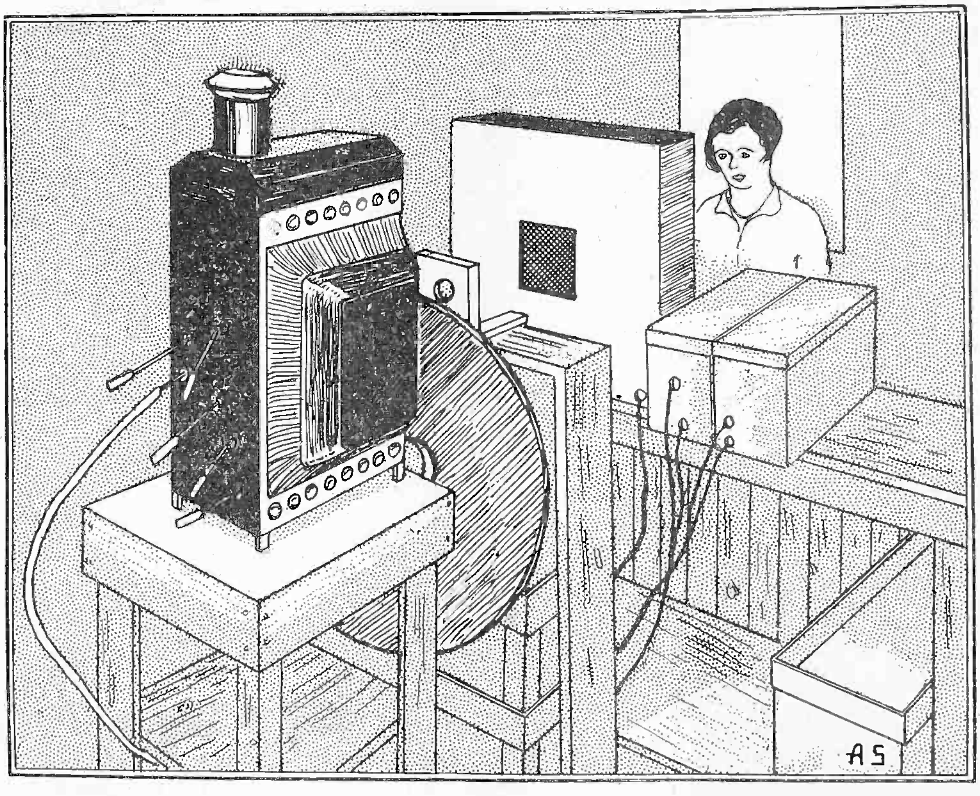
AERIAL COUPLING METHODS

An AC Audio Circuit with B Supply

ELECTRO-DYNAMIC SPEAKERS

Broadcast Bouts Debated

HOME TELEVISION DEMONSTRATED



TELEVISION PROJECTOR used for transmitting vision from the laboratory of the General Electric Company, Schenectady, to homes in that city. The large disc, in revolving rapidly, causes the beam of light from the arc light to cover the picture to be transmitted. The reflected light falls on photo-electric cells, which convert the light fluctuations constituting the picture into equivalent electric current fluctuations. See article on Page 3.

HOW TO BUILD RADIO WORLD'S Four-Tube Universal Receiver fully described by Herman Bernard in the March 12, 19 and 26 issues of RADIO WORLD. Send 45c. RADIO WORLD 145 West 45th St., N. Y. C.

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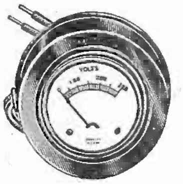

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[Entered as second-class matter, March, 1922, at the post office at New York, N. Y., under Act of March, 1879]

Home Television Demonstrated

Alexanderson's Receivers in Three Points in Schenectady Pick Up General Electric's Broadcast of Moving Vision on 37.8 Meters While the Voice of the Subject Is Brought In on egular Radio Set on 379.5 Meters—Curl of Cigarette Smoke and Flash of an Eye Clearly Visible—Forerunner of Machines for Home Use Still Under Experiment

Schenectady.

RADIO television leapt the barrier between the laboratory and the home in the first demonstration of television broadcasting, arranged by the Radio Corporation of America and the General Electric Company. At three different points in this city, including the home of E. W. Allen vice-president of the General Electric Company, groups of engineers, scientists and newspaper men, standing before the first "home television sets" ever to be demonstrated, saw the moving images and heard the voices of a man and a woman transmitted from the research laboratories of the General Electric Company, several miles away.

So lifelike were the lights and shadows reproduced from the research studios that the curl of smoke from a cigarette and the flash of an eye were transmitted by radio just as a picture unfolds on a movie screen.

The first home television set is of very simple construction, not unlike the familiar phonograph cabinet in size and exterior appearance. It was developed by Dr. E. F. W. Alexanderson, consulting engineer of the Radio Corporation of America and of the General Electric Company, and his assistants in the laboratory here.

Uses Short and Long Waves

In this instance the transmission of the moving object was made on 37.8 meters wavelength, while the voice was simultaneously sent through the air on 379.5 meters, the normal wavelength of WGY.

The receiver which Dr. Alexanderson used differs from the ordinary short wave receiver in that it converts the electromagnetic wave into light instead of into sound, and the light becomes an image corresponding in movement to the action of the artist at the transmitting end.

"While this is an historical event comparable to the early experiments in sound broadcasting, the greatest significance of the present demonstration," declared David Sarnoff, vice president and general manager of the Radio Corporation of America, "is that the radio art has bridged

(*Continued on page 5*)

E. F. W. ALEXANDERSON, CHIEF CONSULTING ENGINEER OF THE GENERAL ELECTRIC COMPANY AND INVENTOR OF A SUCCESSFUL TELEVISION APPARATUS FOR HOME USE, SEATED IN FRONT OF A TELEVISION RECEIVER AND VIEWING AN ANIMATED PICTURE SENT BY RADIO FROM THE LABORATORY IN SCHENECTADY. SYNCHRONIZATION BETWEEN THE TRANSMITTER AND THE RECEIVER IS EFFECTED MANUALLY WITH THE LITTLE DEVICE SEEN IN THE HANDS OF THE INVENTOR.

Dr. Alexanderson Outlines

Technique of Home Television Machine

By Dr. E. F. W. Alexanderson

Chief Consulting Engineer, Radio Corporation of America, and General Electric Co.

BEFORE we could think seriously of television broadcasting we had to convince ourselves that a television receiver could be simplified to the point where it could be made available in the home of the average man.

To test out the practicability of a television receiver for the home we constructed a model receiver of the greatest possible simplicity and distributed several duplicates of it in some homes in Schenectady.

Television receivers may be worked out in a variety of ways according to well-known principles. The first choice to be made was to select the source of light. This choice was soon narrowed down to two alternatives: the light control developed by Professor Karolus of Leipsig and the Neon lamp developed by D. McFarlan Moore of the Edison Lamp Works of the General Electric Company.

Tests of these two sources of light for television soon convinced us that each has its own distinct field of usefulness.

When a large volume of light is needed for projection on a screen the Karolus system is preferable. The work on television which I described in a paper last year was built around the idea of using the Karolus light control for projecting television images on a large screen.

Moore's Lamp

The other light source available for television was the lamp invented by Mr. Moore, who proposed this lamp for television in a paper as early as 1906 but it was not until 1913 that he received a quantity of neon from Sir William Ramsey which enabled him to construct a practical lamp.

While the Neon lamp does not compare with the Karolus light in brilliancy it is more sensitive and easier to operate.

The distinct fields of usefulness of these two systems thus become evident, the Karolus light for the large television projector and the Moore light for the home receiver.

Most experiments with television in Europe, as well as America, have used the Moore lamp.

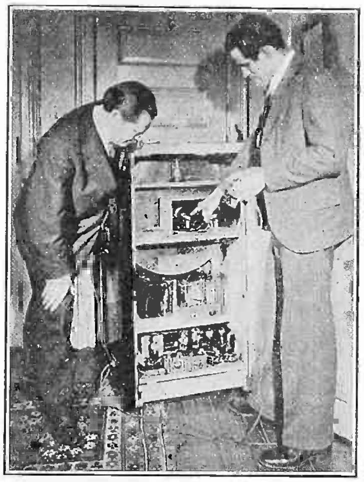
Mr. Moore has developed one television lamp which gives a uniform glow over a flat plate and another which gives a concentrated light in a cavity in the electrode. An enlarged and improved lamp of the first type was one of the important elements used in the demonstration of television by Dr. Ives of the Bell Laboratories last April. The tubular lamp, with 2,500 electrodes was also based on the Moore invention.

Photo-Electric Cells

One of the features of the demonstration by the Bell Laboratories at that time appears to be a valuable contribution to the art of television,—the arrangement of large photoelectric cells for intercepting the reflection from a moving spot of light. The system saves the eyes of the subject from the glaring light to which otherwise he would be exposed.

The Bell Laboratories photoelectric system has ben adopted in our equipment for broadcasting television and will probably prove to be one of the factors in the development of practical television.

Returning to the design of the television receiver, we had the choice between three well known systems,—the mirror drum, the disc with lenses and the disc with holes. Our conclusion was that, while the mirror drum and the lens disc may have certain advantages for television production on a larger scale, from the point of view of television in the home a hole is more economical than a lens and 48 holes are more economical than 48 lenses.



THE RECEIVER OF THE ALEXANDERSON TELEVISION SYSTEM SET UP IN A HOME NEAR THE GENERAL ELECTRIC COMPANY AT SCHENECTADY. THE LARGE DISC DETERMINES WHAT PART OF THE FIELD IS RENDERED VISIBLE.

Whenever television has been discussed in the past there has always been some pessimist who has wound up the discussion by asking: "How are you going to synchronize?" The answer has always been that we will have a synchronous motor and transmit a special synchronizing wave or synchronize to the picture frequency or to a tuning fork. But all these devices mean higher cost, special amplifiers, and more things that may get out of order. We, therefore, simply decided to leave out all of this complication.

Uses Household Motor

We took a standard electric motor made for household use and are manipulating its speed by an electric hand control. With a little practice and coordination between the eye and the hand it is possible to hold the picture in the field of vision as easily as one steers his car on the middle of the road. In special cases when the transmitting and receiving system are on the same power network the machines may be operated by 60 cycle synchronous motors.

Experimental television programs will be continued to be broadcast from a laboratory transmitter on a wavelength of 37.8 meters with the accompanying voice transmission on the regular 379.5 meters of WGY. As soon as it is found that the range can be extended the television transmitter will be transformed to the high power short wave experimental station at South Schenectady. A new transmitter is being built for this purpose so that the voice and the television can be radiated simultaneously by two transmitters.

We feel that the inauguration of this new development will be the starting point of practical and popular television. The transmission is the expensive part of such an undertaking and we feel that it is our privilege to provide it. We show the television transmitter which is nearly completed at our South Schenectady plant.

New Type Antenna

A part of this equipment is a new type of projector antenna which is now being tested with music and voice modulation, and favorable results have already been observed in San Francisco and Europe. We have called this a projector antenna because it does not pretend to be a beam. The radiation that would be wasted backward and sidewise is saved and projected in the general direction where it is desired.

After trying several types of projector systems we have arrived at a type which we call the checkerboard antenna, built in a checkerboard pattern, the sides of each square being a wire half a wave-length long. All these half-wave antennas are connected in such a way that they oscillate in phase and require no tuning or adjustment.

A duplicate of this transmitter is being installed in the San Francisco broadcast station of the General Electric Company. This plan was decided on to provide means for systematically studying the physical phenomena of wave propagation over long distances.

Television will here serve as a means to an end, but in the determination of wave phenomena one thing is certain, that the eye is infinitely superior to the ear for ascertaining facts and for a critical analysis and comparisons. This has already been proven by our television tests in Schenectady.

Delving Into Secrets of Space

Occasionally when we "look-in" on television at our homes uptown we observe a visual echo of the wave from the electronic layer on the upper atmosphere. The evidence of the echo is that two images appear side by side instead of one. The echo image is usually displaced a distance, corresponding to one fifteen-hundredths of a second, showing thereby that the echo wave had traveled about 200 kilometers and yet the echo image is occasionally as strong as the direct image which traveled only a few kilometers. Such phenomena obviously can not be observed by the ear.

What we may learn about wave propagation by systematic study of television across the continent is something we can only vaguely imagine, but we do feel without any doubt that television is the new tool by which we are going to explore the secrets of space.

COMPOSER BROADCASTS

Schenectady, N. Y.

Zez Confrey, the composer and pianist with the twinkling fingers, broadcasts every Thursday evening at 6:30 from WGY. Mr. Confrey is the composer of "Kitten on the Keys," "Dizzy Fingers," "Stumbling" and many other pieces which require dexterity and accuracy in the playing. Mr. Confrey and his recording orchestra play at the Hotel Kenmore in Albany.

The Daven AC Five

A Batteryless Receiver of Excellent Quality

By Henry Harbord Chisholm

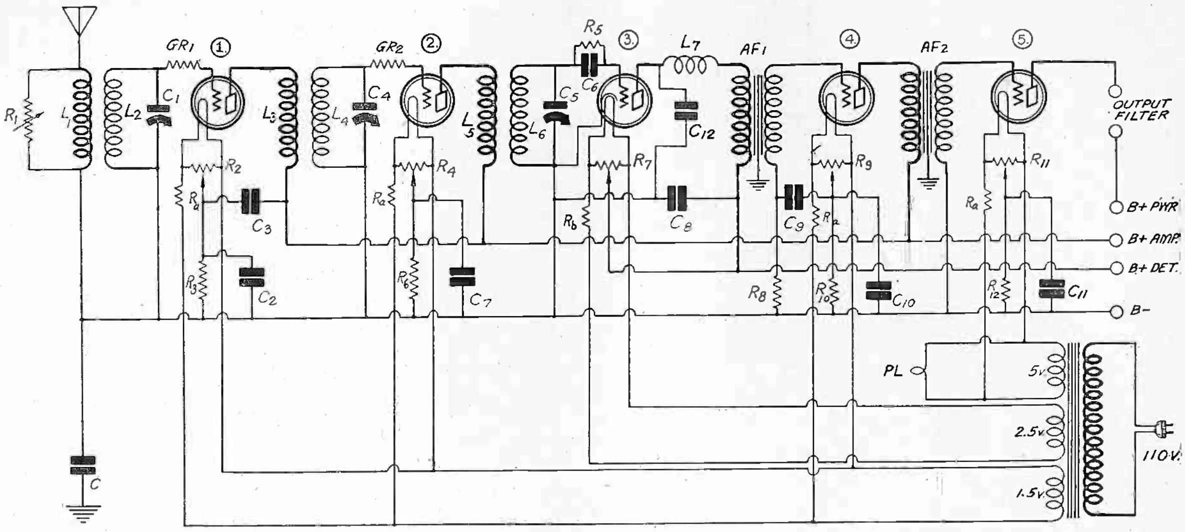


FIG. 1

THE COMPLETE CIRCUIT DIAGRAM OF THE DAVEN AC FIVE. IT COMPRISES A VOLUME CONTROL, OSCILLATOR PREVENTERS, FILAMENT PROTECTORS, GRID BIAS RESISTORS, AND A FILAMENT TRANSFORMER.

THE success of an AC operated receiver is simply a matter of correct design. If care in balancing has not been taken, the receiver may hum. If precautions have not been taken to protect the filaments of the tubes, the life of the tubes may be very short. But hum and brevity of life of the tubes can always be traced to poor design or incorrect assembly of parts. The AC tubes are not inherently short-lived. The hum in many AC sets is avoidable.

Let us consider briefly the Daven AC 5 as an example of correct design.

The correct filament voltages and currents for the various tubes are derived from a Karas AC Former which has three secondary windings of 1½, 2½ and 5 volts. The low voltage winding supplies the filament current to three AC-26

(Continued on next page)

Trained Observers to Test Television Models

(*Concluded from page 3*)

be taken towards the development of television receivers for the home.

"With all that has been accomplished there are still many experimental stages to be travelled before a commercial television service can be established.

"The first step contemplated is the placing of laboratory models of the present television receiver at central and strategically located points so that with the aid of technically trained observers, future experiments may be continued not only in the reception of but in the simultaneous transmission both of sight and sound.

"Sound broadcasting has now developed to an art and industry of world-wide scope and significance.

"The television receiver as at present developed will supplement and not replace the modern radio receiving set in the home. Broadcasting of television, it seems clear, will develop along parallel lines with broadcasting of sound, so that eventually not only sound but also sight through radio broadcasting, will be available to every home."

The elements of the television home receiver are a light source, the scanning device and the synchronizing system. The signal, or electro-magnetic wave from the television transmitter, is received in equipment designed to receive modulations as high as 40,000 cycles.

The amplifier is substantially the same as the amplifier of the home loudspeaker.

The receiving system differs from a modern loudspeaker system in that a neon gas filled lamp is substituted for the loudspeaker. The amplified current is delivered to this lamp, known as the Moore lamp, and which responds to the intensities of the current and gives fluctuations of the light intensity just as a diaphragm of the loudspeaker reproduces pulsations of the air waves.

Field for Experiment

The scanning disc is 24 inches in diameter with 48 small holes, each hole 35 mils in diameter and arranged in a spiral so that each of the 48 holes will pass each other and trace successive lines of the picture, completing or literally painting a picture in one revolution.

In other words, if the disc were revolved very slowly a ray of light through successive holes would trace over the entire object. The disc is revolved by a standard motor, similar to those used in household devices such as the washing machine or vacuum cleaner.

The revolutions occur at a speed of 18 per second, slightly faster than a film passes through a motion picture camera. An observer, looking at this revolving disc as the light from the Moore lamp shines through these small holes, would see the image being sent by radio, but this picture would be only 1½ inches square.

Magnifying lenses enlarge the picture twice, so that it is 3 inches square in the aperture in the front of the receiver cabinet.

Synchronization of the scanning disc of the receiver with the scanning disc of the transmitter is obtained by manually operated control, a push button held in the hand. By means of this button, of the bell ringing type, the picture may be held in the field of vision with a little practice, as naturally after a time as driving an automobile or steering a bicycle.

The reproduced picture or object has a pink color, which is characteristic of the neon gas used in the lamp. D. McFarlan Moore, inventor of the lamp and an engineer at the Edison Lamp works of the General Electric Company, found in early work that this gas was most efficient and most sensitive for reproducing a light which will go on and off in a millionth part of a second.

The transmission system is of the type using a disc with spiral holes, a duplicate of the disc in the receiving machine. A spot light is projected on the object through the moving disc and the reflection of this light is intercepted by photo electric cells, which converts the light to electric waves, ready for the short wave transmitter.

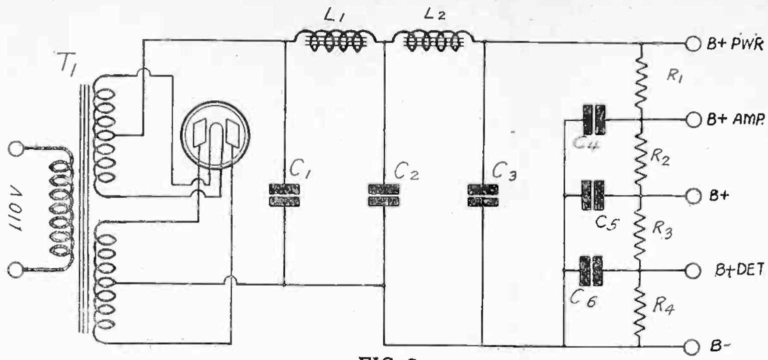


FIG. 2

AN ELIMINATOR ESPECIALLY DESIGNED FOR THE DAVEN AC FIVE RECEIVER. IT MAKES FULL USE OF A FULL WAVE THERMIONIC RECTIFIER THE OUTPUT OF WHICH IS ADEQUATELY FILTERED.

tubes, two of which are RF amplifiers and one of which is the first AF amplifier. The 2½ volt winding supplies the heating current to one AC-27 detector tube. The 5 volt winding supplies the —71A type power tube.

Long Life Assured.

As a protection against surges in the line voltage and consequent possible damage to the filaments, Daven AC ballasts are used. These help maintain the voltage across the filaments constant for variations in the line voltage as great as 20%. This action is due to the fact that the resistor material has a very high temperature coefficient of resistance change at the normal operating temperature. Thus these ballasts, which are marked Ra and Rb in Fig. 1, stand guard over the filaments and insure their long life as well as consistent operation of the receiver throughout the life of the tubes.

The ballasts marked Ra are Daven AC 26 and the ballast marked Rb is a Daven AC 27 ballast. The ballast Ra in the filament of tube No. 5 may be omitted if desired, as this tube is not critical. A 5-volt pilot light is conected across the filament circuit of the power tube next to the transformer. This is a part of the Hammarlund drum.

How Hum Is Banished.

The use of ballast resistors in the filament circuits upsets the balance so that the center taps on the filament transformer cannot be used without introducing hum. In place of the center taps on the transformers artificial center taps are provided with the aid of four 10 ohm Davohms, which are accurately center tapped. These are connected across the filament terminals on the sockets so that even the resistance of the filament leads cannot enter to upset the accurate balance of the center tapped resistors. These center tapped resistors are marked R2, R4, R7 and R9 on the circuit diagram.

R11 is a similar center tapped resistor across the filament of the —71A type tube, but its resistance must be higher than the resistance used for the other tubes. This is due to the fact that the voltage across it is higher and that the resistance of the filament is higher than the resistances in the other tubes.

Suppose the 10 ohm resistance be connected across the filament.

The current through it would be ½ ampere. But the filament of the tube only takes ¼ ampere. Hence the resistor would take twice as much current as the tube, and the drain from the 5 volt winding, exclusive of the pilot light, would be the same as 3 of the —71A tube would draw. The total resistance of R11 should be at least as high as the resistance of the filament, so that the current is no more than doubled. This might be obtained by putting two of the 10 ohm resistors in series and using the junction between the two as the center tap.

Grid bias for all the tubes in the receiver is obtained from drops in resistors. One resistor is used for each amplifier tube as a means of minimizing interstage coupling and the resulting distortion effects on the output. Resistors R3, R6 and R10 serve AC-26 tubes and therefore they are all of the same value. Each should have resistance of 1,500 ohms and should have a wattage rating of 1 watt or more.

Resistor R12 gives the negative bias to the grid of the power tube, and since this is of the -71A type the resistance should have a value of 2,000 ohms. The resistor should have a rating of 1 watt or more because its dissipation will be .8 watt.

Condensers C2, C7, C10 and C11 are connected across the respective resistors to prevent the plate circuit of a tube from feeding back voltage into its own grid circuit and thus decrease the amplification. C2 and C7, which handle only radio frequency currents, need not be larger than .01 mfd., but C10 and C11 which handle audio frequency currents should be at least 4 mfd. each.

C3 is also a radio frequency condenser used mainly for by-passing the leads to the B battery eliminator. C8 is an audio condenser and should be at least 2 mfd. but C12 is a radio frequency condenser and it should not exceed .0005 mfd.

R8 is a resistor inserted in the grid circuit of the first audio tube to prevent audio feed-back. Its value is 100,000 ohms and it is by-passed with a condenser C9 of 2 mfd.

L7 is a Hammarlund j5 millihenry choke coils which is used to prevent the transmission of radio currents to the audio amplifier.

L1L2, L3L4 and L5L6 are three Daven tuning coils which fit the three Hammarlund .0005 mfd. condensers C1, C4 and C5.

The volume is controlled with a variable resistance R1 of 2,000 ohms resistance, which is placed in shunt with the primary of the first RF coil.

(Part II next week)

LIST OF PARTS

L1L2, L3L4, L5L6—Three Daven RF coils for .0005 mfd. condensers.
L7—One Hammarlund 85 millihenry RF choke coil.
AF1, AF2—Two Halldorson overtone audio frequency transformers.
C1, C4, C5—Three Hammarlund .0005 mfd. midline condensers.
C2, C3, C7—Three Carter .5 mfd. condensers.
C6—One Carter .00025 mfd. grid condenser.
C8, C9—Two Carter 2 mfd. by-pass condensers.
C10, C11—Two Carter 4 mfd. by-pass condensers.
C12—One Carter .0005 mfd. fixed condenser.
C—One Carter 1 mfd. condenser.
R1—One Centralab 2,000 ohm variable resistor.
R2, R4, R7, R9—Four Daven 10 ohm center tapped resistors.
R11—Two Daven 10 ohm center tapped resistors.
R3, R6, R10—Three Daven 1,500 ohm? resistors 1 watt type.
R5—One Daven 2 megohm Glastor grid leak.
R8—One Daven 100,000 ohm Glastor.
R12—One Daven 2,000 ohm resistor, 1 watt type.
Ra—Four Daven AC-26 ballasts.
Rb—One Daven AC-27 ballast.
GR1, GR2—Two 1,000 ohm Daven grid resistors.
PL—One 5-volt pilot light.
Thirteen resistor mountings.
One Karas AC Former (filament transformer).
Four Benjamin sockets.
One Benjamin 5-prong socket.
One Hammarlund drum dial.
Six XL binding posts.
Two Frost pup jacks.
One Cortlandt Panel, 7x24 inches.
Three Daven AC-26 tubes.
One Daven AC-27 tube.
One Daven AC-71 tube or UX1NA or CX371A.
Two rolls Acme flexible Celatsite.

Rubber Company Tries Short Wave to Liberia

Washington.

The Firestone Tire and Rubber Company, of Akron, Ohio, has been granted an experimental three month license, to enable it to use a transmitter with call letters 8XAS to communicate with the men in charge at their rubber plantations in Liberia.

The license permits the use of from 200 to 5,000 watts of power on waves from 5.35 meters to 16.6 meters and from 42.8 to 52.6 meters.

Different Colors Used In Benjamin Sockets

The Benjamin Electric Mfg. Co., 120 South Sangamon Street, Chicago, Ill., are now making their famous spring-cushioned sockets according to the color-code adopted by the Radio Manufacturers' Association and the National Electric Manufacturers' Association.

According to this code the sockets for general purpose tubes are made in a rich maroon color and the sockets for detector tubes are made in a dark green color. The green detector sockets are made for both four and five prong tubes, so that both the special detector and the heater type of tubes are provided for. The maroon sockets fit all the standard amplifier tubes such as —01A and the —26 types.

The Benjamin sockets, besides adhering to the standard color code, have exclusive features which make them non-microphonic even when used with tubes which are most sensitive in this respect. The tubes are held suspended on supple and well balanced springs.

The Impedance of Condensers

Explained in a New Way for the Novice

By Brewster Lee

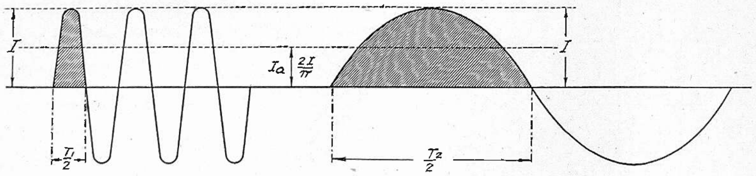


FIG. 1
TWO SIMPLE HARMONIC WAVES OF EQUAL AMPLITUDE, ONE OF WHICH HAS A FREQUENCY 6 TIMES THAT OF THE OTHER. THE SHADED PORTION SHOWS THE QUANTITY OF ELECTRICITY TRANSPORTED BY A CIRCUIT DURING ONE HALF PERIOD.

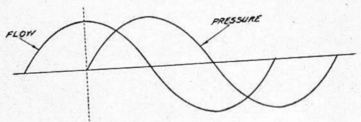


FIG. 2
TWO SINUSOIDAL CURVES OF EQUAL FREQUENCY ILLUSTRATING HOW THE FLOW LEADS THE PRESSURE BY A QUARTER PERIOD. THIS IS THE RELATIONSHIP BETWEEN THE VOLTAGE AND THE CURRENT IN CONDENSER.

THERE are few radio fans indeed who do not know that high frequency currents pass through condensers much more easily than low frequency currents. It is well known that an audio frequency current of 100 cycles is practically stopped by a condenser of .001 mfd. and that a radio frequency current of 1,000,000 encounters practically no obstruction in passing through the same condenser. Why does a high frequency current pass through so easily and why does not a low frequency current get through?

The answer to that question will be more readily understood if the reader realizes that no current actually passes through a condenser but that electricity passes into the condenser and out again. The alternating current in the circuit surges back and forth and charges and discharges the condenser. The current is the rate of change in the amount of electricity in the condenser, or it is the rate at which electricity passes in or out of the condenser. For example, if the charge on the condenser changes at the rate of one coulomb per second the current is one ampere. Also if the charge on the condenser changes at the rate of one micro coulomb per microsecond the current is also one ampere. Again if the charge on the condenser changes at the rate of 60 coulombs per minute the current is one ampere.

The charge on the condenser cannot change unless electricity flows in or out of the condenser, and it takes an electromotive force to drive electricity in, and it requires a path for the electricity to leave the condenser.

Question Answered

The answer to the question of why a condenser of a given capacity admits high frequency currents better than low frequency currents lies in the definition of current that it is the rate of change of charge on the condenser. Suppose two currents have the same amplitude but that one has a frequency 6 times that of the other. The average value of the current in a half period is the same for both currents because the amplitude is the same and the average current during the half period is $2/\pi$ times the amplitude, or .636 times the amplitude.

The total amount of electricity that flows in a half period is average current times the time of a half period. Since the frequency of one of our assumed currents is 6 times that of the other, the half period of the higher frequency is only 1-6 that of the lower. Thus if the duration of a half period of one is T that of the other 6T. Since the total quantity of electricity in a half period is equal to the average current times the time of a half period, the quantity that flows in one case is .636IT and that in the other is 3.816IT, where I is the amplitude of either of the two currents. The total change in the charge of the condenser is therefore 6 times as great for the lower frequency current as for the higher frequency current. Generally, if T is the time of a half period and Ia is the average current during that period the quantity of electricity moved during the half period is TIa.

Graphic Representation

In Fig. 1 two sine curves are given which represent two alternating currents of the same amplitude I but one having a frequency 6 times that of the other. The period of the high frequency current is T1 and that of the low frequency current is T2. The corresponding half periods are shown in the diagram as ½T1 and ½T2. The mean current is represented by Ia equals $2I/\pi$. The total quantity of electricity moved during a half period is represented by the area of one loop bounded by the axis and by the curved line as shown by the shaded portions. It is obvious that the quantity represented by the low frequency at the right is many times greater than that at the left. Calculation shows that it is 6 times as great. If one current has a frequency of 100 cycles per second and another 1,000,000 cycles per second the ratio is not 6 to one but 1,000,000 to 100, or 10,000. The quantity in one loop of the audio frequency current is 10,000 times as great as that in one loop of the audio frequency current.

Now it will be recalled that the quantity of electricity that can be put into a condenser of a given capacity is directly proportional to the voltage used in charging the condenser. Doubling the voltage doubles the charge. It follows that it takes 6 times as high voltage to force a 6 unit charge into the condenser as to force a unit charge into it. Since an alternating current through a condenser is simply a periodic charging and discharging of the condenser it is obvious that it takes a much higher voltage to maintain a given amplitude when the frequency is low than when it is high. The voltage depends on the charge or quantity in each loop of the alternating current, and that differs widely for radio and audio frequency currents of equal amplitude.

Actual Values Given

Suppose we consider the relative quantities in single loops of two currents each having an amplitude of one ampere but one having a frequency of 1,000 cycles and the other a frequency of 1,000,000 cycles per second. The mean value of current is the same for both and is .636 ampere. The duration of a half period of the 1,000 cycle current is .0005 second. Hence the quantity is 318 microcoulombs. The duration of a half period of the 1,000,000 cycle current is ½ microsecond. Hence the quantity in this case is only .318 microcoulomb. Thus the ratio is 1,000 to 1, just as the ratios of the frequencies.

Perhaps the action can be visualized better with the aid of an airpump and an air tank. The pump represents the source of emf or the battery. The tank represents the condenser. The pump may be operated with a short stroke at a very high rate of speed, or it may be operated with long strokes with a very slow speed. It is obvious that in either case the rate at which the air is forced into the tank may be the same, that is the amplitude of the air current may be the same in both cases. But the short stroke may force into the tank only a thimble full of air, while the long stroke may force a 1,000 thimble fulls into the tank. One thimble full will not alter the pressure in the tank very much, and there will be very little back pressure on the piston because of the addition of a thimble full. But when a 1,000 thimble fulls are forced in the change in the back pressure is much greater—a 1,000 times greater—and the piston meets a greater impedance. Yet in both cases the rate at which air enters the tank is the same. In one case the air enters at the rate of one thimble full in one millisecond for example, and in the other case at the rate of a thousand thimble fulls per second, which are just two ways of stating the same thing.

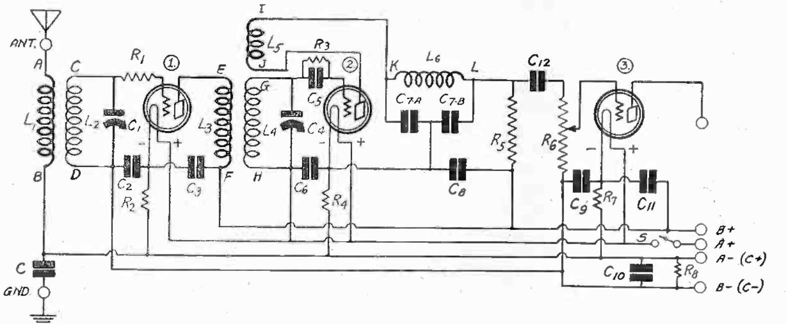
Current Leads the Voltage

Another fact about a condenser not easily visualized is that the current in and out of it leads the voltage by 90 degrees, or by a quarter period. When the voltage is zero the current in or out of the condenser is maximum and when the voltage has reached its maximum value the current is zero.

There is nothing unique about that behavior. Analogous phenomena abound in physics. Referring to the air tank and pump again we have a perfect analogy. At the beginning of a stroke the piston is stationary and there is no compression of the air in the tank. The instant the piston begins to move the air rushes into the tank but the rush decreases in violence as the tank fills up. When the piston is at its greatest displacement the pressure is greatest but the piston is not moving. Hence there is no current flowing into or out of the tank. This is illustrated in Fig. 2. The current is indicated by "flow," and it is either an electric current or an air current according as the "pressure" is electric or pneumatic. The maximum of flow is a quarter period ahead of that of pressure.

The Pre-Power Unit

By H. B. Herman



THE PRE-POWER UNIT CONSISTS OF A STAGE OF TRF, A REGENERATIVE DETECTOR AND A RESISTANCE COUPLED AUDIO STAGE. A TRANSFORMER STAGE IN A POWER PACK, WITH 11 OR 10 TUBE, IS TO BE USED WITH THIS.

AFTER you have built any set you are exceedingly anxious to determine its capabilities, but how do you go about it?

Perhaps you give the set just a general tryout, with no particular point in mind. Perhaps you note carefully the selectivity, and appraise the other factors later. Or maybe the tone quality engages your first attention.

With me it is different.

I test a receiver first for its sensitivity on the high wavelengths. Let me hear KYW, Chicago, (526 meters, 570 kilocycles) or WHO, Des Moines, Ia., (535.4 meters, 560 kc), in my home in New York City, and I will appreciate the sensitivity of the set.

I know that on the lower wavelengths—higher frequencies—about the only problem will be safeguarding against too much amplification. This is because of the rising characteristic of tuned radio frequency amplification, whereby the higher the frequency, the higher the amplification.

By that test the Pre-Power Unit (Fig. 1) stood up beautifully, for scarcely a night has passed during the three weeks that I have been experimenting with the set without my bringing in KYW soon after WNYC, New York City's municipal station, signed off. Both occupy the same wavelength, but do not broadcast simultaneously. And WHO, occupying the second highest assigned wavelength, is another steady visitor.

Not a Usual Thing

This amplification at the lower frequencies is a decidedly advantageous feature, and is something not too commonly encountered. It marks the radio part of the Pre-Power Unit as something well worthy of construction.

Granting good tubes, properly voltaged, this sensitivity at the higher wavelengths, with its assurance of even greater sensitivity at the lower ones, is accounted for largely by the coils and by-pass condensers. The coils are of adequate proportions, where the diameter comes close to the formula's requirements for low-loss design, when that diameter is compared to the axial length of the winding. The primaries are generous, too, and this is particularly necessary in a radio amplifier consisting only of two tubes, if high-wavelength amplification is to be of the desired amount.

With this attainment of adequate sensitivity on the higher wavelengths come certain problems. One is selectivity and another is stabilization at the lower wavelengths. The selectivity is sufficient to separate WABC, New York City (309.1 meters, 970 kc) from KDKA (315.6 meters, 950 kc). This is done without critical adjustment of the ticker coil, L5, but when the regeneration is pressed a bit farther the selectivity increases considerably. Hence the selectivity.

If you want the ultimate in practical selectivity you gain it at the expense of volume and sensitivity for the same number of amplifier tubes. A middle course was struck, so that the number of tubes in the radio amplifier (one RF and one detector) is kept at a minimum.

Resistance RF in First Stage

One audio tube is included in the cabinet, this being a resistance coupled stage. Finest tone quality is preserved and full utilization is made of the high RF gain by using a resistance coupled step here. The other audio stage (not shown) is to be a part of the B supply that will be constructed. Or, if you have a B supply, then you may put the second audio coupling in a container with the output filter and run the A and B supply leads thereto, as well as the speaker cords.

The design was settled upon as shown in Fig. 1 because of the popularity of home-constructed or custom-built eliminators with a stage of transformer coupled audio incorporated. Hence the circuit as shown is preliminary to a power pack, feeding nicely into it, without distortion. That is why it is called the Pre-Power Unit.

The design may be followed economically, also, for while only first-class parts are used, there are no non-essentials and no items that run into money, excepting perhaps the bypass or filter condensers C2, C3, C6, C8, C9 and C11. The set will work without these, and work well, but not so well as with them in, nor should as much DX be expected with them out, so if possible one should include them. Their object in the radio part of the circuit is to bypass the radio frequencies, keeping them out of the B supply and out of the leads running to that supply, as well as negativing the antenna effect of those leads. Such effect is injurious to selectivity. On the audio side they help preserve the purity of tone, tend to reduce self-oscillation at audio frequencies and reduce stray noises.

You'll Be Satisfied

On the radio side their effect is gainful, hence with them in the set will be more likely to be too regenerative at the lower wavelengths. That is as it should be, since when we have too much amplification we always know what to do about it, but when we have not enough we are often at a loss to know what to do, except add more tubes, and that means building a new set. It is a poor inducement to build any receiver if the net outcome is a conclusion to build some other set. In other words, you may follow the outline as in Fig. 1 with assurance of success, even elation.

The Pre-Power Unit was operated with a Victoreen B Supply, with built-in audio stage, including the last audio tube, and there was amplification aplenty at both radio and audio frequencies. Indeed, on strong local signals, such as WEAF, WJZ and particularly WOR, the final audio tube will overload, but that is easily taken care of by loosening the tickler coupling.

(Part II, conclusion, next week)

LIST OF PARTS

L1, L2, L3, L4, L5—One Hammarlund antenna coil and one Hammarlund TCT23 coil, constituting HR23.

L6—One Samson 85 millihenry choke coil.

R1—One Lynch 800-ohm suppressor, (optional).

R2—One 1A Amperite.

R3—One Lynch 5 meg. leak, with mounting.

R4—One 1A Amperite.

R5—One Lynch 100,000 ohm (.1 meg.) metallized resistor.

R6S—One Frost S 1895 Potentiometer (switch attached).

R7—One 1A Amperite.

R8—One volume control Clarostat (used as grid bias resistor).

C—One Polymet .5 mfd. filter condenser.

C1—One Remler twin rotor .0005 mfd. condenser (649 S. L. Frequency or 639 S. L. wavelength).

C2—One Polymet .5 mfd. filter condenser.

C3—One Polymet .5 mfd. filter condenser.

C4—One Remler twin rotor .0005 mfd. condenser (649 S. L. Frequency or 639 S. L. wavelength).

C5—One Polymet .00015 mfd. mica fixed condenser.

C6—One Polymet .5 mfd. filter condenser.

C7A, C7B—Two Polymet .0005 mfd. mica fixed condensers.

C8—One Polymet .5 mfd. filter condenser.

C9—One Polymet .5 mfd. filter condenser.

C10—One Polymet .5 mfd. filter condenser (optional).

C11—One .5 mfd. Polymet filter condenser.

C12—One .5 mfd. Polymet filter condenser.

Two binding posts (Ant. and Gnd).

Three Frost sockets No. 530.

Two Remler standard dials, type 636.

One 7x21x3-16 Celeron front panel.

One 7x18 Celeron panel (for subpanel).

One pair of Benjamin or Bruno brackets (for front panel attachment).

One pair of Benjamin brackets (for extra support of subpanel).

One four-lead cable.

ACCESSORIES

One Corbett 7x21x8½ cabinet, 2" sloping front.

One CeCo type F (112) tube (socket 1).

One Q. R. S. type 200A detector tube or CeCo type H (socket 2).

One CeCo type A tube (socket 3).

Radio University

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When writing for information give your Radio University subscription number.

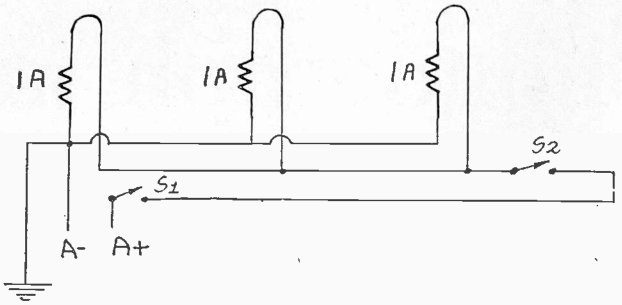


FIG. 597

WIRING OF FILAMENT CIRCUIT, WHEREBY IT IS POSSIBLE TO CONNECT A BATTERY USED FOR SET, TO OUTSIDE SOURCE.

I WOULD like to know how to hookup the filament circuit of my three tubes, using three 1A Amperites, with two filament switches in series with each other. The idea is to connect up the A battery through one switch and then disconnect the filaments from the battery, so that the battery can be used for testing.—FRED EDGEWORTH, Brawley, Ark.

See Fig. 597. S1 is used to connect the battery to the filaments through S2, when it is closed. When S2 is opened, the battery can be used for external purposes.

* * *

I AM very much interested in the five-tube receiver described on pages 10 and 11 of the November 12 issue of RADIO WORLD.

(1)—Could I use two separate variable condensers of .0005 mfd. capacity?

(2)—In winding my own coils, I am going to use 3 inch diameter tubings and place 15 turns on, for the primaries, and 50 turns for the secondaries, using No. 22 double cotton covered wire. Is this all right?

(3)—I have several 1 mfd. fixed condensers around my workshop. Could they be used anywhere in this receiver?—JIMMY CROSTER, Chicago, Ill.

(1)—Yes.

(2)—Use 12 turn primaries. Your other data are all right.

(3)—Place one between each B plus post and the minus A terminal.

* * *

PLEASE ANSWER the following questions regarding the Winner 4-tube receiver, which was described in the October 1, 8, 15, 22 and 29 issues of RADIO WORLD.

(1)—I have all the necessary parts for this receiver, except one ballast, but I have an extra 20-ohm variable resistance. Could this be used in place of R3 in the detector stage?

(2)—Can all fixed condensers, of the .5 and 1 mfd. fixed capacity type, be placed in a single metal container?

(3)—This will necessitate placing the audio transformers closer to each other. Is this all right?—ARTHUR BLATNER, Troy, N. Y.

(1)—Yes.

(2)—Yes. Be sure to keep the leads insulated from each other.

(3)—Yes.

* * *

I DESIRE to build the Tone Control described in the January 7 issue of RADIO WORLD.

(1)—Will a 30 henry choke coil serve the purposes where the choke coil is to be used?

(2)—Can I use a Clarostat (0 to 5 megohms) across the output?—ANTONY GRAPIDO, Houston, Tex.

(1)—Yes.

(2)—Yes.

* * *

HOW MANY milliamperes will pure No. 24 copper wire pass?

(2)—How much current will pure No. 40 copper wire pass?—SED FRANCIS, Basin, Mont.

(1)—From 275 to 400 milliamperes.

(2)—From .5 to 10 milliamperes.

* * *

SOME OF my friends have told me that the silver coat on the glass envelope of a tube is a determining factor as to the efficiency of the tube. That is, the more silvery it is, the better the tube works. Is this correct?—ARTHUR K. LONTREN, Johnston, S. C.

No. This silvery coat you see is nothing more than the deposit of magnesium, which accumulates on the inner surface during the process of getting rid of gasses inside of the glass envelope. That is, after the tube has been evacuated as much as possible with mercury pumps, a small piece of magnesium of which is attached to the plate of the tube is heated with a radio frequency coil, until it vaporizes and then flashes. When this happens, the metal is deposited on the inside of the glass walls, at the same time combining with any of the gases present and completely eliminating them. The degree of silvery deposit is not a factor.

I HAVE built a 4-tube Diamond of the Air, and am having some trouble with it.

(1)—I can hear signals on the earphones, but when I plug in on my loudspeaker, I don't hear a thing.

(2)—The detector tube does not regenerate either. Anything you can suggest will be gratefully appreciated.—WARD TIAMDOM, Delaware, Ind.

(1)—The trouble is in the jack at the detector output. Either one of the inner springs probably does not make contact with the upper or lower springs, when the plug is taken out. Suggest you insert a new jack.

(2)—Place a .00025 mfd. fixed condenser across the tickler leads. Reverse these leads and increase the plate voltage.

* * *

REGARDING THE construction of a direct current A and B eliminator.

(1)—Can't the standard 30 henry choke coil be used in the A filter side of the eliminator? I have two of these.

(2)—In the diagram, I have, three fixed resistors are connected in series with the main output line to drop the voltage. Can a single variable resistor be used, instead? I wish to use only 90 volts for the audio and radio tubes, and the other voltage for the detector.—PERRY MANZAN, Lexington, Ala.

(1)—No. You will have to use a heavy duty choke, having an inductance of about ¼ henry and being able to stand 2 amperes, at least. The 30 henry choke can only stand a couple hundred milliamperes.

(2)—Yes, you can use the variable resistor. Do not forget to by-pass it with a 1 mfd. fixed condenser.

* * *

IN LOOKING over some issues of RADIO WORLD I noticed the circuit diagram of a 6-tube receiver on page 11 of the Feb. 26 issue, which I would like to hookup. There are, however, several things, about which I am in the dark.

(1)—What are the capacities of the condensers connected between the B plus posts in the radio frequency circuits, and the minus A posts?

(2)—The grid returns of the radio frequency, detector and first audio tube tubes are all returned to a minus C post. What voltage battery is used here?

(3)—Is it all right to us a 2 ohm rheostat, which will pass 1½ amperes in series with all the filaments?—JOHN K. ORERT, Maple Lake, Minn.

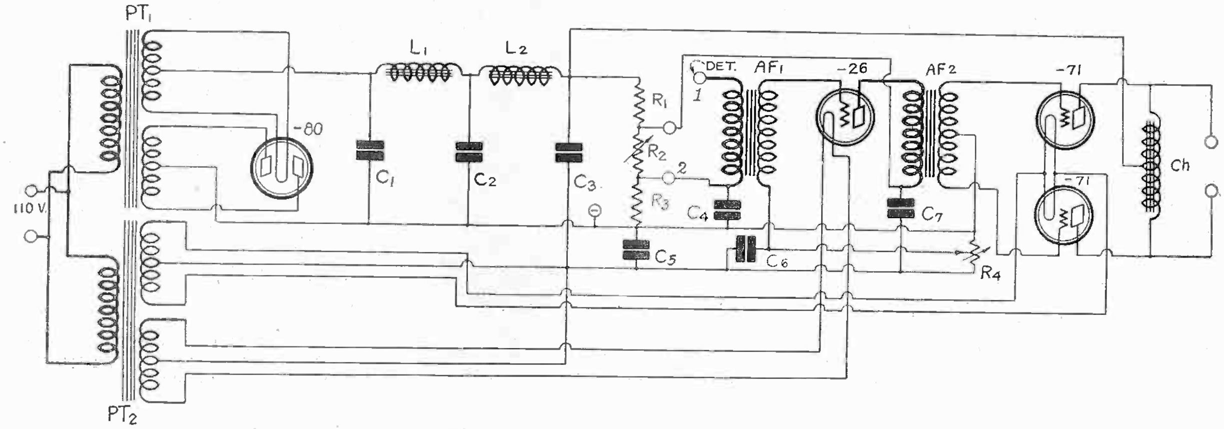
(1)—They each have a capacity of 1 mfd.

(2)—Use a 4½ volt battery.

(3)—Yes. It would be better, though, to use 1A Amperites in each of the filament legs.

An AC Audio for Phonograph and

By Chester



THE DIAGRAM OF A POWER SUPPLY AND POWER PUSH-PULL AUDIO FREQUENCY AMPLIFIER DESIGNED FOR USE WITH EITHER A RADIO TUNER OR A PHONOGRAPH PICK-UP. SPECIAL CONNECTIONS HAVE BEEN MADE IN THE FILTER TO ELIMINATE HUM AND DISTORTION.

THE use of the audio channel of a radio receiver in conjunction with a phonograph electric pickup is growing in popularity. A man may search out his favorite record and put it on the phonograph. But somehow that alone won't sound just right. It does not please as it did formerly. Is the fan suffering from an acute attack of ennui? Is he in a state of mind where nothing will please him? Or has a change taken place in his favorite record so that he no longer likes it?

A change has crept in, to be sure, but it is not in the record. That is as good as ever. The change is purely psychological and is centered about the fan who is ill at ease. He has heard good radio reproduction of his favorite selection and is disappointed if his phonograph does not reproduce it as well. He wants one to be as good as the other and both to be the best.

Where Difference Lies

The difference does not lie in the record, for that is of the latest electrically recorded type. It is not in the rendition, for the record is the same as that which pleased him before. The difference lies in the mechanism between the record and the listener. The mechanical reproduction with the formerly prevalent soundbox does not have the brilliancy characteristic of the reproduction with the electrical pickup, e.g., the Phonovox.

And then the thought occurs to the troubled fan that what has been electrically recorded should be electrically reproduced. The idea seems logical to him and he resolves to try it out. He has heard of the possibility of this both from the phonograph and the radio interests.

Investigation brings out that certain conditions must be met if the electrical reproduction is to be comparable to the best in radio. He must have a good motor and turn table; he must have a good pickup unit; he must have a high power, high quality audio frequency amplifier; and he must have a steady and dependable power source which will deliver all the power required.

The motor and turntable in his old phonograph will suffice provided that the spring is good, and also provided that the speed governor is functioning properly. If the motor will turn a record satisfactorily in the old phonograph, it will serve very well in the electrical reproducer. We pass to the next condition.

Good Pick-up Essential

It is absolutely necessary that a good pick-up be used. It is that which converts the mechanical vibrations into electrical vibrations, and the value of the pick-up depends on how faithfully the conversion is made. The pick-up is the heart of the electrical reproducer, and it is as important in this connection as the microphone is in the broadcasting studio.

There are several electro-magnetic pick-up units on the market having a balanced magnetic system which give satisfactory results.

The third condition requires that a high type audio frequency amplifier be used. It must be capable of handling the high quality music stored in the record without adding to or subtracting anything therefrom. Such amplifiers are now available and are even used in radio sets quite extensively. The amplifier might well be push-pull in at least one stage. Such an amplifier is incorporated in the unit illustrated in Fig. 1.

It is assumed at this point that the radio fan who is equipping his outfit for electrical reproduction of phonograph records will want to use his audio amplifier and power source for both the radio set and the phonograph. The unit shown in Fig. 1 is designed on that basis.

The terminals of the pick-up unit are connected across the points (1) and (2) on the primary of the first audio frequency transformer AF1. This transformer excites the grid of a —26 type tube, which in turn feeds its output into the primary of the push-pull input transformer AF2. The secondary of this transformer excites the grids of the two —71A tubes connected in push-pull relation. In the output of the two power tubes is a high inductance choke coil Ch which is tapped at the center point. The loudspeaker is connected across this coil without the intervention of any stopping condensers whatsoever.

Grid Bias Obtained

R4 is a double slider potentiometer inserted in the plate circuits of the tubes to yield a grid bias to the tubes. Note that the resistor is placed so that the plate current of all the tubes flows through it. The —71A tubes draw about 40 milliamperes and the —26 tube takes about 6 milliamperes. Hence the total current through R4 will be 46 milliamperes. A total drop of 40½ volt in R4 is required. A 1,000 ohm potentiometer which will carry at least 50 milliamperes is suitable, provided that it has two sliders so that the bias for both the —26 and the —71A tubes may be obtained from it.

The question of the introduction of distortion and hum into the signal through R4 must be disposed of before this circuit is acceptable.

As the last stage is push-pull there will be very little AC from this stage in R4. It will be appreciable only when

Amplifier Set with B Supply

Charlton

LIST OF PARTS

PT1—One Samson transformer No. 132.
PT2—One Karas AC Former.
L1, L2—Two Samson 30 henry chokes No. 30.
AF1—One Karas Harmonik audio frequency transformer.
AF2—One Samson Type Y push-pull transformer.
Ch—One Samson Type Z output choke.
R1, R3—Two Centralab 3464 ohm resistors No. FT-3464.
R2—One Centralab 10,000 ohm heavy duty variable resistor HR-010.
R4—One Centralab 2,000 ohm 4th terminal potentiometer.
C1, C2—Two Tobe 2 mfd., No. 602 condensers.
C3—Two Tobe 4 mfd., No. 404 condensers.
C4—Two Tobe No. 304 4 mfd. condensers.
C5—Two Tobe No. 304 4 mfd. condensers.
C6—One Tobe No. 304 m 4 mfd. condenser.
C7—One Tobe No. 404 4 mfd. condenser.
Six Eby binding posts.
Four Benjamin standard sockets.

ACCESSORIES

One CeCo R-80 full wave rectifier.
One CeCo M26 type amplifier tube.
Two 71A type amplifier tubes or CeCo type J.

the two push-pull tubes are much alike. For practical purposes any two —71A tubes can be considered alike. Hence even if no other precautions had been taken to prevent hum and distortion as a result of the use of R4, the last stage will introduce no appreciable amount of them.

The absence of stopping condensers in series with the loudspeaker and the use of high inductance chokes (Ch) also help to reduce to the vanishing point the bad effects of R4. Only pure DC flows through R4 as far as the last tubes are concerned.

But the plate current of the —26 tube also flows through R4, and since there is nothing to balance out the effects of this it is possible that hum and distortion might creep in at this point. Let us see about that.

Residual Current

By virtue of the size and special connection of condensers C3 and C7 relative to the grid bias resistor R4, practically none of the AC current from the plate of the —26 tube can get into R4. The by-pass condensers C5 and C6 further prevent any of the AC from flowing through R4. Of course the by-pass condensers also prevent the residual current from the last two tubes from getting into R4, that is, the AC current which is due to the lack of absolute equality of —71A tubes.

Any residual current from the first tube through R4 cannot act as an input to the push-pull stage as the effect is balanced out by the push-pull system.

Neither can any of the hum from the eliminator enter the signal in any appreciable amounts. This is due to the special connections employed in the eliminator, to the push-pull stage, and to the adequate by-passing that has been provided for.

The fourth condition calls for steady and dependable power supply with an adequate ripple filter. A thermionic rectifier tube of the —80 type is satisfactory. As it is a full wave rectifier the hum will be of 120 cycles per second and will be relatively easy to filter.

Two choke coils L1 and L2 in series with the line prevent any of the ripple from circulating in the main circuit, and two by-pass condensers C1 and C2 provide paths for the ripple currents to circulate without going through the output resistances.

The New Way

Note that C1 and C2 are connected across the entire line whereas the remaining condensers are connected across only portions. The method of connection is the same as described by J. E. Anderson in RADIO WORLD Jan. 21, and which is designed to provide a power supply and power amplifier with a minimum of hum and the least possible signal distortion.

C1 and C2 should be 600 volt condensers and each should have a capacity of not less than 2 mfd. and preferably 4 mfd. C3 can be 400 or 300 volt condenser since the normal voltage across it will not be more than 180. Its capacity may be either 4 or 8 mfd. Ordinarily a large condenser would be recommended at this point but due to the fact that it serves mainly a push-pull stage the 4 mfd. size may be used.

C7 is an important condenser in this circuit in that it prevents AC from the —26 tube from entering R4 and thus cause distortion. The voltage across it will not be greater than 135 volts and therefore a 200 volt condenser may be used. Its capacity should preferably be 8 mfd. or more.

Another Important Capacity

Perhaps the most important condenser in the filter system is C4. It steadies the detector tube plate supply and thus prevents any small ripples in the plate voltage from entering the detector and modulating with the signal. Certainly this condenser should be an 8 mfd. Since it is connected across a 45 volt source of voltage it need not be designed for more than 100 and 200 volts.

C5 may be a duplicate of C4. It serves to by-pass R4 and thus to minimize hum and distortion. C6 by-passes that portion of R4 which gives bias to the —26 tube. It may well be combined with C5.

The resistor strip R1, R2 and R3 connected across the filter output provides three different voltages, 45, 135 and 180 volts. These not only provide the requirements of the power tubes and the first audio stage, but also the voltages for the radio frequency tubes and the detector in the receiver.

Two separate transformers are used to provide the required voltages. PT1 has two secondaries both of which are mid-tapped. One is of 5 volts and heats the filament of the rectifier tube. The other is a high voltage winding and it supplies the current to be rectified. The second transformer has three secondary windings, 5, 2½ and 1½ volts, though the 2½ volt winding is not shown on the drawing. The 2½ volt winding cah be used for heating the cathode of a —27 tube.

He Wields Wide Influence

EDITOR RADIO WORLD:

I am a professional set builder.

As may be assumed, I move a lot of parts in the course of a year, and these I order from regular distributors. My own opinion of any new or other circuit for home construction has some effect on the number of such circuits that will be built by persons who have confidence in my judgment. Also, of course, it has everything to do with my own adoption or rejection of the circuit for customers' use. I try out nearly all circuits as they are published in radio magazines, and have become especially familiar with those which I like. I know what helps to make a circuit successful, what helps therefore to sell parts for manufacturers. and I sometimes wish that some manufacturers would follow my advice and thereby sell more parts.

The time may not be far distant when even professional set builders will be able to adopt time payment methods, because of the interest of finance corporations in this growing and solid branch of the radio business. Indeed one of my good friends, Leo Fenway, has adopted it for the corporation of which he is president, and is blazing the path. It is quite possible, I realize, to devise a plan whereby time payments would prevail, and without extra cost to the customer, because if he will pay fair prices for parts and equipment, and there is enough turnover, the credit extension cost can be absorbed by the business. But the turnover in my particular business is not great enough. Fenway's business is much, much larger, and I believe his plan will work.

J. C. FOSSET,
Nyack, N. Y.

Why an Electro-Dynamic

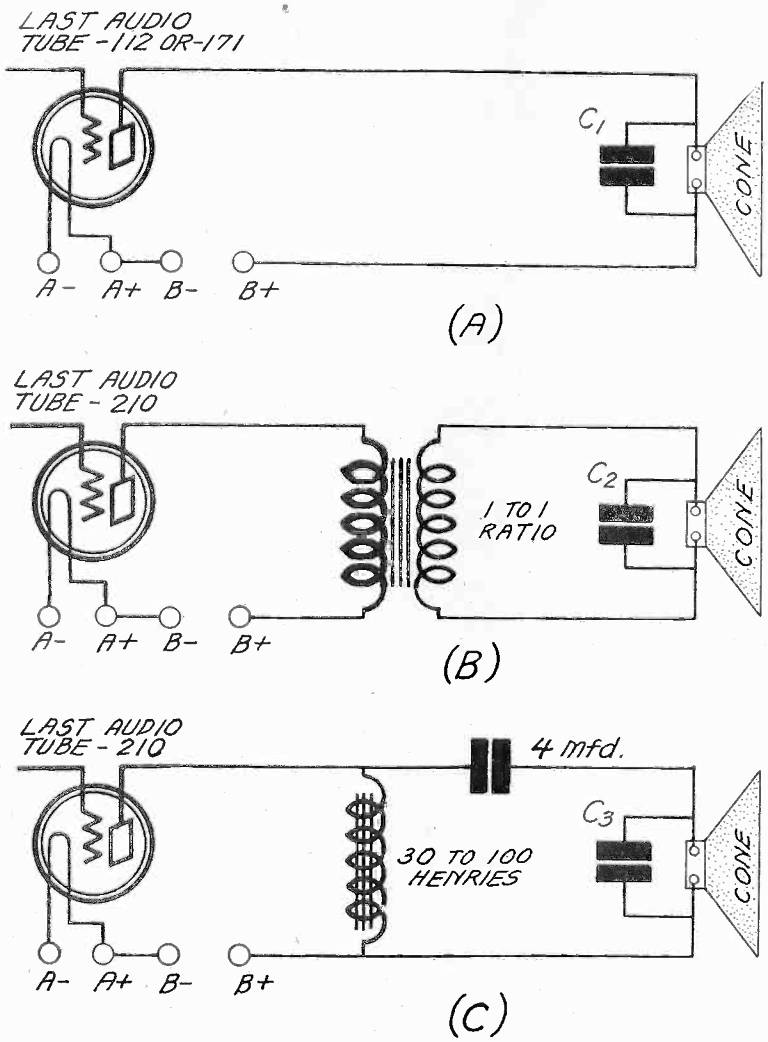


FIG. 1

A. THIS SHOWS HOW AN ELECTRO-DYNAMIC REPRODUCER MAY BE CONNECTED TO THE OUTPUT OF A 112 OR A —71 TUBE. THE CONDENSER C1 IS USED TO ELIMINATE TUBE AND BATTERY NOISES.
B. WHEN A —10 TUBE IS USED WITH HIGH VOLTAGE IT IS PREFERABLE TO INTERPOSE A 1 TO 1 TRANSFORMER BETWEEN THE SPEAKER AND THE TUBE.
C. OR THE SPEAKER CAN BE PROTECTED BY THE USE OF A SERIES CONDENSER AND A CHOKE COIL AS SHOWN HERE.

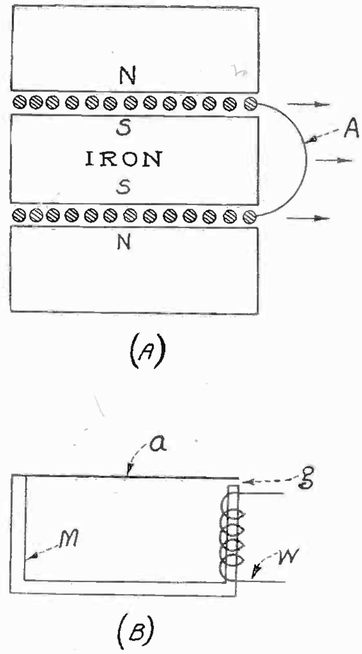


FIG. 2

A.—THIS SHOWS A CROSS SECTION OF ARMATURE AND POLE PIECES OF AN ELECTRO-DYNAMIC SPEAKER, ILLUSTRATING THE FREEDOM OF THE ARMATURE TO MOVE AXIALLY WITHOUT DANGER OF STRIKING ANYTHING.
B. — THIS SKETCH ILLUSTRATES THE PRINCIPLE OF MANY PERMANENT MAGNET TYPE OF LOUDSPEAKER UNITS AND IT SHOWS HOW THE POLE PIECE PREVENTS A WIDE SWING OF THE ARMATURE AND HENCE THE SOURCE OF BLASTING ON LOUD VOLUMES.

By Billy Honduras

THE power of audio frequency amplifiers has been increased greatly during the last year. Tubes to handle higher voltages and greater plate currents are popular and devices have been developed to supply the increased power.

Along with this development, amplifier coupling devices have been improved so that all frequencies in the audible band are amplified with remarkable fidelity and impartiality. The improvement has been greatest at the bass end of the scale. The lower musical notes now come through with amplitudes comparable to the amplitude of the original, and in the same relationship to the amplitudes of the higher notes. Realism in a startling degree is the result. The reproduction now sounds like the original and no draughts on the imagination are necessary to convince the critical ear that this is so.

Blasting Occurs

But now and then on the lower notes the reproducer is overworked. The ordinary loudspeaker can swing only a certain distance before the armature strikes against the pole pieces. When that occurs it is said the speaker is blasting.

The exact sound of this blasting depends on the frequency at which it occurs, but usually it can be described as a buzz. It is most unpleasant, not per se, but because it happens at important passages in the music or speech.

One remedy for blasting is obviously to turn down the volume to a point where the loudspeaker used is able to handle the signal without any buzzing where there should be only true tone emphasis. But if that is done there is no object of having a power amplifier. It is just a waste of equipment and of power.

Another remedy is to remove any amplification peaks from the reproduced signal. Of course there are no such peaks of appreciable altitude in the output of the best amplifiers, but loudspeakers are not always used with the very best amplifiers. This removal can usually be accomplished with by-pass condensers placed across the source of plate voltage or the source of grid voltage. They must be very large to be of much effect, say 8 mfd. or more.

Stop Those Blasts

Another method of avoiding blasting is to separate the AC from the DC in the output of the power tube and use only the AC in the reproducer. This can be done with an output transformer as is shown in Fig 1B. This transformer, having a ratio of 1:1, has no other object than to keep the DC component of the plate current out of the speaker winding. This protects the speaker winding against excessive heating from the DC, yet the speaker gets all the AC in the output. The separation also eliminates the unbalance which the direct current introduces into the speaker, and hence it enables the speaker to handle greater power before blasting occurs.

Still another way is shown in Fig. 1C. The speaker winding is connected in series

Speaker Prevents Blasting

with a condenser and then the combination is connected across a choke coil of from 30 to 100 henrys inductance. This has the same effect as the transformer.

When blasting occurs on the high notes, as it sometimes does, this may be remedied by connecting a condenser across the speaker winding, as has been done in all three cases in Fig. 1. The condenser may have as high a value as .01 mfd., but it is preferable to use smaller values when they are effective. The larger by-pass condensers have the effect of cutting out the higher audio frequencies; and many designers deliberately put condensers of more than .01 mfd. across the speaker to eliminate background and battery noises. But this impairs the reproduction of speech perceptibly in that articulation becomes poor.

The Electro-Dynamic Principle

The best way of preventing blasting on the low notes is to replace the reproducer with one that is able to handle the requisite power and amplitudes. A speaker designed to handle high power on low notes must have a wide clearance between the armature and the pole piece, so that the armature can swing widely without striking.

But in the ordinary type of loudspeaker the sensitivity is greatly reduced by widening the possible swing. Hence in practical loudspeakers of this type it is necessary to compromise between sensitivity and volume.

Therefore little will be gained by replacing the old speaker unless a type is found in which the pole pieces do not put a limitation on the swing of the armature.

Such a type is found in the Magnavox electro-dynamic reproducer. The possible motion is practically unlimited, and in it there is no necessity of compromising between volume and sensitivity. The unit is ultra-sensitive and it can handle enormous volumes without any danger of blasting.

Fig. 2 illustrates the difference between the two types and shows clearly why the electro-dynamic is far superior. In Fig. 2A is shown a cross section of the electro-dynamic speaker. The small shaded circles labeled A represent the turns in a small coil which constitutes the armature. This coil is placed in an annular gap in a specially shaped electromagnet. It has a central core which is one of the poles in the electro-magnet. In the figure this is marked as the south pole. The north pole of the electro-magnet surrounds the armature coil and it is marked NN.

An Exclusive Virtue

The turns of the armature coil move axially in the strong magnetic field established by the magnet. The force on the coil is the same no matter where the coil may be, within practical limits, and therefore the sensitivity of the unit does not depend on the position of the armature. No other unit has this virtue.

The sensitivity does depend on the intensity of the magnetic field across the air gap in which the armature coil is moving. That in turn depends on the magnetizing coil used (not shown) and on the distance across the gap. If the moving coil is small and mounted accurately the length of the airgap can be made very small and still leave the armature perfectly free to move. How far the armature can move axially without striking depends more on the external requirements of construction than on any requirements in the unit itself.

It is different with the ordinary type of loudspeaker motor. Fig. 2B shows a typical construction. The armature is marked a, the permanent magnet M, the armature winding W and the air gap g. The smaller g is the more sensitive this unit is, but the sooner will the armature hit the pole carrying the coil W. And when it strikes there is a buzz. If the gap g be made large enough to handle the large amplitudes met in high power, low note reproduction, the unit will be so insensitive that a great deal of power is required to give any response at all.

While the construction shown in Fig. 2B represents one type of speaker, the preceding objections apply to all having a permanent magnet and a moving iron armature. It includes the balanced types.

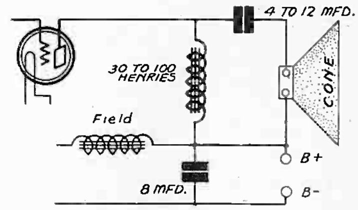


FIG. 3

AN ELECTRO-DYNAMIC REPRODUCER CONNECTED TO THE PLATE CIRCUIT OF A POWER TUBE THROUGH THE MEDIUM OF A SERIES CONDENSER AND A CHOKE COIL. THE FIELD COIL OF THE DRIVING UNIT IS CONNECTED SO THAT IT SERVES AS ONE OF THE CHOKE COILS IN THE FILTER CIRCUIT IN THE ELIMINATOR.

Another Advantage

The electro-dynamic reproducer has one other advantage above all others. It has a high inductance field coil which maintains the steady magnetic flux across the armature gap. The coil can be used as one of the choke coils in a filter circuit, provided it is proportioned to work on suitable voltages and currents. This method of use is shown in Fig. 3. While the field coil is shown as part of the filter circuit it is actually built into the speaker labeled cone. It carries all the direct current delivered by the B battery eliminator. There is supposed to be another coil in the filter but this is not shown. The field coil is put in second place because in that position there is less current fluctuation, and it is desirable to have a steady field for the loudspeaker.

The speaker and its series condenser are put across an inductance coil of from 30 to 100 henrys in order to force most of the AC output of the last tube through the speaker. The series condenser should be from 4 to 12 mfd. to facilitate the passage of the low notes through the speaker circuit.

When the output of a high power and high quality audio frequency amplifier is put into an electro-dynamic reproducer like the Magnavox R-4 and R-5, there is no blasting whatsoever, and the quality is as realistic as the transmission permits.

Melhuish New Head of N.E.M.A. Radio Work

H. T. Melhuish, former manager of sales administration of the Radio Corporation of America, has joined the staff of the National Electrical Manufacturers Association as director of the Radio Division.

Prior to joining the R. C. A., Mr. Melhuish practiced law in Pittsburgh, Pa. for five years, leaving his law practice to enter business in New York.

Custom-Set Builders

Custom-Built Set Editor:

Reading your magazine suggested that I write a few words of encouragement to the parts manufacturers.

I believe the custom set builder is here to stay, and no amount of commercial competition can dislodge him from his rightful field. No commercial manufacturer making a generalized, compromise set can give the value the custom-set builder can in a special-purpose receiver.

For instance, down here in Florida there is a demand for a reasonably priced set that will consistently tune in the WEAF chain programs with the highest quality reproduction and ample volume

I built such a set at a wholesale cost of about $100, not including tubes and batteries. What manufacturer could duplicate the special features listed below for this sum? Here is one of my standard layouts:

Choice of several very excellent reproducers in cabinet, with a concert grand or other high grade unit. RCA Unirectron or any other approved 210 power amplifier or 171 type push-pull amplifier. Any good circuit, three tuber containing one stage of high frequency and regenerative detector, such as the Diamond of the Air with only one audio circuit.

This combination in the hands of a reasonably expert tuner will do anything any one can expect a set to do, with wonderful quality and volume, at a reasonable price. For those willing to pay more, I add a conventional three circuit tuner with inductances adjusted to receive WGY's short wave rebroadcasts, placing this side-by-side with the broadcast receiver on the top of the air column cabinet. This combination will bring in chain programs every day in the year from this point.

If the customer will stand still more, I add a light motor and turntable and electric pick-up.

What manufacturer is likely to put me out of business for the next few years?

Yet every single part that goes in my sets is of the highest possible quality, and may be the highest priced item in its class.

My last set contained genuine Browning-Drake coils, Hammarlund tuning assembly and condensers, Vedee metal cabinet, Ferranti transformers, Silver-Marshall Unipac, Bremer-Tully short wave coils, a well-performing unit, with finest quality, standard parts built to perform. There is no sales or promotion expense attached to my overhead, no service charges, nor returned merchandise loss. The reproduction is of the highest possible quality at the present state of the art, selectivity is adequate for local conditions, the sets are highly sensitive if properly operated, both on broadcast and short waves, and the cost is reasonable. I have no trouble finding buyers.

ARTHUR SMITH,
President, Arthur Smith Music Co.
1107 Franklin St., Tampa, Fla.

Quality Factors in Audio

By Herman Bernard

MANY experimenters like resistance coupled audio frequency amplification because of the excellent quality obtainable therefrom, but certain problems are introduced in the up-to-the-minute application of this system that baffles them. Frequency distortion and uneven amplification, besides self-oscillation and quantitative values of constants are puzzling, but all soluble.

The predominating difficulty is self-oscillation, because with the recent growth of B supplies in popular favor the chief cause of such self-oscillation has been introduced.

When a B supply (eliminator) is used in a direct coupled circuit, such as resistance, impedance, double impedance or other variant circuit, the audio amplifier and its plate supply source constitute a united circuit in which there is much common resistance. This is most likely to be a source of coupling, and if the phases are right the coupling introduces too much self-oscillation.

A little is a benefit.

It is the same thing, but it appears in different and variously audible clothes. So new is this condition that not only is the category of remedies still incomplete but the terminology for the ills, not to mention the remedies, has yet to be constituted. Only two expressions stand out—motorboating and peanut whistle.

All One Line

The total power supply and biasing system for any circuit are one continuous branching line, even if batteries are used. Assuming batteries, you start with the most negative C, come to minus A, then to positive A, (B minus connected to A minus or A plus), and then reach the successive B voltages. Hence you can trace a line from the grid return of any tube in any radio or audio circuit and simply move up the voltage scale a step at a time. There is union among tube circuits, and it is said that in union there is strength. But it may be destructive strength, and that smacks unwholesomely of weakness, so one must necessarily, address himself to devising the remedies.

Any oscillating circuit can be tamed, whether it oscillates at audio or radio frequencies. You have only three things from which to write the prescription—inductance, capacity, resistance—and you may combine them in any of thousands of ways, or use one or two and omit the others.

Effect of Different Capacities

If you encounter motorboating you may not know it, for its frequency will vary from, say, ¼ cycle to 50 cycles, and ultimately become a "peanut whistle" at 2,000 cycles. If it reaches high frequencies the remedy becomes simpler. In fact, the rule of the higher the frequency the simpler the solution is pretty sound, since a condenser of suitable capacity, placed across the line, would be the remedy.

If the frequency is high enough this condenser need not be inordinately large, not more than .006 mfd., put across the speaker terminals. Maybe up to .02 will have to be used, but that would be unfortunate, since the higher broadcast frequencies would be by-passed in this fashion. The remedy has been applied for years in elimination of hissing strays, forms of tube noises and other high audio frequency forms of interference, with .006 mfd.

Indeed, although the remedy of condenser-across-the-line is a good one only for higher frequency interference, whether oscillatory or merely parasitic, it is true also that a condenser will cure every form of motorboating, and it need be placed only across any grid leak in the audio channel, or across any grid choke, if impedances are used.

But in such a case the remedy is worse than the ailment, for the high notes are completely cut off, by even .1 mfd., and if much larger capacity is used, the middle frequency scale is invaded. Naturally, as motorboating of any frequency is oscillatory in origin, a condenser of suitable capacity will remove the oscillation, and if the capacity is large enough will go down far enough to remove all the modulation, so you get no reception whatever. The condenser by-passes all of the signal.

Where It Is Constructive

Nevertheless, equipped with a variety of capacities of fixed condensers, any one desiring to stop low frequency oscillation—the only kind to which the word "motorboating" is applied in common technical speech—he may connect in parallel with any audio leak or plate coupling resistor a condenser of the smallest capacity that will perform the estoppel. At least the trouble will be cured.

Low note suppression is no evil at all compared with a four cycle oscillation that sounds like the outboard motor of a rowless rowboat. Moreover, more than eighty per cent. of all radio sets are low-note suppressors of a high order, if not outright discriminators against all reproduction below 150 cycles, because of abuse of the biasing resistor, inclusion of too small value of audio leaks and stopping condensers, overbiased grids and, most particularly, the coupling and speaker used. So the condenser across the line to stop a receiver from put-putting like a motorboat engine is not only pardonable but orthodox and constructive.

While in certain regions of the higher audio frequencies self-oscillation is easiest to cure without detriment to quality, in the lower regions the difficulty not only is greater but easy injury may be done to an otherwise highly acceptable amplifier.

Slow Motorboating

Take the slowest form of motorboating one is likely to notice—and he may have to be truly observant to notice it at all—the motorboating in the fractional cycle frequency realm. Assume the frequency to be one-quarter. That means that one cycle takes four seconds for completion. If the degree or severity of the motorboating is not unduly large this form of trouble may pass unnoticed by the ear because all it does is to vary the intensity of the signal in such gradual and limited manner as to be a sly evader of attention.

While this self-oscillation is taking place some distortion is being introduced, but it is not sustained, since the plate current change (DC component) is accomplished over a period of four seconds, during which the current value is within the distortionless swing for longer duration than it is out of that wholesome area, hence as the fidelity is a major fraction the distortion often passes unnoticed by the ear. But the slow motorboating may always be read on a DC milliammeter (0-50 ma) connected in series with the choke coil in the last audio tube (Ch in Fig. 1), or, if there is no choke or other such device there, in series with the speaker itself.

You can determine the frequency of the slow motorboating by looking at the second hand of your watch and observing the swing of the needle at the same time.

How to Determine Frequency

Take the mean plate current reading and count how long it takes the needle to swing to one side, then to the other side, then back again to the mean point. If it takes four seconds, the frequency is one-quarter of a cycle per second. In other and quicker forms of motorboating the needle oscillates so fast you can not count the frequency. Also, when the frequency gets considerably farther up (into the audible scale) the needle stops wabbling and the motorboating is just sound—so fast in frequency the needle, sluggish thing, can not follow. So it is, indeed, with the plate current in all receivers that are bringing in a station—the DC milliammeter does not follow the modulation at all, except to kick slightly one way or the other on too strong a note for the characteristic of the tube circuit as constituted. If the needle kicks up (toward higher reading), decrease the negative grid bias; if it kicks down, increase the negative grid bias; that is the rule, although not an infallible one, since the trouble may necessitate a different remedy than mere bias alteration will afford.

Slow motorboating is something that deserves a great deal of consideration, experimentation and analysis, and will receive more attention in time to come. One reason why it has been almost ignored—except in the pages of this publication—is that the world is not generally aware of its presence or existence, since it is elusive, a sort of trouble that must be hunted, and most persons are content to investigate only such troubles as impede their personal enjoyment.

The simplest ready remedy I have found for correction of the evil of slow motorboating is to use a low mu tube in the output, e.g., a CeCo type J, CX-371A or UX-171A or Armor 571, and to increase the intermediate grid bias. If the radio amplifier is biased from the same source the variation should include this part of the circuit, too. But this suggestion is not a panacea; rather an ameliorant.

Bias Through Resistor

Much more likely these days is that the bias is obtained through the voltage drop in a resistor. This method is diagrammed in Fig. 1, where R7 is the resistor, a 2,000-ohm Centralab fourth terminal potentiometer. B minus is most negative and is used as the connecting point for the grid return of the final audio tube, that being the desired most-negative voltage. The plate current flowing from A minus through R7 produces a voltage drop across the resistor, so by moving the upper arm, to which points requiring lesser C voltage are connected, one may obtain the desired voltages. In the diagram two points, lower right, are marked A and B, and if these are interconnected no voltage will be wasted, since less than the total of 2,000 ohms

Resistance Coupled Amplifiers

Managing Editor,
Associate, Institute of Radio Engineers

will be required, and by this method you drop only what you need.

Unless the by-pass condenser be used, and its capacity be 4 mfd. or larger, and 8 to 10 mfd. may well be used, low note suppression, particularly below 150 cycles, will be almost complete. Use 1 mfd. and there will be small improvement, 2 mfd. fair improvement, 4 mfd. good improvement, 8 mfd. excellent improvement—and here you may add 2 mfd. to play doubly safe. This single condenser in a circuit using the biasing resistor method will do more to improve the quality of any audio amplifier—including transformer coupled—than any other single thing, even including the substitution of a good frequency characteristic speaker for a poor one.

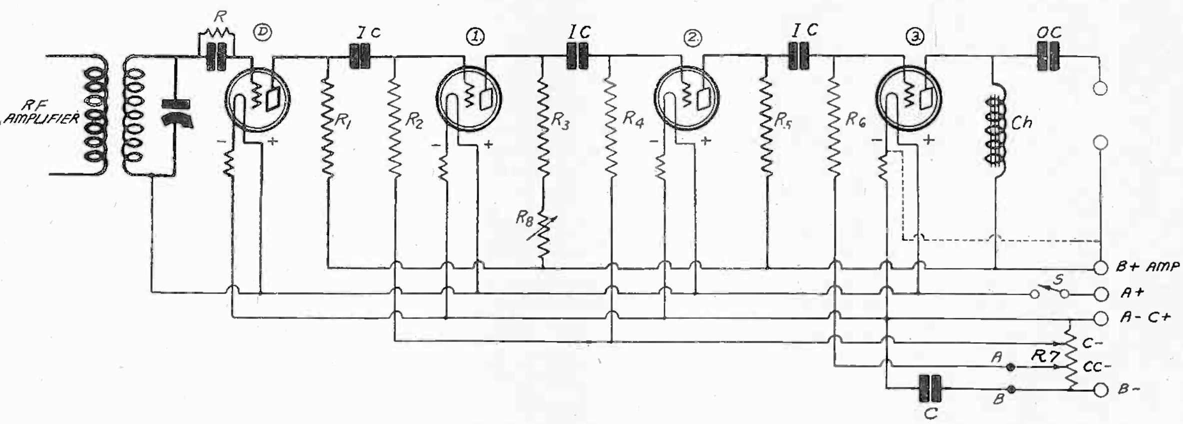


FIG. 1

A RESISTANCE COUPLED AUDIO AMPLIFIER.

You Can Hear Difference Easily

When the capacities are increased as suggested you can actually hear the difference—and if you are musically trained you can hear and distinguish the instruments in an orchestra that were not brought out or indentifiable under the previous conditions. That is one outstanding reason why a man who builds his own circuit can reproduce ever so much better quality on his receiver. He knows that he is spending his money to put a vital condenser across a biasing resistor—a condenser likely omitted from all quantity production specimens except in fancy-priced installations. Yet if you are buying tone values you can not get them in any batteryless or "electric" set that omits the 8 to 10 mfd. across the biasing resistor, although it may well be that the final condenser across the B supply line may be made to include the biasing resistor. Also you quickly find out with 8 mfd. across R7 how poorly or well is the filtering in your B supply, since the great gain in low note restoration includes the 60 cycles of the DC line and the second harmonic (120 cycles). If the hum grows too strong the condenser is vindicated and the B supply is corrected. Add 4 mfd. to the last filter capacity.

Amplification itself has much to do with the construction of a stable amplifier of any sort. Any radio or audio circuit can and will oscillate if the amplification is great enough. That was the principal reason for suggesting a low mu output tube for any resistance, impedance or double impedance audio channel. The output signal intensity is less, but it is all that it need be, and more, especially with one B plus serving detector and first and second audio. This is desirable as tending to stabilize the circuit, reducing the network of impedances that couple the components in the amplifier and contribute to oscillation troubles.

Effect of Bias

No doubt the bias adjustment for intermediate grid voltages (C minus in Fig. 1, as distinguished from CC minus), helps get rid of slow motorboating for the same reason: the higher bias reduces the amplification. Tube operation may thus be slightly off the straight portion of the plate current-grid voltage curve, but that is entirely tolerable, as also is the identity of grid voltages for the first and second audio tubes with the RF amplifier grid voltage, since about 3 volts will suffice, if the plate voltage is around 100.

The extra bias also makes the impedance of each such grid circuit a smaller percentage of the common impedance.

A poor way to reduce the amplification is to use low values of grid leaks in the audio channel, as this tends to cut off low notes, unless IC is 1 mfd. or so, whereas too small value of plate resistor injures the efficiency of the amplifier. The plate resistors usually will be on the order of 100,000 ohms (.1 meg.), although 250,000 ohms is the usual value recommended for high mu tubes.

There is no use adopting high mu tubes unless the volume from type A tubes is not great enough, for the resistance coupled amplifier has a definite volume limit before motorboating begins, and high mu tubes help to bring about motorboating by reason of the high amplification. You will read that 30 mu tubes give actual amplification of 20, when 250,000 ohm plate resistor is used at 180 volts.

Frequency Difference

But any circuit will oscillate if the amplification is high enough, and in the case of high mu tubes a resistance coupled amplifier may, and usually does, oscillate even if only two stages are used, when the amplification is not high enough. The oscillation is due to the B supply, the characteristics of the tube and the adventitious coupling in the common impedances. The only difference between the motorboating with two stages and three stages is in the frequency, for in a two-stage amplifier it is faster.

Remove the detector tube ahead of any operating audio circuit. If there is no motorboating then, most likely none will be encountered at all. By this test a stage of resistance coupled audio followed by a transformer coupled stage, comprising a complete audio amplifier, does not motorboat, and indeed in laboratory experiments it was impossible to make it motorboat except by forcing a wrong connection whereby no broacast signals could be heard anyhow.

In line with the reduction of amplification and the alteration of impedance values so as to minimize coupling, the variable resistor, put in series with the plate resistor in the first audio stage (R8 in series with R3) often will completely stop medium motorboating. But the higher frequencies suffer reduction of amplification more than do the low ones, noticeable when the esses and zees become less pronounced.

Remedy for Chattering

The plate coupling resistor in the detector tube is important. If a special detector tube of the gaseous variety is

(*Continued on page* 20)

FIGHT or *No Fight?*

Two Writers Take Issue on Whether Ring Encounters Should Be Broadcast

By Tim Turkey

THE door bell rang one evening while I was enjoying a classical program played by an orchestra. The sound of that bell crashed in on the music both electrically and acoustically. It was a discordant crash and it jerked me out of a peaceful reverie.

A stranger was at the door. I knew that, for none other would ring the hall bell and remain below until invited up. There was a promise of a different evening. It was nine o'clock when the bell rang, but that had no significance at the time.

The stranger came up, and he turned out to be no stranger at all, but an old friend disguised by the changes that years effect.

"Well, Bill, it's good to see you again after all these years," said I after my old friend had been seated. "You certainly have prospered physically," I added noticing that the anemic boy had grown up into a man of heavyweight championship calibre.

"Yes, Tim, I have prospered in every way except in love. I never got to first base in that game. But my failure has not worried me any, for I have found compensation in other forms of strife. I am partial to fights in which a man has at least an even break."

My old friend was a humorist, a trait by which I knew him well; but his philosophy dealt with love and strife, one of which is strange to me. As he talked he gradually left the romantic and turned more to pugilism. He dragged pugilist after pugilist into the conversation, none of whom had any part in our common past. By this fact I should have known that he had some other purpose for coming than to review the past. I did not even suspect his motive.

His Real Motive

While my friend was talking pugilism my radio set was reproducing softly the music of an orchestra. It was pleasing music yet it became apparent to me that my visitor did not enjoy it. I asked him whether he liked that type of music.

"Yes, it's good stuff all right," he admitted out of courtesy, "but you know there is a championship fight on tonight, and I thought perhaps they would broadcast it."

"Sure, some station will broadcast it, and if it is within range of this receiver we'll listen to it," I said, welcoming the chance to listen to a good fight with somebody.

Together we scanned the daily radio programs to find what station was broadcasting the fight. We located it under WABC, at 9 o'clock. Fifteen or twenty minutes had passed since the first gong and some of the preliminaries. When the signal from WABC was first tuned in that night the announcer was telling about the semi-final bout. We got some of the blow-by-blow description of this fight, and it was a real treat. I had not tuned in a more interesting radio program for a long time.

The Main Bout

We would have been satisfied, or at least I would, if the pugilistic broadcast had ended at the conclusion of the corking semi-final bout. I had had my money's worth and would gladly have gone back to one of the repeats of the weekly features. It was not necessary that night. There was something more interesting and exhilarating in store for us. We were to be the recipients of the same mental kick that the ringsiders received; we were to be jarred by the same emotional wallop that is so dear to the inveterate fight fan.

The main bout had no sooner started than the reproducer began to count one man out. At the stroke of nine the speaker eased the tension a bit by announcing that the recumbent champion had risen. While the announcer chattered about the fight my friend grew enthusiastic about the opponent.

"I saw him fight in Youngstown," he said, "and believe me, he is a fighting fool." He got no further for the speaker was counting again, ". . . six, seven, eight, nine." The ten did not come; instead of that the announcer said that the fighter who was down before was up again. But the "fighting fool" had scored a second knock-down in the first round. My friend found relief from the excitement of the moment by joining in the cheering that the receiver brought from Madison Square Garden.

White Hot Expectancy

The activity in the first round of that fight created an intense state of expectancy in the minds of the listeners, and this did not end until the fighter who had been down twice had been declared the winner on points. That expectancy helped to keep interest at white heat throughout the fifteen rounds, but there was enough activity in every round to keep hundreds of thousands of listeners glued to the loudspeaker until the last announcement had been made.

I am glad my old friend visited me that night. Without him I would have spent an average radio evening. Instead we sat in on an exciting contest between two young gladiators held in the greatest arena, in which two healthy men willingly fought each other and with an equal chance to win.

The game may be brutal and degrading. Be that as it may. The fact is that it appeals to every red-blooded man. All appreciate any fair contest in which the contestants take part willingly and in which each of the fighters has an equal chance. The game appeals as strongly to the reformer as to the men who attend the fights openly. But the reformer feels it his public duty to condemn the sport in which the adversary is real and tangible.

From now on I am a radio fight fan. I get more kick out of it than I do out of a great symphony; I sense more drama in it than I do in a modern production of Hamlet; I hear more noise in it than I do in a brass band; I hear more dischord in it than I do in modern jazz and in rhapsodies; I love the element of chance in it. I am delighted to know that it is the other fellow's nose that gets caved in and not mine, that his ears get shriveled up and not mine, that he takes the blows under his heart and not I.

The fight game is all right with me.

By Cuthbert Spencer Wells

MERELY for comparative purposes I listened in recently to the broadcasting of a description of a pugilistic encounter. I have always been opposed to this form of sport, but was willing to acquire some new data and indeed change my mind if any reason presented itself, but none did.

I am aware that large numbers of persons enjoy listening into the description of a ring contest and that considerable opposition develops when any suggestion of curtailment or prohibition of ring activities is suggested. Education can change this state of mind, since education focuses our minds and tastes on wholesome things.

My principal objection to pugilistic fights is their brutality, and I believe anything even suggesting brutality should be kept off the air. Bull fights are illegal in this country and I assume that the Government is as much interested in a pugilist as in a matador, a toreador or a bull.

Fighting Dangerous

The clash of fists that entices so many is dangerous to the human mind and body, since the fighters suffer injurious blows, the sounds of which come with thwacking realism right into our homes. Although any one may tune out such a program, so many tune it in that the women and older children of the household are subjected to the doubtful "entertainment."

Hand-to-hand combat, unfortunately, still has an appeal to the "red blood" of a man, but this is the blood inherited from primitive life and does not represent the real blood of the race, which has been refined by centuries of education and religion.

The second greatest accelerant of fight popularity is the commercialism of the sport—the great fortunes that change hands with titles—and so fine an instrumentality as radio should take no part in this commercialization of a brutalizing sport.

Not for the Love of It

Fighters do not fight for the love of fighting but for the money and glory that is in it. Take away the big money and the glory still has some appeal to them, but it is much less than many suppose. Hence all who listen to or attend fights contribute toward the commercialization of physical suffering.

I do not propose any radical move at this time, but it behooves the public to consider the bad side of pugilism and to act toward it in that courageous manner that the situation requires. Personally, I shall not listen in to another fight broadcast. I hope that many converts will follow my course and that the better element of the community will take up the cudgels in behalf of real manhood and womanhood.

Suggests Mothers Decide

The mothers of the land, if given a chance to vote on pugilism or its broadcasting, probably would side with me. Therefore I ask every radio listener who does tune in fights, if God still blesses him with a mother's love, to ask mother what she thinks of the subject, and be guided accordingly.

Flashlight Real Need to Operators of Circuits

Often a radio fan wants to take a peek into the cells of his storage battery to ascertain whether the cells are gassing or whether they need more distilled water. Light on this operation is always needed and there is a great temptation to strike a match to furnish it. Striking a match there is a risky procedure. It might lead to an explosion with painful and costly consequences.

Now and then a radio fan must go out on a dark night and inspect his antenna and ground equipment. He needs light. Without the light he cannot inspect and without light he might stub his toe with painful results. Striking a match will avail him little if the night is wet and windy. And when is it not windy enough to blow out a match?

Occasionally a radio fan finds it necessary to explore the inside of his radio set. And he can't do it without a light. He cannot very well employ a flame such as that of a match or a candle. He needs another light.

The Need of a Portable Light

In all these and in countless other cases the radio fan needs a portable light which is dependable, flameless, and sane. A flashlight meets these conditions, a light which operates with electricity. Just press a button and point the light toward the object that needs illumination, and the object stands out in plain view.

A battery flashlight may be used, or a power plant carried in your coat pocket. A power plant in the coat pocket! What a ridiculous idea! Power plants are located by the riverside or by the railway side, and they usually cover many square blocks. Even the smaller plants develop thousands of horsepower of electrical power. Sure enough, but still you can have a power plant in your coat pocket, and what is more, you can carry the whole electrical distributing system in your pocket as well.

A prime mover, a dynamo, a distributing circuit, and a load are the essential elements in a power plant. Size has nothing to do with the principle, though size determines the power capacity.

What is the prime mover in a pocket-sized power system[There are two parts to the prime mover. You are the first part and a clock mechanism is the second. You yourself are really the furnace while the clock is the mechanism which converts your heat energy into kinetic energy or energy of rotation. You simply wind the clock spring and let the wheels turn.

The Dynamo

The spring-driven spindle in the clock is coupled by means of a train of speed-increasing gears to the rotating field of miniature electro dynamo. The rotating field is a permanent bar magnet. The permanent bar magnet can be spun about its center of mass. A soft iron ring carrying coils and provided with inward pointing projections surrounds the spinning magnet. The coils are connected in series with the load, in this case a 2½ volt, ½ watt flashlight.

Air gaps between the ends of the magnet and the pole projections on the ring are very short, so that when the magnet is aligned the reductance of the magnetic circuit is low and the magnetic flux in the ring is great.

A Comparison of Seven

By Peter

Contributing

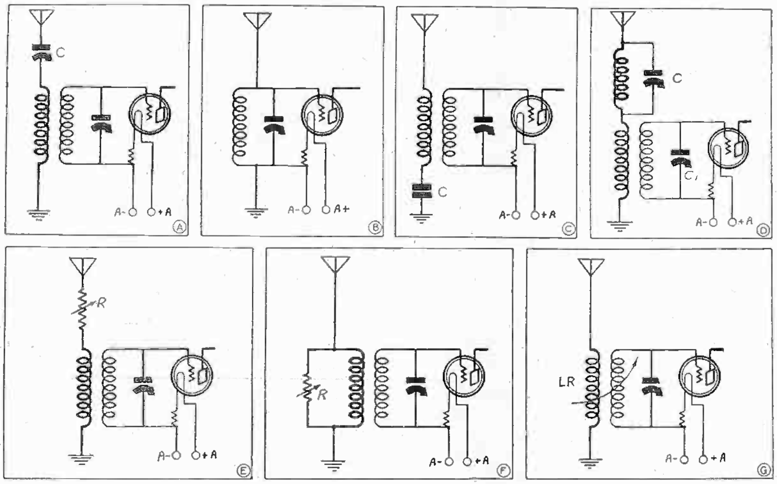


FIG. 1

SIX DIFFERENT ANTENNA ARRANGEMENTS AND METHODS OF COUPLING. (A) TUNED ANTENNA WITH A SERIES CONDENSER.
(B) TUNED ANTENNA BY DIRECT COUPLING TO THE SECONDARY CIRCUIT.
(C) UNTUNED ANTENNA WITH A PROTECTIVE CONDENSER IN THE GROUND LEAD.
(D) UNTUNED ANTENNA WITH A WAVE TRAP IN THE ANTENNA LEAD.
(E) APERIODIC ANTENNA WITH A VARIABLE SERIES RESISTOR FOR VOLUME CONTROL.
(F) APERIODIC ANTENNA WITH A SHUNT VARIABLE RESISTOR FOR VOLUME CONTROL.
(G) APERIODIC ANTENNA WITH VARIABLE COUPLING BETWEEN THE PRIMARY AND THE SECONDARY.

"DO you think if I added 50 feet of wire to my antenna that I would get greater distance, greater selectivity and better tone on my set?"

That is just one of the thousands of questions asked about antennas.

A good antenna is necessary on any set. It does not matter what the set may be nor how many tubes are used in it. But an antenna may be good for one set and no good at all for another.

The antenna must be suitable to the set.

A small indoor antenna or a loop may be all right on a Super-Heterodyne, but such an antenna may give poor results on a three tube set.

The purpose of the antenna is to pick up the signals from space and transfer them to the amplifying system. The intensity of signal picked up by an antenna depends on the height of the antenna for one thing. The pick-up is directly proportional to the effective height above ground. An antenna twice as high as another will pick up just twice as much.

But there are other factors that enter and that affect the amount of the signal that is transferred from the antenna to the amplifying system, and some of these factors are the capacity, the inductance and the resistance of the antenna. These depend also on the height of the antenna, consequently the effect in the loudspeaker does not always indicate that the pick-up is directly proportional to the height.

Length of wire deceptive

The amount of wire used in the antenna is not all important. If 200 feet of wire is strung two feet above the ground the pick-up will not be as great as if 100 feet of wire is erected straight up. But the capacity of the low-lying antenna is much greater than that of the vertical wire, even if that wire is 200 feet high. The inductance of the longer antenna is also greater than that of the shorter, as is the resistance. The resistance particularly is likely to be great in the low-lying antenna, due to the proximity of the wire to absorbing substances.

The length of the ground wire has a great deal to do with the effectiveness of an antenna. If a coil is used for coupling the antenna to the amplifier, that coil should be placed as close to the ground as possible, for the greatest antenna current is near the ground. Therefore the ground lead should be as short as possible.

The antenna has nothing to do with the tone of the set. If the reproducer delivers the signal as pure and undistorted as the antenna delivers it to the amplifying system the tone would be practically perfect, and any deviation from perfection would not be the fault of the antenna.

This, however, does not mean that the effectiveness of the antenna and the quality of the signal are not related in practice. If the antenna is ineffective so that it is necessary to increase the amplification to bring the volume up to the desired level, many forms of distortion enter which would not enter if the antenna were effective.

For example, if the antenna is ineffective it is necessary to tune the circuit sharply, and high selectivity cuts off the higher audio frequencies. If it is also necessary to introduce a good deal of regeneration the higher frequencies are still further reduced in intensity and the output becomes boomy.

Also, if it is necessary to increase the amplification in the set to make up for the deficiencies of the antenna, all tube and battery noises become relatively greater.

This all goes to show that the antenna should pick up a strong signal, and therefore that it should be fairly high.

Broad tuning may result

But the price of a strong signal may be extreme broadness of tuning as well as an increase in the amount of interfering noise. From this point of view, then, it is necessary to limit the effectiveness of the antenna. Therefore it is necessary to compromise and call an antenna good when it picks up a moderately strong signal which does not require excessive amplification in the receiver.

For ordinary purposes we might pick on an antenna made of 100 feet of wire. As much of this as possible should be vertical. As little of it as possible should be between the set and the ground. And what is left over should be horizontal. The horizontal adds a little to the effective height of the antenna so that all of it is not lost.

Again, the radio wave is not always vertical but it tilts forward a bit. The horizontal portion of the antenna catches the horizontal component of the wave.

In Fig. 1A the antenna coil is large and a variable condenser is put in series with it. This is an old-timer and used to be a favorite. Condenser C is in series with the capacity of the antenna itself, so that the effective capacity in the primary circuit is small.

If C is to be used for tuning it must be a small condenser, smaller than the capacity of the antenna. This limits the size of the condenser to about a .00035 mfd. The coil in series with it must also be quite large, much larger than coils ordinarily used for tuning. The size cannot be given, for it would be a different one for every antenna. It will probably lie somewhere between .4 and 1 millihenry.

If both the antenna circuit and the secondary are tuned it is necessary to make the coupling between them loose, and that, in view of the large coils used, means that the coils should be far apart. The correct separation can only be found by experiment. If the coupling is too close, only one of tuned circuits will be effective and the secondary tuning condenser might as well be omitted.

Condenser volume control

But in modern receivers C is more often used for controlling the volume by throttling the antenna current than for tuning the circuit. In that case the primary coil has the ordinary value of from 10 to 30 turns and the variable condenser can be an ordinary tuning condenser.

Under these conditions the secondary circuit is selective and the volume is under complete control except for the shortest waves.

When the antenna in A has a small primary coil it is usually spoken of as an aperiodic circuit, but really it has a period which is below the lowest wavelength in the broadcast band. When a condenser is connected in series the circuit is also of the same type but the wavelength is still shorter.

In Fig. 2B the antenna is connected directly to the top of the tuned circuit, or to the grid itself. In this case the antenna capacity is connected in parallel with the tuning capaciy, as is the resistance of the antenna. The coupling between the antenna and the tuned circuit is very close. The circuit is very broad

Antenna Coupling Types

V. O'Rourke

Editor

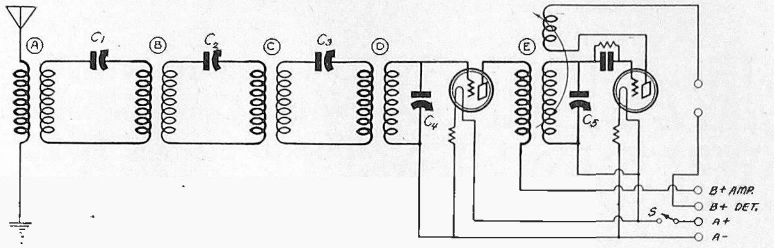


FIG. 2.

A CIRCUIT SHOWING A CHAIN OF TUNED CIRCUITS FOR INCREASING THE SELECTIVITY OF A RECEIVER WHEN THE DETECTOR IS NOT INHERENTLY SELECTIVE. RF TRANSFORMERS ARE USED, WITH PRIMARIES CONNECTED TO PRECEDING SECONDARIES.

on account of the close coupling and the resistance which is connected across the tuned circuit. But the signal intensity as transmitted to the amplifier is very high.

The principle objection to this circuit is its limited tuning range. The capacity across the coil can never be made less than the capacity of the antenna, and since this is considerable, the tuning coil has to be small if the circuit is to reach the shorter wavelengths in the broadcast band.

The fact that the capacity in the circuit is relatively large and the inductance is relatively small lowers the input voltage for a given pick-up, and thus part of the signal is sacrificed. But even so, this is a very effective connection when volume is the main consideration. As not all wavelengths can be tuned in this fashion the higher ones usually are tuned, the lower ones not, so that the rising characteristic of TRF is flattened out somewhat.

When this hook-up is used the required selectivity in the circuit must be obtained in the subsequent tuners.

The arrangement shown in Fig. 1C is essentially the same as that in A, except that the condenser is put in the ground lead and that it is fixed in value. It can be used for a variety of purposes. If the circuit is too broad the condenser can be put in with some advantage. In this case the condenser should have a small value, say about .00025 mfd. if it is to be effective at the short and medium waves.

This condenser in the ground lead can be used also as a protection against short circuits in certain cases, particularly when the antenna is metallically connected to the amplifier and when the circuit is connected to a direct current power source. For that purpose it may be large and of high voltage rating.

A condenser in the ground lead may prevent a short-circuit.

Wave Trap Circuit

In Fig. 1D the antenna is of the so-called aperiodic type but a parallel tuned circuit is connected in series with the antenna lead. The values of inductance and capacity in the trap circuit are not much different from the values ordinarily used in tuned circuits for the broadcast range. For example a condenser of .0005 mfd. capacity and a coil consisting of 40 turns of No. 24 double cotton covered wire on 3 inch tubing can be used.

The object of the parallel tuned circuit in the antenna lead is to trap out the signals from an interfering station. It rejects only one station at a time but does it effectively. The trap circuit is tuned to the station that is interfering and the secondary circuit containing C1 is tuned to the desired station. The two tuned circuits are mutually dependent to a certain degree and it is necessary to tune and retune two or three times before the desired signal is maximum and the interference is rejected completely.

The circuit in Fig. 1E contains a truly aperiodic antenna, provided that R is not too small. The purpose of the variable resistance R is to control the volume in the set, which it does by reducing the antenna current as in case A. But in this case the reduction is the same for all frequencies and the present device is therefore a better volume control. R should be a variable resistor having a maximum value of 5,000 ohms. The use of this type of volume control does not reduce the selectivity of the secondary tuned circuit but rather has the opposite effect. This phenomenon is due to reduction of the radiation resistance.

Fig. 1F shows a variable resistor in shunt with the primary of the input transformer. This is a very effective volume control and it operates by detouring the antenna current around the primary coil. Its range may be the same as the series resistor in Fig. 1E but it should be so arranged that the shunt circuit can be opened completely for maximum volume and sensitivity.

Effect on Selectivity

The effect on the selectivity of the shunt resistance R is just opposite to the effect of the series resistance. It reduces the selectivity at the same time it decreases the volume. It also tends to detune the secondary circuit. Both of these effects are due to putting a partly short-circuited coil in the field of the tuning coil. The lower the value of R, the lower is the volume and the lower is the selectivity.

In case G we have perhaps the nearest approach to the ideal method of controlling the transfer of energy from the antenna to the tuned circuit and the amplifier. It is the old time variocoupler, the primary of which is adjustable in position or in orientation with respect to the secondary. The coupling between the antenna and secondary can be varied from practically zero to maximum by means of this device by simply turning a knob.

The adjustment of the primary of the variocoupler with respect to the secondary has little effect on the tuning of the secondary or on the selectivity of the circuit. It simply controls the amount of energy that is transferred from the antenna to the amplifier.

The volume control methods shown in Fig. 1E, F and G are especially applicable to receivers employing AC heated tubes in which the volume cannot be controlled satisfactorily with filament rheostats or plate circuit resistors.

Tandem Tuning

There is another antenna connection, and that is the single circuit, direct coupled connection. In this the grid is connected metallically to the antenna in such a manner that the voltage across the tuning coil is made use of. This is about the most effective collector of radio energy but it is also the least selective. It is not shown because it is wholly unsuitable to present broadcast reception. It ceased to be useful when the second broadcasting station went on the air.

In one of the early attempts to gain selectivity when neither the transmitter nor the receiver was capable of great frequency discrimination the method of tandem tuning was employed. This method is illustrated in Fig. 2, which shows no less than four tuned circuits through which the signal must filter before reaching the detector. While the drawing shows a regenerative tube detector the scheme was ordinarily used with crystal detectors.

In this arrangement the several tuned circuits are loosely coupled so that they will be as independent of each other as possible and still leave enough coupling to transfer a readable signal to the detector. The only difference between this arrangement and that used in TRF receivers is that in the present case there are no amplifiers interposed between two adjacent tuned circuits.

Why Show it?

The only object of the circuit shown in Fig. 2 is to increase selectivity, and the increase can only be gained at a considerable loss in signal strength. Why then, it might be asked, is the circuit shown? Because of a new development in radio, one which calls for greater selectivity and at the same time supplies amplification enough more than to compensate for the losses in the tandem tuned circuits. The new development is the shielded grid tube (UX222, CX322, Shieldplate 122).

The new tube has a high amplification constant, which makes it possible to attain a radio frequency voltage amplification per stage of from 30 to 50 depending on the circuit constants with which the tube is operated. This gain is much more than would be lost in a reasonably well designed and coupled chain of tuned circuits.

But when two or more of these shield grid tubes are used in a receiver the tuners can be distributed just as in ordinary sets, although in so doing the net selectivity of a given number of tuned circuits will not be so great as if used according to the arrangement shown in Fig. 2.

The stability and ease of tuning, however, would be greater when the tuners are interspersed with the amplifiers.

Next week: The Tyrman Shielded grid super, the Four Tube Diamond of the Air and other big features.

A THOUGHT FOR THE WEEK

RADIO is much like poetry in the sense that you know whether it is good or bad by its appeal to the ear. That more or less abused person, "the man in the street," might not know the wherefore of good reception, but if his hearing is acute, his ears will register satisfaction.

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Station Elimination Opposed by Some Fans

Two Readers Well Satisfied, Ask Toleration—Third Writer Complains Middle West Is Unfairly Treated, Due to Stations In East and West, on Same Wave, Killing Each Other Off.

STATION EDITOR:

As far as I am concerned the latest reallocation work by the Federal Radio Commission was very good. It suits me fine. But it seems that some persons cannot be pleased at all. They demand the impossible of the Commission. For example, these people demand that the Commission so allocate wavelengths and powers as to insure all the people constant and unfailing radio reception, not only free of heterodyne disturbances but also free of fading troubles.

I think that consolidation of stations as much as possible should be urged and that no more new licenses should be issued. But to order a station off the air outright or to confiscate it takes money and the cost would ultimately have to be borne by the taxpayers.

I repeat that I think that the radio situation as it is at present is good. When I want a good radio I turn to the locals. When I want DX I can have that too, for my set has reached out 2,000 miles many a time. I am satisfied and I do not crave the impossible.

What is really needed today is toleration rather than station elimination.—LOUIS T. THOMA, Cincinnati, Ohio.

* * *

STATION EDITOR:

In my opinion we should keep the stations which are now licensed but we should refuse to license any more. Some stations from time to time will drop out, of their own accord, so that after a little while this should afford some relief in the congested part of the broadcast band.

It is desirable to have as many non-interfering stations as possible, for it allows the man with a good receiver to tune in on a good program at any time.—R. E. BROWN, Highland, N. Y.

* * *

STATION EDITOR:

I appreciate the effort made by the Federal Radio Commission to clear the air of heterodyne interference, but I protest against the method it used for bringing it about.

The Commission ignored the fact that persons living in the middle of the United States cannot tune in either one of two stations operating on the wavelength without having their programs impaired by interference. If they try to tune in the Eastern station, the Western station comes in with almost the same intensity as the station desired, and if they try to tune in the Western station, the Eastern station interferes. The result is that persons living in the middle part of the United States cannot enjoy either station with any degree of pleasure.

KFI and WRC come in with about equal volume; KFI and Atlanta interfere; as do WEAF and Ft. Worth; KRLD and WRR; and KFNF and WCEA. KOIL and one of the stations in Seattle also interfere with each other and New Orleans is interfered with by one of the stations in New York.—A. L. NELSON, Clarksdale, Miss.

Licenses of Stations Extended to March 1

Washington.

Extension of all broadcasting licenses until March 1 was ordered by the Federal Radio Commission, the acting chairman of the Commission, Judge Eugene O. Sykes, announced. Sixty-day licenses which were granted by the Commission December 1 in accordance with its policy to issue them only for short terms to make for flexibility in wave, power, and time assignments were accordingly made effective for an additional month.

Judge Sykes issued the following statement:

"In view of the fact that three of the four present members of the Federal Radio Commission are yet unconfirmed by the Senate, I have recommended to my colleagues that the station transfers and other changes designed to improve reception in the broadcasting band, be postponed until confirmation of a quorum of the Commission's membership, and that all broadcasting licenses be extended and made to expire on next March 1."

WGY INVITES THE WEST

Schenectady.

For the entertainment of far Western listeners WGY is on the air until after midnight two mornings each week. Tuesdays and Thursdays are the days on which these extended programs are put on the air.

Broadcast by Beecham Follows Radio Attack

Sir Thomas Beecham, well-known English musician, conducted the New York Philharmonic Orchestra recently on the stage of Carnegie Hall, New York City. This marked the first appearance of Sir Thomas as a conductor on an American stage, although he has been in this country several times, and it also marked his first appearance as a radio artist. When he stepped on the stage three microphones faced him, all of which were connected with the transmitter of station WOR, which broadcast the concert.

Less than a year ago Sir Thomas classified radio as "music's greatest menace," and he has characterized English broadcasting as a "stupidity and a crime against music."

Damrosch Music Lessons for Children Gets Trial

Walter Damroch, conductor of the New York Symphony Orchestra, is giving a "sample" by radio of his plan for teaching music to the children of the United States in three broadcasting periods.

The first of these broadcasts was broadcast January 21, from 8 to 9 a.m.; the second is scheduled for Saturday morning, February 10 from 11 o'clock until noon, and the third one week later at the same hour.

Deaf Indian Listens In Through Wife's Fingers

Glacier Park, Mont.

While at work in his log cabin studio on the St. Mary Road in Glacier National Park, during the long shut-in Winter months, John Clark, deaf and dumb Indian artist-genius, gets inspiration from the wide world over the radio.

Mrs. Clark, a former reservation school teacher, sits nearby, occasionally dropping her knitting or fancy-work to transmit in the "finger language" to her husband things of interest that are brought in "out of the air."

Clark, besides doing some painting, hews trunks of trees out of the forest and from these he carves bears, goats and mountain sheep, using a bowie-knife and chisel as his sole tools. Some of Clark's carvings, including his masterpiece, "The Bear in a Trap" have a permanent place on exhibition in the Chicago Art Institute.

How Quality is Obtained from Resistance Audio

(*Continued from page 15*)

used (UX—200A, CX—300A or Q.R.S. 200A type), a chattering or gurgling may be heard when tuning. This disappears at resonance, but is very annoying otherwise. It is due to an unsuitable load impedance, causing self-oscillation which is detoured by the phenomenon of "infinite impedance" at resonance. Use a larger value of load resistance. Instead of, say 100,000 ohms for R1 use 250,000. This may decrease the amplification slightly, unless the plate voltage is increased. But amplification decrease is not to be taken as a shortcoming, since ample volume for the home is taken as a prerequisite in all these considerations.

If the suggested change is made in a receiver that has a regenerative detector the higher value of detector plate resistor may defeat regeneration on the higher waves, but this can be overcome by decreasing the intermediate grid bias on the radio amplifier and in the audio amplifier as well (since there is one bias for these).

It is not only true that there is a definite limit to the total amplification which may be gainfully employed but it seems to be true that this limitation is specific even as to individual stages, including the detector. And in rating an audio channel the detector tube must be included as an audio amplifier. Although its amplification at audio frequencies may be small with some tubes, the effect on phase relationships in the audio amplifier is present at all times and with all detector tubes.

In the interests of best quality and stability of the amplifier the isolating condensers IC should be large, because if they are small they will suppress the low notes slightly. The gain in low note amplification is bought so dearly that it should not be sacrificed by too small capacity here. If small capacities are there already it may be well to put larger capacities in parallel with them, so that .1 mfd. or more is the total capacity of each isolator. It so happens that best stability was experienced in circuits using 1 mfd., and that capacity is a good one to use, as the low notes are not by-passed.

To support the just favoritism shown to low notes, AF plate resistors should not be very high. It is well to adhere to .1 mfd., especially where intermediate C minus is common to several tubes, including RF, for if the plate resistor is high the DC voltage actually reaching the plate will be too low for the common bias. In other words, separate intermediate C biases would have to be introduced, but if batteries are used that is a simple matter.

On the other hand, the audio grid leaks should be no less than 2 meg. The detector grid leak, if resistance audio is used, may be of greater resistance than usual, and 5 to 10 meg. is a suitable range of choice.

The condenser coupling the speaker to the last tube, OC in Fig. 1, may be 2 mfd. or more, but increase beyond 2 mfd. produces no change noticeable to the ear. If that condenser is of a DC voltage test well in excess of the total B voltage, the return connection may be made as shown by the dotted line, to negative filament. It is more usual to show this connection to minus A, but that returns the speaker to a part of the C bias system, and this is avoided for theoretical reasons—the same reasons that deter one from making the return to B minus in Fig. 1.

The fine quality of which a resistance coupled amplifier is capable therefore may be preserved to full extent if necessary precautions are taken, particularly if a B supply is used instead of batteries, and even if a biasing resistor is used to furnish grid biasing voltage. As many experimenters possess and construct such amplifiers this report of extensive experiences with such channels was prepared as a guide to the correction of errors in existing construction and in amplifiers that are to be built.

As success depends partly yet strongly on the values of the constants, the following are recommended for application to Fig. 1:

Tubes: D (detector) Q. R. S. 200A type, the loudest detector tube I ever encountered; CeCo type H, CX—300A, UX—200A. First and second audio: CeCo type A, CX—301A, UX—201A. Last audio CeCo type J, CX371, UX171, Armor 571. (Do not use a 112.)

Lynch plate resistors: R1, .1 or .25 meg.; R3 and R5, 100,000 ohms.

Lynch grid leaks: R (detector leak) 5 to 10 meg.; R2, R4, R6, first, second and third audio, 2 to 5 meg.

R8 (optional): Volume Control Clarostat.

Filament resistors: 1A Amperites throughout, unless a .5 ampere tube is used in the last stage (types without the suffix A); then use a 112 Amperite there.

IC: Isolating condensers of .1 to 1 mfd. These may be of one capacity throughout or staggered.

Ch: An output choke of 35 henrys or more, with low DC resistance, and used with a 2 to 4 mfd. condenser OC; or these two may well be the National output filter.

R7: One Centralab fourth-terminal potentiometer, 2,000 ohms.

C: Condenser of no less than 4 mfd. under any circumstances, but far preferably 8 to 10 mfd., with 8 as a sufficiency and 10 as an extra precaution in favor of quality. Low voltage type ample.

Maximum Sun Spots Aid Long Waves by Day

The results of scientific studies of solar activity on broadcasting were announced by the Department of Commerce. The statement, based on findings of the Bureau of Standards, was in full as follows:

It is reasonably certain that long wave daylight radio signals, both from distant stations and from those only two or three hundred miles away, were stronger in 1927 when the 11-year sunspot cycle is near its maximum than in 1923 when it was at its minimum. This was one of the conclusions of Dr. L. W. Austin and Miss I. J. Wymore of the Bureau of Standards.

A commercial radio expert, G. W. Pickard, has shown, on the other hand, that at night in the broadcasting range, signals grow weaker when the number of sunspots increases. Hence it appears that effect of solar activity on signals is reversed when day gives place to night.

Confirms Bell Laboratories

This corresponds to the conclusions of the engineers of the Bell Laboratories, that magnetic storms which are known to be connected with sunspots weaken medium and long wave signals at night and slightly strengthen them in the daytime.

The evidence regarding the influence of magnetic storms and solar activity on ultra short waves is somewhat conflicting. There are many authentic reports of poor reception at the time the long continued observations of Dr. A. H. Taylor of the Naval Research Laboratory, as averaged by Mr. Pickard, indicate an increase of night signals with increasing sunspots or the reverse of the effect on longer waves.

Very few observations have been published on long wave night transmission, on broadcasting day transmission nor any, so far as is known, on broadcasting night signals extending over more than one year. This offers a very promising field of experiment for those interested in the scientific side of radio.

"Enormous developments" in the field of long and short wave radio communication were predicted by H. A. Bellows, former member of the Federal Radio Commission, testifying at a subsequent session of the commmittee.

Testimony, while first designed to explain some of the actions and policies of the Federal Radio Commission since its inception with respect to radio broadcasting, turned almost exclusively to the matter of short waves and other technical developments in the radio art when Senator Dill (Dem.), of Washington, sponsor of the Radio Act of 1927, asked for Mr. Bellows' opinion as to the proposed prolongation of the Commission for another year.

"The Commission," said Mr. Bellows, "during the first year has been greatly handicapped by the deaths of Col. John F. Dillon and Rear-Admiral William H. G. Bullard, and has been unable to do anything like the job Congress intended.

"Another year will enable it to take up other questions than broadcasting, such as the short and long wave lengths, which will present a problem even more important to the public interest than broadcasting.

Television Discussed

"These represent a perfectly enormous development, largely technical, primarily with respect to the use of short waves for distance code communication, and possibly later for television fascimile reproduction and other phases of the art for which the channels in the lower end of the radio band are being developed.

"The Commission needs experts and engineers to aid it, and it needs technical equipment to continue its work."

Metal Shield Patent for Tubes is Granted

The Orange Research Laboratories, 247 McKinley Ave., East Orange, N. J., have been granted U. S. Patent No. 1,564,694, covering a metallic shield to be placed over vacuum tubes for preventing undesired interstage coupling. "Vac-Shield" is the name of the device. It is made in two types, one for the —01A type tube and the other for a —22 shielded grid type tube. The only difference is a hole in the top of the shield for the control element of the 22 tube.

The Vac-Shield prevents interstage coupling by acting as a static screen; it makes tuning in distant stations easier by minimizing stray capacity effects; it protects the tube from breakage by offering a mechanical guard; and it minimizes the tendency toward microphonism by loading the tube down and lowering its natural period of mechanical vibration.

Volume Control Model Clarostat Announced

Differentiating between the heavy-current requirements of the usual radio power unit and the relatively light-current requirements of the usual radio receiver, there has been added a smaller and moderately priced type to the well-known Clarostat line of micrometric variable resistors.

The new type is known as the Volume Control Clarostat. It is of about the same diameter as the standard type, but only a third as deep. The current-handling capacity is approximately one-third that of the standard type employed in radio power units and for the heavier receiver requirements. In several turns of its knob, the Volume Control Clarostat covers a resistance range of approximately zero to 500,000 ohms. It has single-hole mounting. It is provided with screw terminals for ready wiring.

NEW NBC WASHINGTON STUDIOS

The new Washington Studios of the National Broadcasting Company, which furnish programs to the Radio Corporation of America's station WRC and the NBC's Red and Blue Networks, are in operation. The studios are located in the National Press Building at F and Fourteenth Streets, N.W., Washington, the newest and largest office building in that city. The building is in the center of the capital's business and theatrical section.

INDEPENDENTS ELECT RUSS

Walter C. Russ has been elected secretary and patent counsel for the RPA Laboratories, Inc., an organization of radio manufacturing companies, members of the Radio Protective Association, according to A. D. Lord, president of the RPA Laboratories and receiver for the DeForest Radio Company.

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