The AEROVOX Research Worker

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AN A. C. SUPERHETERODYNE

by John F. Rider

Say what you will, the superheterodyne is one of the most dependable receivers available to the radio public. With due consideration to all the tuned radio frequency receivers, the various regenerative detector combinations, the many types of reflex receivers, a well designed, conventional superheterodyne, is one of the best receiving systems.

The greatest fault found with the majority of the superheterodyne receivers which have found their way into the hands of the radio fan has been instability. Sensitivity has never been lacking. Instability, was attributable to two causes:—One, incorrect operation of the receiver, caused by incorrect A, B and C potentials; two, faulty design of equipment.

Herein is described an A. C. superheterodyne utilizing A. C. tubes. The filaments of all the tubes are supplied with raw A. C. and the B potentials are obtained from a B battery eliminator. This B eliminator also supplies the C potential for the output tubes. A bank of small C batteries supplies the grid bias voltages for the tubes preceding the output audio tubes.

This receiver is the culmination of a study of existing types of superheterodynes—the result of a lengthy series of experiments and measurements. It is a modern receiver, utilizing the most modern equipment and designed according to the most modern ideas. The fact that A. C. tubes are used and that the B supply is a B battery eliminator does not impose any limitations upon the receiver. It has been tested under many conditions, and it affords what the radio fan expects of a radio receiver. It is sensitive, but the sensitiveness is not gained at a sacrifice of quality.

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It is a stable receiver, despite its sensitivity, thus overcoming the greatest defect of superhet receivers. It is a convenient receiver, operating from a loop. Two tuning controls are used, one for the loop tuning and the other for the oscillator tuning.

It is a nine tube receiver, employing three stages of audio frequency amplification with push pull output. Two stages of intermediate frequency amplification are employed with perfect satisfaction; ample selectivity and amplification being obtained without sacrificing quality of reproduction. This paper is not intended as a laudatory discourse, but the appelations "good" and "best" have been applied to so many radio receivers that, in lieu of describing the receiver by using one of these words, we prefer to describe its features.

To give credit where credit is due, a good deal of the satisfaction is due to the system preceding the audio amplifier. This mention is made to the many fans who possess excellent audio frequency amplifying systems and who are seeking a reliable, stable and powerful amplifying system to be used with their audio amplifiers. This covers the equipment from the loop binding post to the input terminal of the first audio frequency transformer.

Despite A. C. filament operation on eight tubes and B eliminator B supply, the hum in the output is barely audible. The main front panel carries the oscillator and loop tuning controls, the intermediate frequency amplifier control and the audio amplifier volume control. The filament control for the system is contained in the B battery eliminator.

The drawings accompanying this article divide the receiver into two parts. Figure 2 shows the 1st detector, oscillator, intermediate frequency amplifiers and the second detector. Figure 3 shows the complete audio system. The frequent use of bypass condensers is attributable to the use of A. C. filament and B supply, and goes far to produce a receiver, which will function satisfactorily. As is evident from the drawing, two stages of tuned double impedance amplification are used in conjunction with a stage of push-pull. The tuning of the double impedance stages aids materially in the attainment of an audio frequency operating curve which "matches" the response curve of the average loud speaker.

"A. C. Super"

The use of the push-pull output stage is of further aid to the operation of the complete receiver. It facilitates the elimination of whatever 60 cycle hum might find its way to the output stage. It permits a greater output without the introduction of distortion.

A

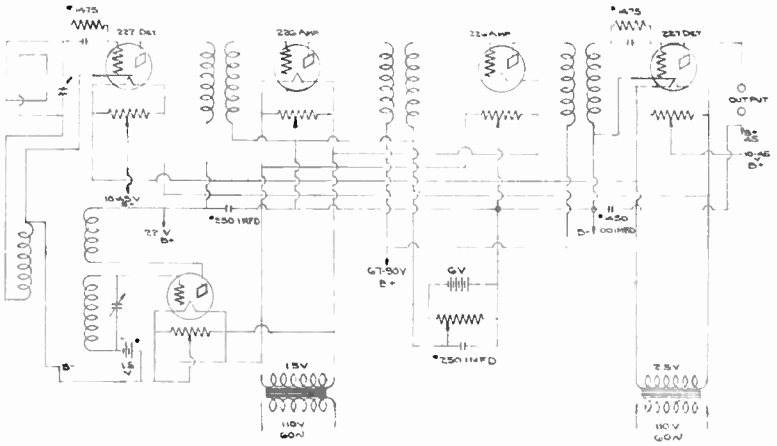


Fig. 1

The following is the list of parts used in the receiver, exclusive of the "B" supply:

- 8 Eby Sockets
- 2 .00035 mfd. variable condensers
- 3 Magnaformer intermediate frequency transformers
- 1 Oscillator Coil
- 1 Push-pull transformer
- 1 Push-pull output impedance
- 2 Tuned double impedance units (1st and 2nd stage type)
- 2 Aerovox No. 600 4 mfd. filter condenser
- 2 Aerovox No. 1450 .00025 mfd. grid condensers
- 2 Aerovox 5 meg. grid leak
- 1 Aerovox No. 1450 .001 mfd. condenser
- 4 Aerovox No. 250 1 mfd. condensers
- 1 400 ohm potentiometer
- 1 0 to 500,000 ohm carbon potentiometer
- 2 No. 227 A C detector tubes
- 2 Aerovox No. 250 1 mfd. bypass condensers
- 5 No. 226 amplifier tubes
- 2 No. 210 amplifier tubes
- 2 Dials
- 1 0 to 50 D C milliameter
- 14 Binding posts as follows: 2, marked output; 2, marked loop; 1, marked C-40; 1, marked B+ 180; 1, marked B+90; 1, marked B+45; 2, marked A C 5 volts; 2, marked A battery; 1, C-4½, 1, marked B battery
- 1 Micarta Black Panel
- 1 Baseboard
- 3 Boxes Acme Celatsite Wire, red, black and yellow
- 1 2.5 Volt transformer tapped for 1.5 volt supply
- 1 7.5 volts 3 ampere transformer

B

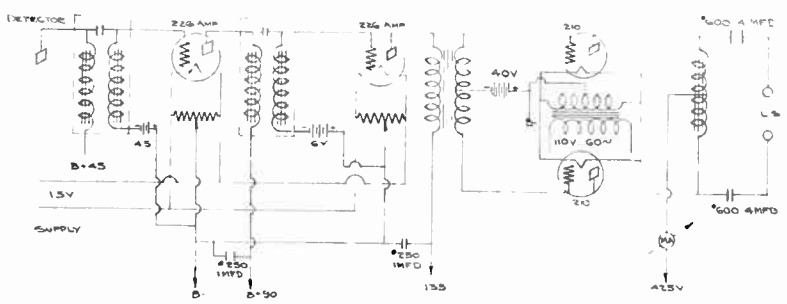
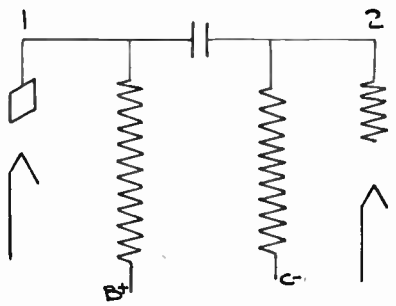


Fig. 2

The Coupling Condenser in Audio Amplifiers

The coupling condenser in a resistance or in an impedance coupled audio amplifier performs two important roles. First, it functions as a coupling medium between the amplifier tubes; second, it functions as the medium that isolates the plate of the preceding tube from the grid of the succeeding tube.

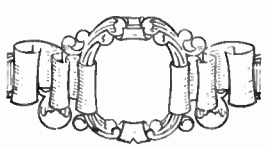


A

This condenser in order to be effective, must perform in a certain manner. First it must prevent the application of the plate voltage of one tube upon the grid of the tube following. This means that it must possess a very high value of insulation resistance. If the insulation resistance value is small, an appreciable portion of the plate voltage of tube No. 1 will leak to the grid of tube No. 2. (See drawings A, B and C). The positive grid bias thus applied will either counteract the regular negative bias or completely nullify it, causing an appreciable amount of distortion. If this leakage of plate potential is great enough, the positive bias will be of sufficient magnitude to permanently injure the tube.

Inasmuch as a high value of insulation resistance is necessary for satisfactory operation, it stands to reason that it is imperative that the original high value be maintained at all times. Hence the design of the coupling condenser must be such as to assure permanency of this value.

(Continued on page 3)



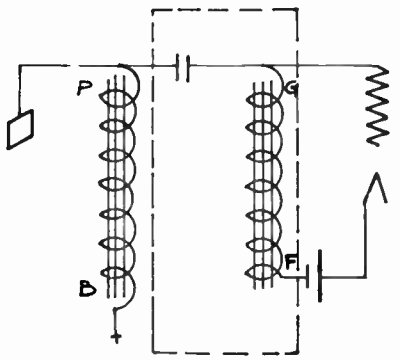
TUNING THE DOUBLE IMPEDANCE AUDIO AMPLIFIER

The Hiler system of tuned double impedance audio amplification possesses three definite characteristics. The first is almost complete elimination of leakage reactance in the units, by virtue of the magnetic isolation of the grid and plate chokes. The second is a desired "bump" or "peak" on the low frequency end of the amplification curve. The third is a flat characteristic on all frequencies higher than the resonant frequency.

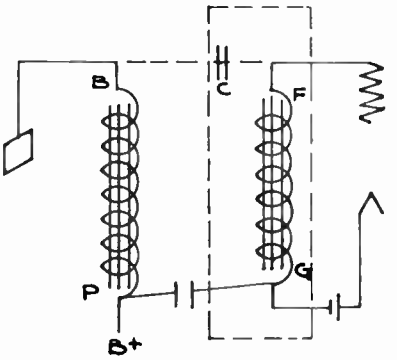
Despite their advantages, we will say little about the first or the third characteristics. The following data pertaining to the second will doubtless prove of interest. The "bump" or "peak" at low frequency is occasioned by the state of resonance between the coupling condenser and the grid choke. Since the value of the grid choke is fixed at 175 henrys in these units, the frequency of resonance is altered or varied by changing the value of the coupling capacity.

By consulting the table shown below one can easily determine the approximate resonant frequency for this value of inductance and various values of coupling capacity, ranging from 1. mfd. to .007 mfd. This table will prove of advantage to fans who are interested in the tuning of this amplifier in the effort to obtain certain response characteristics. In the event that other values of inductance are used as the grid choke, the following formula will permit the determination of the resonant frequency, providing of course, that the value of the grid choke is known.

Coupling Capacity	Frequency
1. mfd.	12.5 cycles
.9	13
.8	14
.7	15
.6	16.5
.5	17.5
.4	19
.3	23
.2	27
.1	37.5
.09	40
.08 mfd.	42 cycles
.07	45
.06	49
.05	54
.04	60
.03	70
.02	85
.01	123
.009	128.5
.008	137
.0007	145



The units within the dotted area comprise the resonant circuit.



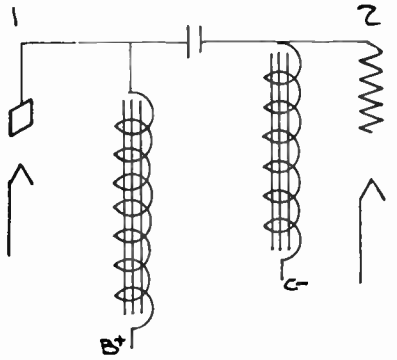
Connection of coupling capacity (C) when unit is reversed.

Frequency equals 1000/ 6.28 x sq. rt. of L x C where L is in henries and C in microfarads. As an example of the function of the table shown let us consider a single stage of tuned double impedance. The coupling capacity within the unit is .03 mfd. What is the resonant frequency? According to the table this frequency is 85 cycles. Let us further suppose that we require a stage which is resonant at 40 cycles. What capacity will be necessary? According to the table this is .09 mfd. If the condenser within the unit is .03 mfd. we must place a .06 mfd. condenser in shunt with the one within the unit.

In case the condenser within the unit resonates the circuit at some freqency lower than is required, the desired state may be obtained by reversing the connections to the unit and adding the correct coupling capacity between the new plate and grid terminals. The data contained in this article is equally adaptable to impedance coupled audio amplifiers which utilize individual plate and grid chokes.

The Coupling Condenser (Continued)

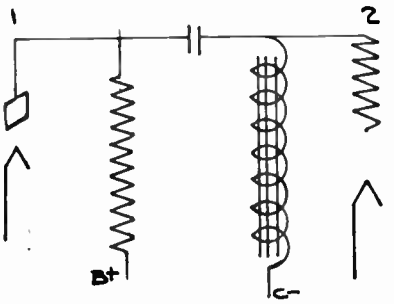
Moisture absorption not only reduces the insulation resistance, but also increases the effective A. C. resistance, or in other words, lowers the efficiency of the amplifier unit. This results in a distinct loss in amplification. Furthermore, the amplifier becomes noisy in operation.



B

Aerovox engineers during experimental work, ascertained that a well designed coupling condenser moulded in Bakelite eliminated all possibility of moisture absorption; that such condensers were effective in operation long after the conventional type of condenser had served its span of life. By designing the condenser for a high value of insulation resistance, and then molding it in Bakelite, the original degree of efficiency is assured. With the above in mind and because similar situations are encountered in other parts of a radio receiver, Aerovox engineers developed two types of fixed condensers which are impervious to moisture. These are the No. 1450 and the No. 250.

The former type of condenser is available in all capacities from .00004 mfd to .02 mfd. The No. 250 condenser also has a high value of insulation resistance and is available in all capacities from 0.1 mfd to 1.0 mfd.



C

PAPER DIELECTRIC CONDENSERS

TYPE 202
INVERTED

All Aerovox filter condensers are non-inductively wound, are manufactured from the best materials obtainable, and are made completely by us under the most modern methods. The dielectric used in all Aerovox condensers has an operating temperature of about 60 to 70 degrees Fahrenheit higher than ordinary paraffin usually used in paper condensers. This insures long life, especially when the condensers are used near transformers, or tubes which develop considerable heat. Individual coating of each section with a moisture proof wax pitch compound of high melting point, coupled with extreme care in manufacturing, results in a condenser of high insulation resistance.

TYPE 200
SHORT

Made for D.C. working voltages of 200-300-400-600-1000.

BY-PASS CONDENSER IN MOULDED BAKELITE CASE

Type 250

The moulded paper condensers of this series are the last word in condensers used for by-pass work. They are non-inductively wound and are sealed in genuine brown bakelite containers. This construction eliminates any possibility of short circuits of the condenser section to the can, and minimizes leakage between terminals.

Made in sizes from .05 mfd to 1 mfd.

MOULDED MICA CONDENSERS

TYPE 1450

TYPE 1745

These condensers are moulded in genuine bakelite in our own plant. By a special process in the manufacture of the condenser element, the capacity is predetermined, and the finished product guaranteed within 10% of marked rating. The bakelite seals and protects the condenser against extreme temperature, moisture, or chemical action. The dielectric is of the finest grade India Ruby Mica, the plates are pure tin foil, and the condenser element is thoroughly impregnated. Compact in size, with special lugs, which allow for screw, eyelet, or soldering assembly. Soldering tabs have split, elongated slots for easy connection to solid or stranded wire.

Made in capacities from .00004 to .02.

PYROHM TAPPED RESISTANCES

Aerovox Tapped Pryohm Resistances are made for all popular circuits and give the user a substantial saving in price, labor, and space.

A large variety of standard values carried in stock for 20 — 40 and 100 Watt ratings.