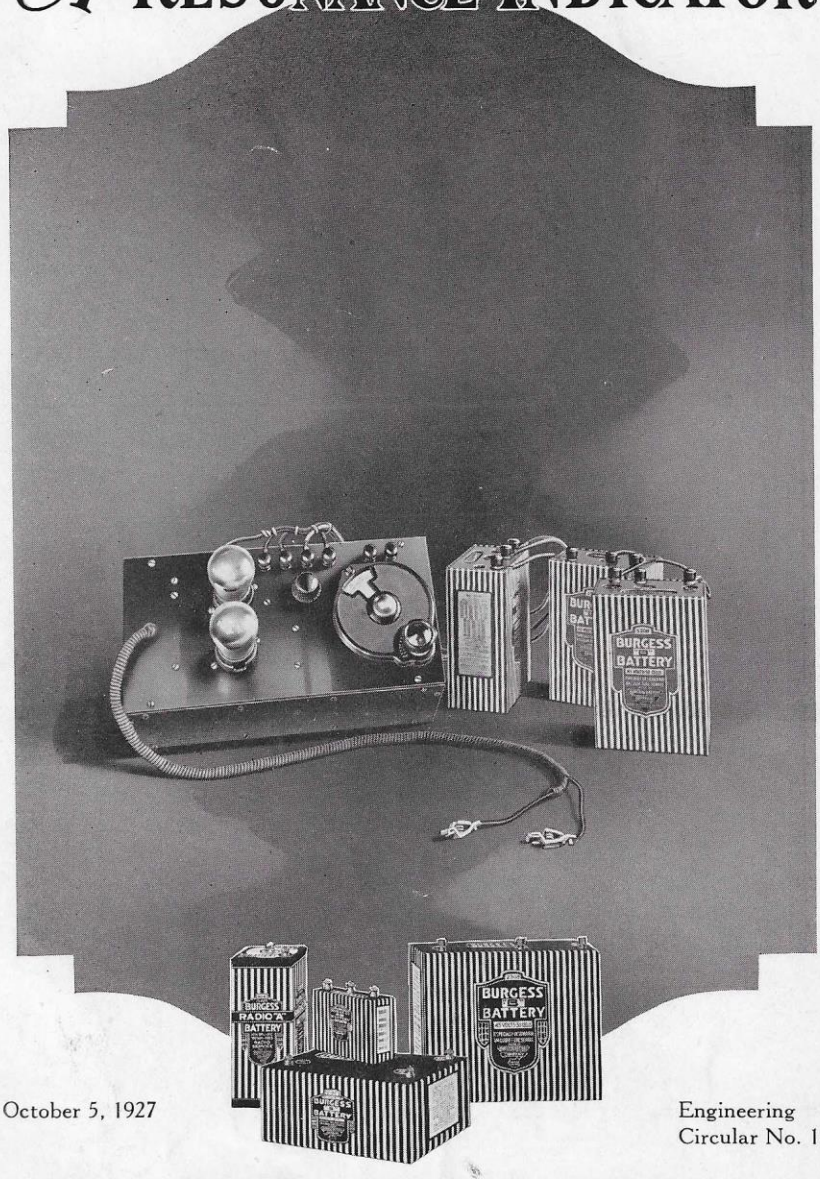
A RESONANCE INDICATOR



October 5, 1927

Engineering
Circular No. 14

BURGESS BATTERY COMPANY

Report No. N-1517
C. F. BURGESS LABORATORIES, INC

for

BURGESS BATTERY COMPANY

ENGINEERS **DRY BATTERIES** MANUFACTURERS
FLASHLIGHT - RADIO - IGNITION - TELEPHONE
GENERAL SALES OFFICE: HARRIS TRUST BLDG., CHICAGO
LABORATORIES AND WORKS:
MADISON, WISCONSIN FREEPORT, ILLINOIS
IN CANADA
PLANTS: NIAGARA FALLS AND WINNIPEG

The description of the apparatus in this Engineering Circular is presented as a contribution to the art and for the benefit of those interested in investigation or experimentation or merchandising. Such apparatus is constructed, experimentally, in the Burgess Radio Laboratory as laboratory equipment, and parts are not manufactured for re-sale by this company.

A RESONANCE INDICATOR

By W. H. Hoffman and F. H. Schnell

For

BURGESS BATTERY COMPANY

Abstract

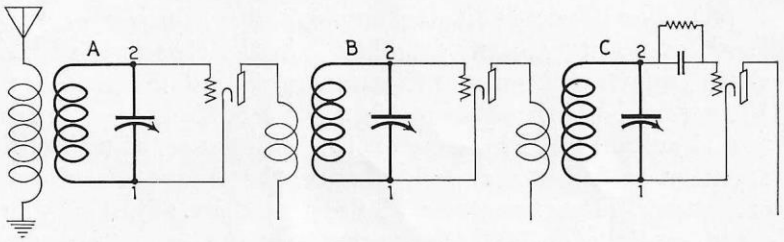
The Resonance Indicator is an instrument for use in comparing the points of resonance of two or more circuits in multi-tuned radio receivers which have a single manual control. In receivers of this design and construction, and where the utmost in sensitivity and selectivity is desired, it is essential that each tuned circuit be in exact resonance with the others. This instrument is invaluable for matching the electrical values of coils, condensers or circuits.

In any radio receiver employing two or more tuned radio circuits, and more especially the radio receiver employing a single manual control for these tuned circuits, resonance in each circuit is essential. Unless each tuned circuit is in exact resonance with the others, there will be a loss in sensitivity and selectivity. Therefore, when exact resonance is obtained, that is, when the electrical values of every tuned circuit match the others, maximum sensitivity and selectivity are obtained. It means simply this: with a coil of known value of inductance and a condenser of known value of capacity and where two or more such combinations are used as tuned circuits in a radio receiver, the condenser usually is the variable means for changing the period of frequency or point of resonance. With a given setting of the condenser or with a given value of capacity in the tuned circuit, the point of resonance is determined and all other tuned circuits should have exactly the same electrical values for maximum efficiency.

To reduce the number of controls of a radio receiver, for the sake of simplicity, there are several types of receivers employing but a single manual control, although the receiver is made up of several tuned circuits. The controls of the tuned circuits are so arranged that by means of mechanical coupling the single manual control operates the several tuned circuits in such a way that resonance is maintained over the entire range of frequency or band of wavelengths—at least that is what is supposed to take place. Many times a receiver does not function as it should simply because there is a very slight difference in the "resonant frequency" of two or more tuned circuits. Properly used, the Resonance Indicator will show what is necessary to correct such receivers, and the accuracy in obtaining the points of resonance is of the order of one-tenth of one per-cent.

The Resonance Indicator is an instrument used for the final adjustment or matching of circuits—it is the means of putting on the final "polish" for the best operation of the receiver. It is best adapted to work of this kind in comparing coils, condensers and circuits. When the electrical values of coils, condensers or circuits are approximately the same, the Resonance Indicator becomes of real service and value in matching them exactly. Because it is not a wave meter, it cannot be used to measure the electrical values of inductance or capacity.

Here is an instrument that should be in the laboratory of every manufacturer of broadcast receivers, unless some other instrument of like purpose is now in use. Too much stress cannot be placed on the necessity of accuracy in aligning condensers in multi-tuned single control receivers. For the jobber and dealer who desires to render service along with his sale of radio receivers, the Resonance Indicator becomes an instrument of decided value. There are times when radio receivers are jarred in shipment or handling which causes a slight shift in one or more condensers. Instead of returning the receiver to the manufacturer, thereby losing considerable time and a possible sale, the jobber and dealer should be equipped to make such slight adjustments as will make the receiver function properly.



THREE TUNED CIRCUITS, A2, B2, AND C2 ARE REPRESENTED BY THE HEAVY LINES. THESE MUST COME INTO RESONANCE AT EXACTLY THE SAME CONDENSER CAPACITY WHEN THE CIRCUITS ARE PROPERLY MATCHED. VERY OFTEN, ONE ADJUSTMENT, IN THE FORM OF A MANUAL CONTROL (DIAL) CHANGES THE VALUES OF THE CONDENSERS SIMULTANEOUSLY.

Construction

The two oscillators in the Resonance Indicator are assembled in an aluminum case, 12″ long, 6″ wide and 4″ deep. The metal case forms a shield which reduces body capacity and the effects of other surrounding objects.

One oscillator is made up of coils and condensers of fixed values, having a natural or constant resonant period of about 360 meters (830 kilocycles). A pair of fixed leads is connected across one of the condensers used in this tuned circuit. It is important that these leads be shielded. A clip is the terminal end of each lead, both of which come out through the top of the case. When these leads are connected to the coil or condenser under test, very tight coupling is obtained. Therefore, a slight change in the circuit under test causes a corresponding change in the oscillator circuit.

The other oscillator is made of a fixed value of inductance in the form of a coil, and a variable tuning condenser. It has a tuning range from 30 to 60 meters (10,000 to 5,000 kilocycles). This circuit acts as a short wave receiver, in addition to its function as an oscillator. When oscillating, it produces the beat note in the ear-phones which are connected in the plate lead. At some settings of the tuning condenser, C4, squeals or howls are produced in the ear-phones. To prevent this squealing or howling, the variable resistor, R2, should be adjusted properly when the squealing or howling will stop.

This Resonance Indicator employs the principle of two tuned oscillating circuits. A change in the constants of one circuit affects the resonant frequency period of the other. If the tuned circuit under test is made a part of one of these two circuits, or tightly coupled to it, a change of value of capacity or inductance will change the frequency of the oscillator. This change may be observed by adjusting the second osciallator until the energy from it sets up an audio beat (in the ear-phones) with the oscillator and circuit under test. If the two oscillators are adjusted to the same frequency or if one is a harmonic of the other, there will be no audible sound because the period of resonance is at "zero beat."

Under this condition of "zero beat" and when a change is made in the circuit under test when the audible signal is produced it may be observed by the use of ear-phones connected in the plate supply of either oscillator.

The wiring diagram, with a list of parts used, is given in figure I. The arrangement of the various parts, as mounted is shown in figures II and III. Figure IV shows the back of panel mounting and the metal shielding case. While the names of the various parts used are given herein, it does not necessarily mean others of like value cannot be used.

In constructing the Resonance Indicator, care should be used in the arrangement of the various parts. Each part should be firmly mounted and all connections should be of sufficiently heavy wire to insure stability, being sure that all joints are well made and soldered.

Operation

Insert one UV 201-A or CX 301-A vacuum tube in each socket. Connect a six volt battery to the filament binding posts marked A+ and A−. Connect "B" batteries, 135 volts between B- and B+135 and tapping off at 45 volts for B+45, using the first block of 45 volts above the B-. Connect a pair of ear-phones between the binding posts marked "phones." By turning the dial of the condenser, C4, beat notes between harmonics of the 360 meter oscillator and the short wave oscillator will be heard at every few degrees on the dial. If the beat notes are not heard or if there is a squealing or howling, adjust resistance, R2, until the beat is

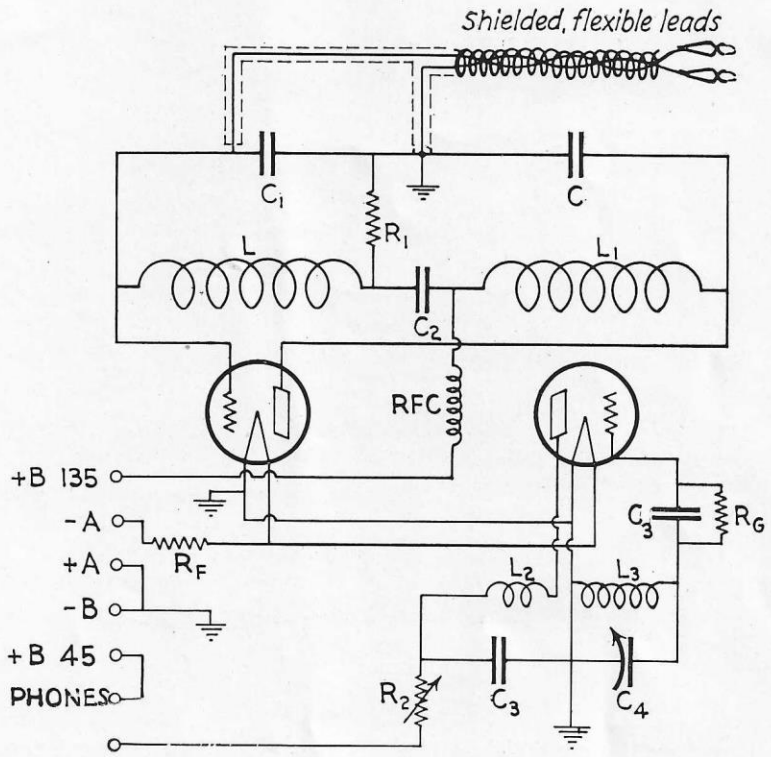


FIGURE I.

C	Fixed mica condenser 0.001 mfd. (Micadon Type 640).
C1	Fixed mica condenser 0.0005 mfd. (Micadon Type 601).
C2	Fixed mica condenser 0.01 mfd. (Micadon Type 640).
C3	Fixed mica condenser 0.00025 mfd. (Micadon Types 601 and 640).
C4	Variable air condenser 0.00015 mfd. (Cardwell Type 167-E).
L & L1	32 turns each No. 22 D. C. C. wire wound on tube 2" in diameter, both coils wound on same tube with ¼" space between coils.
L3	9 turns No. 22 D. C. C. wire wound on tube 2" in diameter.
L2	4 turns No. 22 D. C. C. wire wound on same tube with L3, spaced $\frac{3}{16}$" from L3.
R1	Grid leak resistor 10,000 ohms (Bradley Unit 10R).
Rg	Grid leak resistor 8 megohms (Lynch).
Rf	Filament resistor (Lynch Equalizer, Type 2).
RFC	200 turns No. 30 D. S. C. wire wound on spool 1¼" in diameter.
R2	Variable resistor 10,000 to 100,000 ohms (Bradley-ohm E10).
	Bremer Tully Universal sockets.
	National type "C" vernier dial.

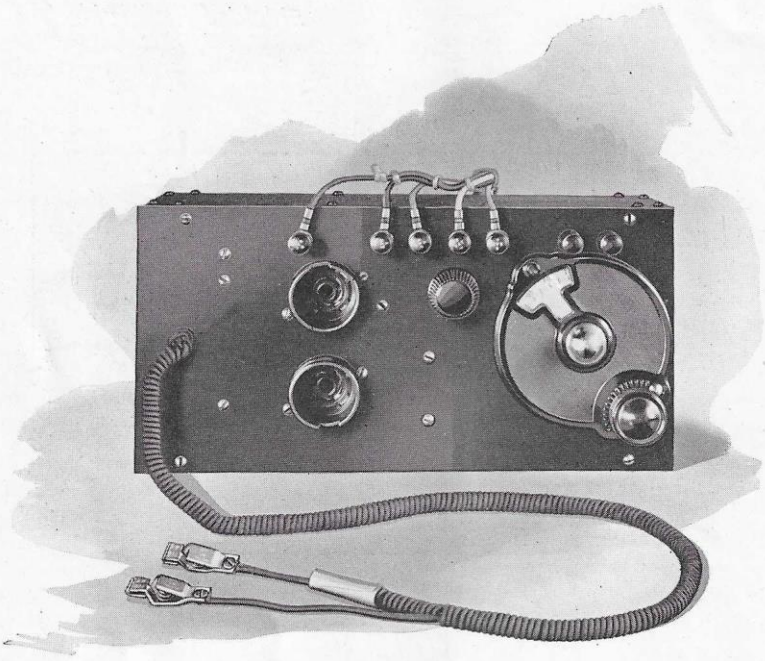


FIGURE II

heard or the squealing or howling stops. Then connect the grounded lead to the rotary plates of the condenser and the other lead to the fixed or stationery plates. Next, set the receiver dial at the point to be checked. Then adjust the tuning dial of the Resonance Indicator until a beat note is heard in the ear-phones; carefully adjust to zero beat, when no signal will be heard. Without making any further change in the Resonance Indicator, remove the clips from the first tuned circuit on which the point of resonance has been found and clip on to the next tuned circuit. Then turn the dial of the receiver very carefully until the point of zero beat against the Resonance Indicator is again obtained. This zero beat should be obtained at exactly the same dial reading as in the first tuned circuit, otherwise these two circuits are not matched and best results cannot be obtained until they are matched. If there are more than two tuned circuits, each one should be tested in the same manner. To obtain best results and greater accuracy, a number of tests should be made, at different points on the dial.

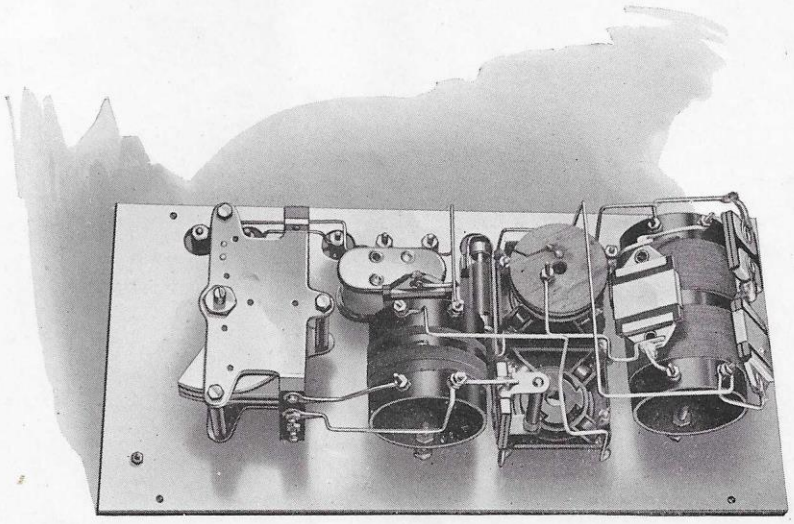


FIGURE III

When comparisons between a number of circuits are being made, it is important that the coupling between the circuit under test and the Resonance Indicator shall be the same in each case. When the circuits under test form the tuned circuits of a radio receiver (tuned radio frequency, etc.) the tests should be made without disturbing the wiring or arrangement of the associated parts in the receiver, if possible. Connections across condensers or coils of the tuned circuits by means of clips is one of the best ways of securing the same degree of coupling in each instance, being sure each clip is in the same relative position.

If the circuits are not properly matched as indicated by tests above, the Resonance Indicator can then be used to determine whether the trouble is in the condensers or the coils of the tuned circuit. To make this test it will be necessary to disconnect the condensers and coils from other associated parts in the receiver. After disconnecting the condensers, they can be tested in the same manner as the tuned circuits outlined above.

However, in testing the inductances, it will be necessary to vary the tuning dial of the Resonance Indicator while the clips are attached to the two ends of the coil under test.

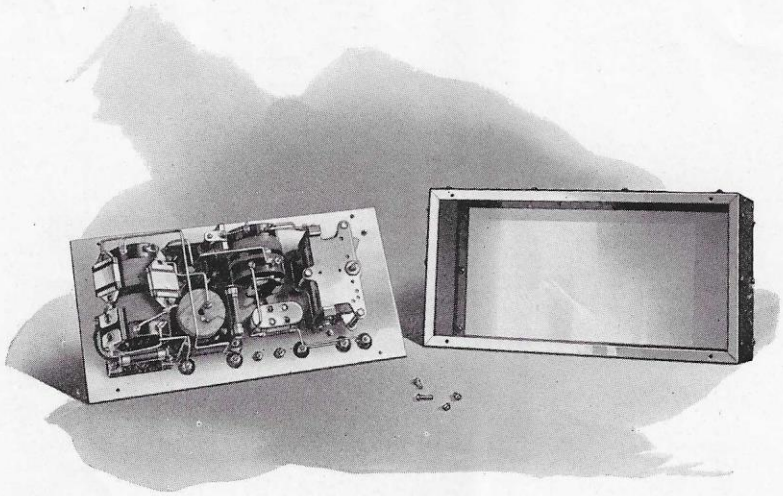
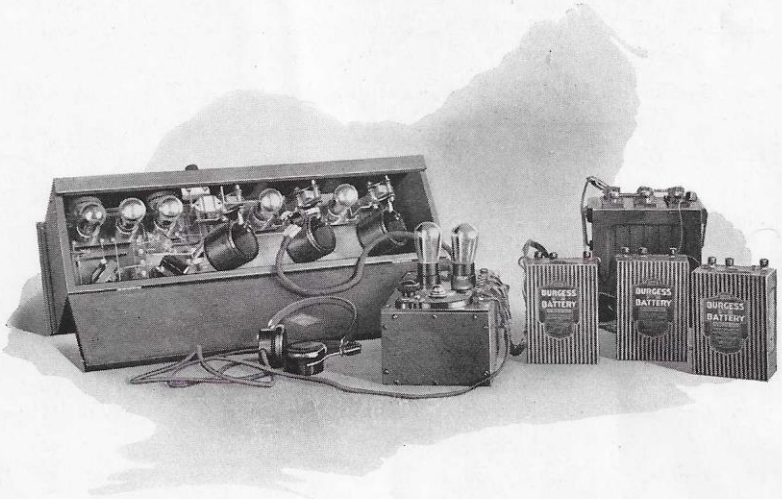


FIGURE IV

The point of zero beat, for each coil, should be at the same dial reading of the Resonance Indicator. Unless this condition is obtained, the coils are unmatched. To correct the coil it will be necessary either to remove or add wire as the case may be. If the coils are of equal value of inductance, the zero beat will be found at exactly the same dial setting on the Resonance Indicator.

When there is a great difference in the electrical values of the coils, care should be taken that the same harmonic is used for the measurement of each coil. In moving the Resonance Indicator dial, a different harmonic will be found every eight or ten degrees. It is only intended for matching coils when their electrical values are approximately the same.



THE RESONANCE INDICATOR SET UP, COMPLETE WITH BATTERIES, SHOWING POSITION OF CLIPS FOR MEASURING A TUNED CIRCUIT.

BURGESS BATTERY COMPANY ENGINEERING CIRCULARS

No. 1—How Long will My "B" Batteries Last—1924. (Out of print.)

No. 2—Small Dry Cell "B" Batteries for Portable Receiving Sets—1924. (Out of print.)

No. 3—Burgess Dry Cell Batteries with the Mac Millan Expedition—1924. (Out of print.)

No. 4—"B" Battery Service Hours—April 20, 1925. (Revision of No. 1—Out of print.)

No. 5—Test Capacity of Unused "B" Batteries of the MacMillan Expedition—May 1, 1925. (Out of print.)

No. 6—Dry Cell Batteries for Plate Voltage of Radio Transmitting Sets—June 26, 1925. (Out of print.)

No. 7—Short Wave Radio Receiver No. III of 9XH—9EK—July 8, 1925.—Reprinted Sept. 15, 1926—May 10, 1927.

No. 8—Baby Radio Transmitter "D" of 9XH—9EK—November 25, 1925.—Reprinted Feb. 15, 1927.

No. 9—Dry-Cell Battery Capacities for Radio Transmitting—January 20, 1926.—Reprinted Oct. 27, 1926—April 20, 1927.

No. 10—Arctic Radio Equipment with Battery Supply.—May 10, 1926—Reprinted Oct. 27, 1926—Feb. 14, 1927.

No. 11—Estimating "B" Battery Service Life.—(Revision of No. 4.) Sept. 2, 1926.—Reprinted May 1, 1927.

No. 12—A High Frequency Driver—Short Wave Wavemeters—September 2, 1926.—Reprinted Feb. 15, 1927.

No. 13—High Frequency Radio Receiver No. VI, of 9XH-9EK,—April 12, 1927.

No. 14—A Resonance Indicator—October 5, 1927.