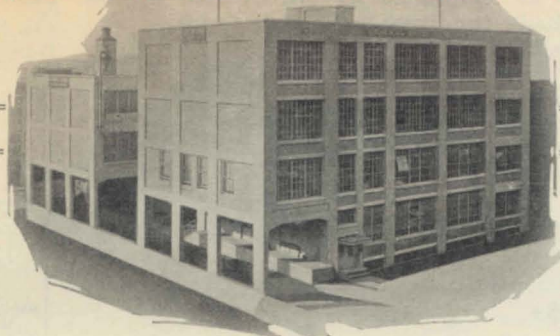


The GENERAL RADIO EXPERIMENTER

VOL. 2 NO. 1

JUNE 1927



IMPORTANT NOTICE

This issue of the "Experimenter" is the First Anniversary Number. Just a year ago Volume I, Number 1 was published and a copy sent to every name on our mailing list.

With the first issue of the "Experimenter" we inclosed a post card to be returned to us properly filled out if future copies of the "Experimenter" were desired. So many cards were returned and new names added that today our mailing list is more than double what it was in June 1926.

We are about to make up our new mailing list for another year. **THIS LIST WILL BE MADE UP FROM RETURNED POST CARDS ONLY.** If you wish your complimentary subscription for the "Experimenter" to continue, please return the inclosed post card promptly, *regardless of whether you have already sent us a card or written us previously.*

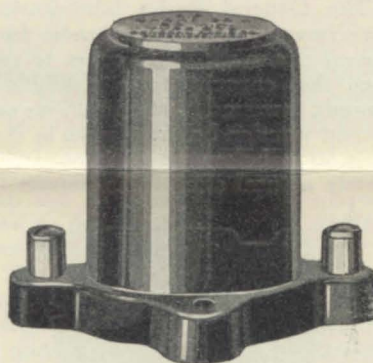
Owing to such a large list, only a few extra copies are available and it will be *impossible to obtain back copies later than a month after issue.*

The Design and Use of the Radio Frequency Choke

By HORATIO W. LAMSON, Engineering Department

The amount of radio frequency amplification which can be employed successfully in the design of a broadcast receiver is very largely limited by the regenerative or "feed-back" tendency of such an amplifier. If the arrangement of the circuits is such that there exists even a small amount of inductive, capacitive, or resistance coupling between the first and succeeding stages a certain portion of the energy from the last tube may be fed back onto the grids of the previous tubes, giving rise to the phenomenon of regeneration. A limited amount of regeneration is beneficial as it effectively reduces the resistance losses of the inter-tube coupling elements. It is well known, however, that an excess of regeneration will cause the whole amplifier system to go into a state of sustained oscillation, which is fatal to its proper operation.

This tendency towards self-oscillation may be combated in a number of ways, one of the most important being the so-called process of "neutralization," whereby a certain amount of energy is fed backward



TYPE 379
Radio Frequency Choke

through the amplifier but with a reversal of phase so that it tends to oppose the natural regeneration of the circuits. This is the principle employed in the popular neutrodyne receivers.

Excessive regeneration may also be prevented to a certain extent by shielding the individual stages, by controlling the grid bias of the amplifier tubes, or by the deliberate insertion of resistance into the individual tube circuits.

Another method of accomplishing the same result consists of more effectively separating the radio frequency circuits of the tubes from each other. The plate circuits of these tubes are almost invariably fed from the same B battery. This battery has necessarily a certain amount of resistance, depending upon its form and condition, which, being common to the plate circuits of the tubes, affords a source of resistance coupling between them if the radio frequency currents are allowed to pass through this battery. When, however, the individual plate circuits are supplied with radio frequency chokes, which prohibit the radio frequency currents from traversing the common B battery, this resistance coupling with its regenerative tendencies can be reduced considerably.

Some of the methods for accomplishing these results are shown on the following pages. The radio frequency choke marked "379" consists merely of a small inductance coil which has a very large impedance at radio frequencies so that it effectively



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blocks the passage of radio frequency currents. At the same time, its resistance to the steady emission current of the tube is low, so that but little B battery voltage is wasted across it, while its impedance at audio frequencies is sufficiently small to offer no appreciable hindrance to voice frequency currents.

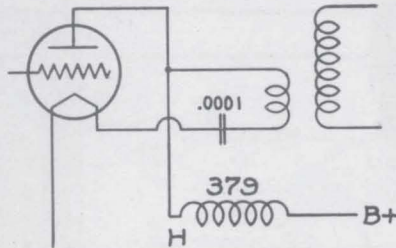


Fig. 1

Figure 1 shows the use of such a choke in the plate circuit of a radio frequency amplifier tube. On account of the choke the high frequency currents in the plate circuit are forced to pass through the primary of the transformer and thence through the condenser directly back to the filament of the tube, while the emission current of the tube passes through the choke to the B battery. The condenser, which offers no great impedance to the radio frequency is, of course, necessary to prevent the B battery from short circuiting to the filament. Figure 2

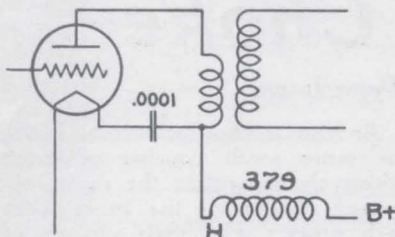


Fig. 2

shows essentially the same circuit except that here the emission current passes through the primary of the transformer.

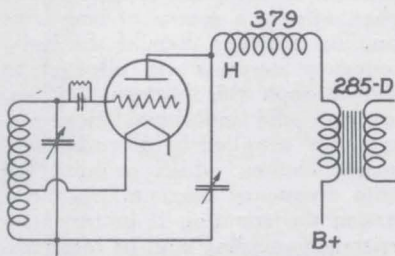


Fig. 3

Figure 3 illustrates how the choke may be placed in the circuit of a regenerative detector to keep the radio frequency currents out of the audio amplifier and the B battery. The emission current of the tube,

together with the rectified audio frequency currents, pass readily through the choke to the primary of the audio frequency transformer. Regeneration of the detector is, in this case, controlled by the variable by-pass condenser in the plate circuit.

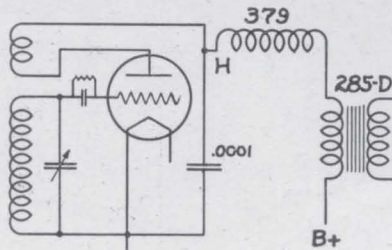


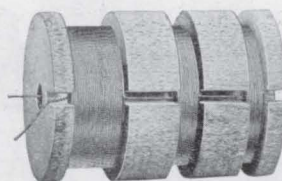
Fig. 4

Figure 4, likewise, shows the use of the choke in the plate circuit of a detector of the familiar tickler coil type.

Many other uses of a radio frequency chokes will suggest themselves to the experimenter.

The construction of a successful radio frequency choke consists of more than merely winding a coil to a sufficient inductance so that it will offer an effective barrier to radio frequency currents. The coil must also be wound in such a manner that its distributed capacity will be very low, else the capacity between the two end portions of the windings may be sufficient to pass the radio frequency currents around the inductive impedance and defeat the whole purpose of the choke.

The General Radio laboratories have recently developed a radio frequency choke which, in order to reduce this capacity to a negligible amount, is wound in three sections on a small wooden bobbin shown in the illustration below which is approximately natural size. This bobbin is



then sealed into a moulded bakelite case and the coil extremities brought out to two terminal posts as shown in the illustration on the front page. The winding sections are respectively $\frac{5}{16}$, $\frac{1}{8}$ and $\frac{1}{16}$ inches in width. The end of the winding in the smallest section is brought to the terminal marked H, and this terminal should be connected to the "high potential" or radio frequency side of the circuits as indicated on the diagrams.

In order to find the best relation between inductance and distributed capacity a number of identical bobbins were wound with different sizes of wire and tested for distributed capacity in the following manner: An oscillator circuit of the Hartley type was set up as shown in Figure

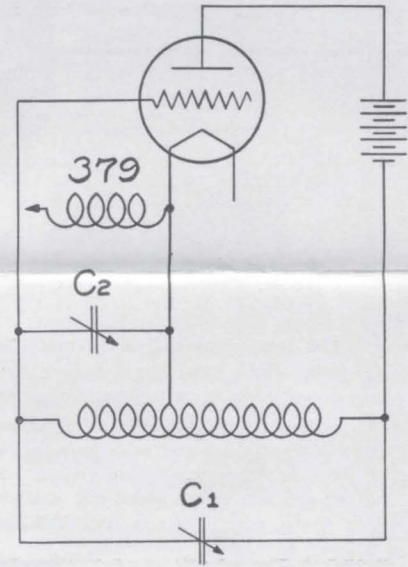


Fig. 5

5. A small calibrated micro-condenser C_2 of 8 MMF capacity was connected between the grid and filament. This had a slight effect upon the tuning of the oscillator circuit. The oscillator was first accurately tuned to a given wavelength with the condenser C_1 by adjusting for zero heterodyne beats against a separate crystal-controlled oscillator not shown. The choke under test was then connected between the grid and filament in parallel with C_2 . If now the choke coil had an effective positive capacity at the frequency in question it would, of course, raise the wavelength of the oscillator slightly. The oscillator would then be retuned to the original wavelength by reducing the variable condenser C_2 by an amount equal to the effective capacity of the radio frequency choke. From the calibration of C_2 the capacity of the choke could thus be measured directly. On certain occasions it was found that the circuit could be retuned only by increasing the value of C_2 after the choke was added, indicating that the choke had a negative capacity effect.

The results of these tests at various wavelengths are shown in the following table which lists the effective capacity in micro-microfarads of several samples at different wavelengths.



RADIO FREQUENCY CHOKES.

Wavelength	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
20	NG	3.5	NG	NG	3.2	1.9	2.4	NG	NG
40	3.1	3.4	1.7	1.8	3.1	2.3	2.5	4.2	2.5
90	.6	2.9	3.0	3.0	3.2	-2.9	3.0	4.3	3.6
160	1.9	3.9	-6.6	-6.0	4.0	1.0	1.6	4.2	3.7
320	8.4	.6	2.9	3.1	1.0	8.8	3.7	4.0	3.6
640	-2.3	2.4	-10.8	-12.0	3.5	-2.2	2.9	3.2	3.2
L=M.H.	14.5	152	7.8	7.9	153	15.3	64	92	243
Winding	1500T No. 36SCC	4800T No. 36 En	1075T No. 34SCC	1075T No. 34SCC	4800T No. 36 En	1500T No. 36SCC	3000T No. 34 En		

A winding identical with No. 7 has been chosen as the General Radio R. F. choke Type 379. This has an approximate inductance of sixty millihenrys and, as seen from the table, is an effective choke for all wavelengths from twenty meters to considerably above the upper limit of the broadcast band. It may, therefore, be used to advantage in short wave receivers as well as broadcast receivers. The resistance of this instrument is about 140 ohms and its current rating 90 milliamperes, corresponding to a DC power rating of $1\frac{1}{8}$ watts. This current rating is for continuous use. For intermittent use, however, as for instance in a transmitter which is being keyed, the rating may be doubled with safety. The choke may, therefore, be used with success in the construction of low power amateur transmitting sets where the above ratings are not exceeded.

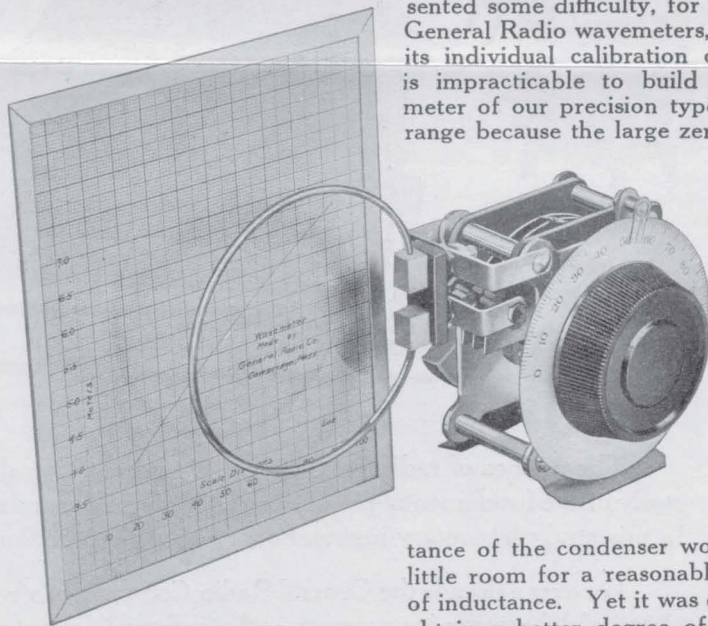
Realizing the demand for a radio frequency choke of higher current rating for use in amateur short wave transmitters, a lower resistance coil has been developed, wound on the same bobbin and incased in the same moulded form. The experimental data, obtained in a manner identical to that described above, are given in the following table:

Wave Length	No. 10	No. 11	No. 12
20	3	2.1	2
40	1	2.9	2.2
80	0.5	0.8	3.0
100	NG	3	0.9
160	3.4	-1.1	NG
Inductance	2.15	8.2	4.27
MH	950 T	1830 T	1340 T
Winding	No. 28 SCC	No. 32 SCC	No. 30 SCC

The winding No. 11, which further careful study showed to have no "dead spots" between 15 and 200 meters, was chosen as the standard Type 379-T choke. This type has an inductance of 8 millihenrys, a resistance of 34 ohms, a continuous current rating of 200 milliamperes, corresponding to a power rating of 1.4 watts.

Either type of choke has a list price of \$2.00.

The Type 458 5-Meter Wavemeter



presented some difficulty, for like other General Radio wavemeters, each has its individual calibration chart. It is impracticable to build a wavemeter of our precision type for this range because the large zero capaci-

The recent developments in transmission at 5 meters (60,000 k c.) have made it desirable to have an accurate wavemeter covering that wavelength. Even when schedules were arranged, it was often the case that the transmitter and receiver were so far out of tune that results were impossible.

The Type 458 wavemeter is supplied unmounted, having only brackets to support the condenser in an upright position. The condenser is of the usual soldered plate, metal end-plate type, having a maximum capacitance of 50 MMF. The importance of soldered plates at this high frequency can hardly be over-emphasized. The coil consists of a single turn of $\frac{1}{8}$ " copper tubing, and is connected to the condenser by means of the convenient General Radio plugs. The coil is silver plated. A four-inch dial and indicator completes the wavemeter. It is found that the metal end-plates so completely shield the condenser that hand capacity is not troublesome.

The calibration of this meter pre-

sent some difficulty, for like other General Radio wavemeters, each has its individual calibration chart. It is impracticable to build a wavemeter of our precision type for this range because the large zero capacitance of the condenser would leave little room for a reasonable amount of inductance. Yet it was desired to obtain a better degree of accuracy than would be possible if another Type 458 wavemeter were used as a standard. This difficulty was overcome by first roughly calibrating a 458 by the usual harmonic and extrapolation method. Then an oscillator was carefully set with a Precision Wavemeter to 20 meters, which is well within the precision range. Another oscillator was then adjusted to approximately 5 meters by the roughly calibrated 458. When the second oscillator was shifted slightly, a beat note was found, and zero beats gave an accurate setting of 5 meters by the roughly calibrated 458. Several points taken by this method gave an accurate calibration curve. All Type 458 Wavemeters are now calibrated against a Precision Standard.

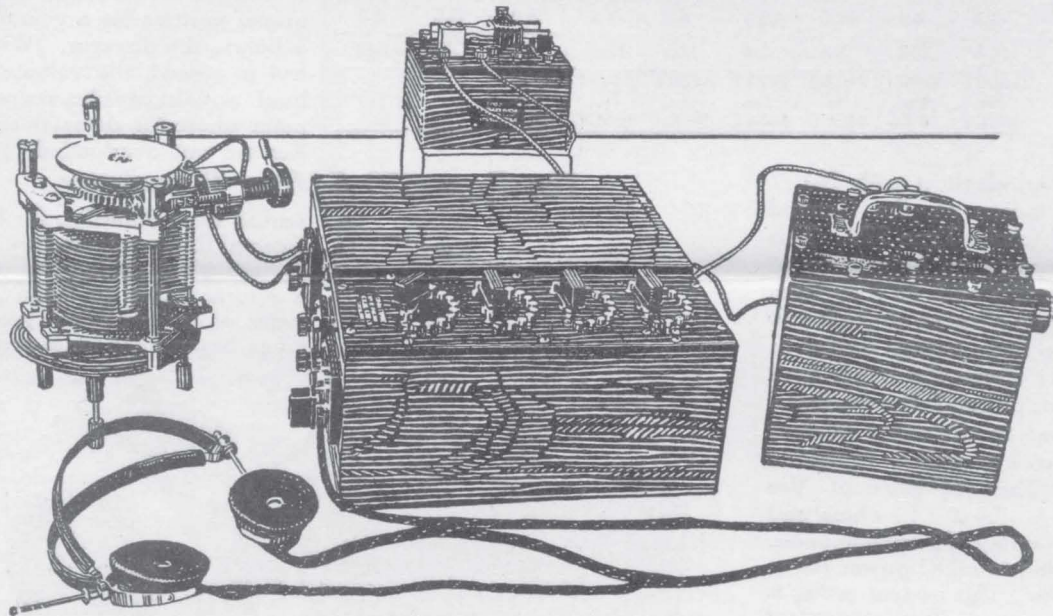
The Type 458 5-meter wavemeter is obtainable from the General Radio factory only. It will be delivered post paid and insured anywhere in the United States upon receipt of \$8.00, or to any foreign country upon receipt of \$9.00.





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